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Introduction

Every winter, the ice sheet around Antarctica increases from about $4x10^6$ km^2 up to $20x10^6$ km^2 by freezing of the Southern Ocean (MAYKUT 1985). Sea ice is, however, not a compact structure but interlaced with brine-filled pores and channels about 200 µm to some cm in diameter (WEISSENBERGER et al. 1992).

This internal system is colonized by an abundant community of bacteria, fungi, algae (mainly diatoms), protozoans and small metazoans (Fig. 2; e.g. GARRISON 1991; GARRISON & BUCK 1989b, 1991; GROSSMANN & DIECKMANN 1994; HORNER 1985; KOTTMEIER & SULLIVAN 1987; PALMISANO & GARRISON 1993; PALMISANO & SULLIVAN 1983; SPINDLER 1994; SPINDLER & DIECKMANN 1991; SPINDLER et al. 1990; STOECKER et al. 1990, 1993). Already early Antarctic pioneers noticed the distinctly brownish coloured layer in sea ice which marks the intensively populated zone (HOOKER 1847). A more detailed biological survey started only recently and revealed that the ice biota is of global significance (LEGENDRE et al. 1992). With very few exceptions (AGATHA et al. 1990, 1993; CORLISS & SNYDER 1986; FENCHEL & LEE 1972; PETZ 1994, 1995; WILBERT et al. 1993), the composition of the ice ciliate fauna has not been investigated before and is thus only very incompletely known.

A comprehensive taxonomic study of sea ice and planktonic ciliates was thus performed in situ utilizing detailed in vivo observations. In addition, the colonization of sea ice was investigated in the austral autumn. To provide a sound basis for the identification of Antarctic sea ice ciliates by non-specialists, all the species found are described and illustrated in detail.

Material and methods

Sea ice samples were collected using an ice-coring auger of 7.5 cm or 10 cm diameter, then cut in 10-cm-sections, melted overnight at +1°C in about the same volume of sterile filtered seawater to relieve osmotic stress for the organisms and subsequently immediately investigated using a cooled microscope. Grease ice and very young pancake ice was obtained using an ice basket. For details on ice formation and types see, e.g., LANGE et al. (1989), MAYKUT (1985).

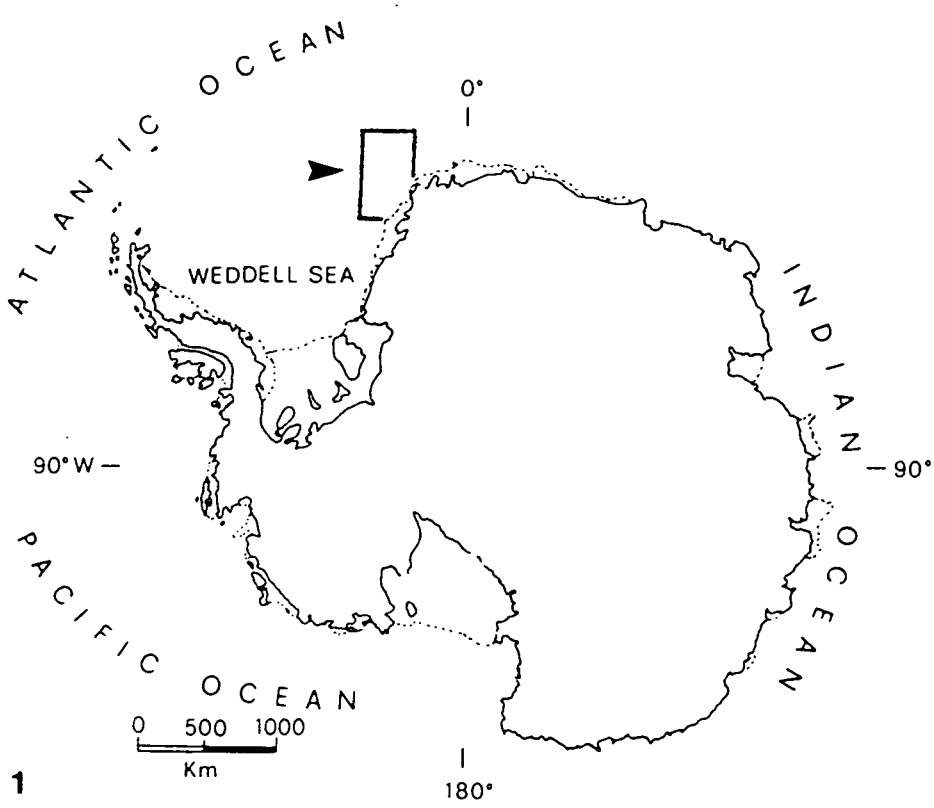


Fig. 1: Study area (arrowhead).

Active ciliate numbers were estimated using a direct live counting method (detailed description in LÜFTENEGGER et al. 1988): 8 subsamples á 0.25 ml were examined from each melted sample; ciliate abundances are already corrected for dilution. Plankton catches were made with an Apstein-net (mesh size 20 µm) from 0-20 m depth for qualitative, and with a bottle sampler (bio-rosette) from 0, 10 and 50 m for quantitative studies (4 x 0.25 ml per sample). The MANN-WHITNEY U-test was computed following KÖHLER et al. (1984).

Field material and raw cultures were used for morphologic studies. WILBERT's (1975) protargol silver impregnation technique was applied to reveal the infraciliature, the CHATTON-LWOFF silver nitrate method according to CORLISS (1953) was used to stain the silverline system. Preparation for scanning electron microscopy follows the FOISSNER (1991) protocol. Living individuals were measured at X 100 magnification; counts and measurements on stained specimens were performed at X 400 and X 1000 magnification (1 measuring unit = 3.1 µm and 1.2 µm, respectively). All

morphometric data are based on randomly selected, protargol impregnated and mounted non-dividers; statistics were calculated following SOKAL & ROHLF (1981); abbreviations in the tables: CV, coefficient of variation in %; M, median; Max, maximum; Min, minimum; SD, standard deviation; SE, standard error of arithmetic mean; $\bar{x}$, arithmetic mean.

Morphologic terminology follows mainly BORROR (1972a), CORLISS (1979), DEROUX (1970, 1976b), FOISSNER (1984a), KAHL (1930, 1931, 1932) and WALLENGREN (1900) and the systematic classification CORLISS (1979). Impregnated cells were drawn using a camera lucida. Unless otherwise noted, biomass was estimated from biovolume using in vivo dimensions, i.e. 1 μm^3 = 1 pg protoplasm (FINLAY 1982), and simple geometric bodies.

The investigation was performed during the cruise ANT X/3 of the RV „Polarstern" in the eastern Weddell Sea in April and May 1992 (Fig. 1).

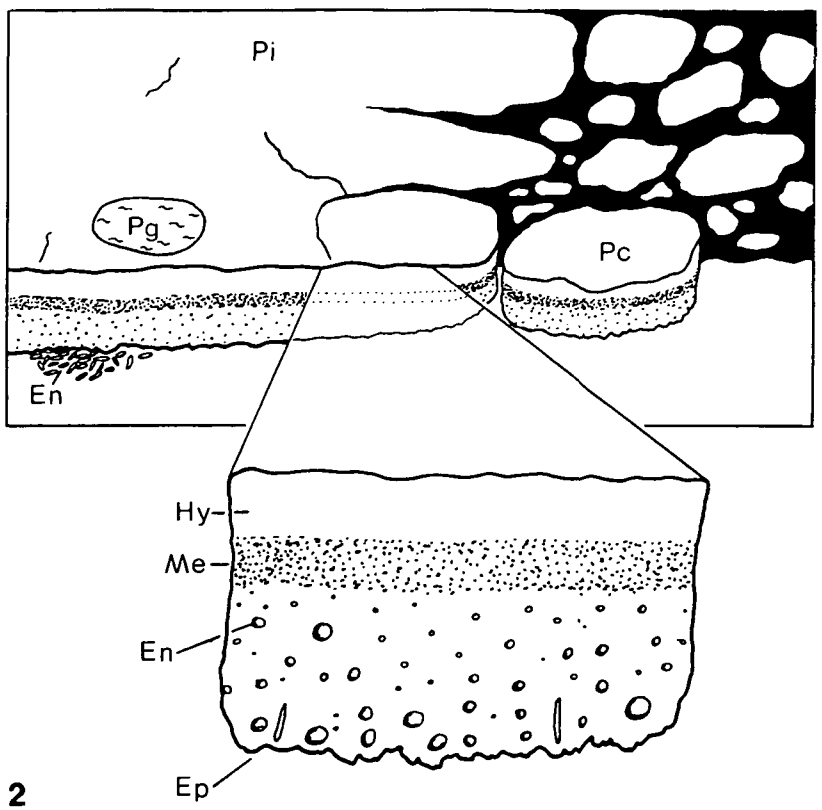


Fig. 2: Sea ice biotopes (pagial). En, endopagial; Ep, epipagial; Hy, hyperpagial; Me, metapagial; Pc, pancake; Pg, pagiotelma; Pi, drifting pack ice.

Type material

As noted, holotype, paratype and neotype slides as well as preparations of other species for reference have been deposited in the collection of microscope slides of the Oberösterreichische Landesmuseum (LI), A-4040 Linz, Austria.

Neotypes have been designated for *Codonellopsis glacialis*, *Condylostoma granulosum*, *Cymatocylis calyciformis*, *C. convallaria*, *Didinium gargantua*, *Lacrymaria lagenula*, *Loxophyllum rostratum*, *Strombidium antarcticum*, *S. crassulum*, *S. emergens* and *Uronychia transfuga*.

In the course of this study, types of *Euplotes algivorus* and original slides of *Cohnilembus grassei*, *Spiroprorodon garrisoni*, *Strombidium rhyticollare* and *Tachysoma parvulum* were investigated; types of the latter species have not yet been deposited. The type slides of *Spiroprorodon glacialis* are apparently lost (see below).

Results and discussion

Colonization of sea ice

Only few active ciliates were found in the water column with the quantitative sampling procedure (Table 1). Grease ice (initial stage of freezing) and very young pancake ice (next stage of sea ice formation) also contained no or very few active ciliates, usually planktonic species (Tables 1, 2). Considerably higher numbers (up to 31 173 active ind./l melted ice) were found in slightly older (max. 50 days; GRADINGER et al. 1993), about 40-cm-thick pancake ice (Table 1). This suggests that a rapid colonization or fast population growth of ciliates occurs within the ice. Growth in sea ice samples is indicated by the regular observation of dividers of, e.g., strombidiids, thigmokeronopsids, *Aspidisca antarctica* and *Uronychia transfuga*.

In these older pancakes, highest ciliate densities occurred near the bottom, i.e. in 20-30 cm depth, and decreased towards the top (Fig. 3). Active ciliate abundances are, however, only distinctly different between 0-10 and 30-40 cm ($p < 0.05$) and between 0-10 and 20-30 cm ($p < 0.1$) using the U-test.

Table 1. Abundance and biomass of active ciliates ($\hat{x}$) in various types of sea ice (counts from different segments pooled for each core) and in the plankton (ind./l).

Sea ice type	Ice thickness (cm)	Abundance (ind./l melted ice)	Biomass (mg/l melted ice)
Grease ice (n = 5)	<1	200[1]	0.005
Pancake ice, young (n = 1)	>1	0	0.00
Pancake ice, older (n = 29)	40	5 347[1,2]	0.24
Multiyear ice (n = 5)	>100	37 490[2]	2.21
Plankton (n = 3)	0-50 m	333	0.0002

[1] Different at $p < 0.05$, U-test.

[2] Different at $p < 0.01$, U-test.

Multiyear ice contained even higher ciliate numbers, viz. up to 57 000 active ind./l melted ice, equalling 3.46 mg biomass/l or 370 µg carbon/l (Table 1). This value is of the same order of magnitude as that reported for other ice microfauna (GARRISON & BUCK 1989b), showing that ciliates make up an essential part of the sea ice community.

These ciliate abundances are generally distinctly higher than previously found (GARRISON & BUCK 1991; SPINDLER et al. 1990; STOECKER et al. 1990, 1993). This is mainly a methodological problem. We enumerated living ciliates in freshly-collected samples whereas the above mentioned authors used preserved material. Ciliates and other protists are rather delicate, thus fixation often leads to a considerable loss of organisms, i.e. many burst (unpublished observations; GARRISON & BUCK 1986; STOECKER et al. 1994).

The ciliate community of the pelagial is distinct from that of sea ice. *Gymnozoum viviparum* and small *Strombidium* spp. (not determined to species level here) generally dominate within ice whereas tintinnids (usually *Codonellopsis glacialis*, *Cymatocylis convallaria*) are most abundant in the pelagial. Previous findings of tintinnids in sea ice (e.g. STOECKER et al. 1993; WASIK & MIKOLAJCZYK 1990) are very likely only records of empty loricae, i.e. not living ciliates (cf. WASIK &

MIKOLAJCZYK 1990). With very few exceptions, ciliates occurring in the plankton were not encountered in sea ice and vice versa (Table 2).

The majority of the Antarctic sea ice is seasonal (SPINDLER 1994). It thus has to be colonized in autumn. Most of the ice-dwelling ciliates belong to benthic genera, e.g. amphileptids, cyrtophorids, hypotrichs (Table 2). This suggests that the ice is colonized from the sea floor as in other groups, e.g. part of the meiofauna, diatoms (CAREY & MONTAGNA 1982; SPINDLER & DIECKMANN 1991). The incorporation mechanism into sea ice is, however, still uncertain (for hypotheses see CAREY & MONTAGNA 1982; SPINDLER 1994). Resting cysts, which are formed by many ciliates, might play a role in this process.

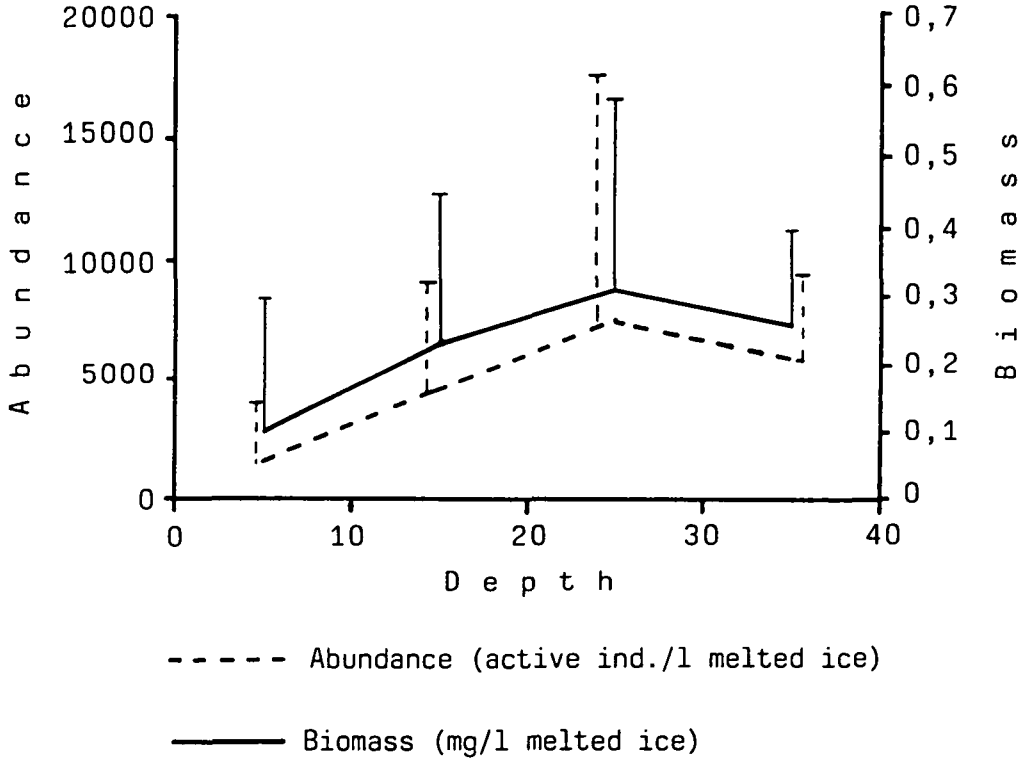


Fig. 3: Vertical distribution of abundance and biomass (+SD) of active ciliates in 40-cm-thick pancake sea ice (n = 8).

Methodological considerations

During ice core melting, the highly saline brine is strongly diluted with freshwater from the ice, which imposes a considerable osmotic stress on the organisms (GARRISON & BUCK 1986). Diluted sea water of different salinities, i.e. normal (about 34‰) and high (60‰, commercial aquarium salt added), was thus used. The higher salinity, however, had no distinct effect on active ciliate numbers, although these were slightly lower than with normal sea water, i.e. on average 7 387 active ind./l melted ice (salinity after melting 29.0‰) vs. 9 471 active ind./l melted ice (salinity after melting 19.4‰), n = 3 (sample size too small for a statistical comparison).

Pore water sampling by drilling holes in sea ice and collecting the accumulated brine as suggested by GARRISON & BUCK (1986) is very likely inappropriate for the quantitative and qualitative investigation of ciliates because many species are thigmotactic, i.e. remain on the substrate surface. This was also indicated by a single comparative enumeration: 3 500 active ind./l brine vs. 8 328 active ind./l melted ice.

Terminology

Sea ice is found in both polar regions as well as at lower latitudes, e.g. Baltic Sea, Gulf of St. Lawrence. It differs considerably from other marine biotopes in physical structure, abiotic and biotic parameters, e.g. salinity, temperature regime, nutrient concentrations and biocoenosis (e.g. CAREY & MONTAGNA 1982; DIECKMANN et al. 1991; GARRISON 1991; GARRISON & BUCK 1991; GARRISON et al. 1986; HORNER 1985; HORNER et al. 1992; LEGENDRE et al. 1992; PALMISANO & GARRISON 1993; SPINDLER & DIECKMANN 1991). Sea ice is thus a distinct ecosystem.

There is no appropriate term denoting this diverse biotope and its community. „Cryal" and „cryon", which were introduced to designate these (MELNIKOV 1989, loc. cit. HORNER et al. 1992), are preoccupied. Kryal and kryon are used for biotope and biocoenosis of glacier surfaces (eukryal) and glacier brooks formed by meltwater (meta-, hypokryal; STEFFAN 1971, 1972). These terms refer to freshwater biotopes and are well known (e.g. FRANZ 1979; HENTSCHEL & WAGNER 1990; SCHAEFER & TISCHLER 1983; SCHWOERBEL 1987). Thus, they should not be used for sea ice. Several other terms like, e.g., epi-, endocryotic, epontic, cryobiont, cryophilic,

cryophyton, cryoplankton or sea ice microbial communities, are generally unsatisfactory because they are inaccurate or misleading (for review see CAREY 1985; HORNER et al. 1992).

We thus propose pagial for the entire sea ice biotope and pagion for its biocoenosis (from „ho pagetos", Greek, the frost, icy coldness). Sympagic (WHITAKER 1977) may be used synonymously with pagialic. Endopagial denotes the biotope within the sea ice, i.e. brine channels, interstices between ice platelets and crystals as, e.g., in grease ice, and endopagion its biocoenosis. Epipagial and epipagion may be used for biotope and community of the aufwuchs mainly on the underside of sea ice, metapagial (metapagion) for the transition zone of snow and ice, i.e. infiltration layer (infiltration community), and hyperpagial (hyperpagion) for the snow covering the sea ice. A melt- or flood-pool on the sea ice surface may be referred to as pagiotelma (Fig. 2).

Pagion is not synonymous with pagon. The latter is a general term denoting aquatic organisms which, to a certain extent, remain viable in frozen state (cf. SCHAEFER & TISCHLER 1983). Many pagialic species might, however, belong to the pagon.

Faunistics

In total, 68 ciliate species were recorded. 55 of these were found exclusively in the brine-filled pore system of sea ice (endopagial), 6 only in the pelagial and 7 both in the endopagial and the plankton (Table 2). Including those already described by PETZ (1994, 1995), 20 species (29%) of the ice-dwelling ciliates are new to science. In addition to these, 11 are first records for Antarctica: *Chaenea teres*, *Condylostoma granulosum*, *Diophrys appendiculata*, *Dysteria monostyla*, *Lacrymaria lagenula*, *Loxophyllum rostratum*, *Pelagostrobilidium neptuni* nov. gen., nov. comb., *Pleuronema puytoraci*, *Strombidium crassulum*, *S. emergens*, *Spirostrombidium pseudocinctum* nov. comb. At least 69% of the species identified by us from the sea ice and water column have been found exclusively in Antarctica. This suggests that a distinct marine Antarctic ciliate fauna exists. *Euplotes sigmolateralis*, *Myrionecta rubra*, *Amphileptus* sp., *Laboea* sp. and *Trochilia* sp., which have also been found in Antarctic sea ice (AGATHA et al. 1993; CORLISS & SNYDER 1986; GARRISON & BUCK 1989b; STOECKER et al. 1993), were not recorded by us.

Of planktonic ciliates, mainly tintinnids have previously been reported from the Antarctic. The tintinnid fauna found in this study corresponds with that recorded earlier in the Weddell Sea (BALECH & EL-SAYED 1966; BOLTOVSKOY & ALDER 1992; BOLTOVSKOY et al. 1989; GARRISON & BUCK 1989a; HEINBOKEL & COATS 1986). However, *Cymatocylis calyciformis* was not reported before from that area.

Compared with the endopagial, distinctly fewer pelagic species are listed (Table 2). This is due to the smaller number of plankton samples and a rather low species diversity.

Description of species

R e m a r k s : Many marine ciliates are very poorly investigated, e.g. strombidiids (MAEDA & CAREY 1985). Thus if possible, instead of establishing new species we identified the populations found with already existing species.

Only recently, several species from Antarctica were described exclusively using preserved material (AGATHA et al. 1990, 1993; CORLISS & SNYDER 1986; FENCHEL & LEE 1972; TUFFRAU 1974). For many of these, living observations, additional morphologic data and morphometric characterizations are given.

The classification of tintinnids relys almost exclusively on lorica morphology although this character is highly variable (e.g. BOLTOVSKOY et al. 1990; DAVIS 1981; LAVAL-PEUTO 1981; LAVAL-PEUTO & BROWNLEE 1986; WASIK & MIKOLAJCZYK 1994b; see also below). We thus provide some redescriptions based on protargol impregnations.

Footnotes to Table 2

[1] Succeeding stages in sea ice formation: Gr, grease ice (very young, unconsolidated ice crystals on water surface); Ni, nilas ice (young, sheet ice); Pc, pancake ice (young, roundish pieces); Ms, multiyear ice; Mf, multiyear land–fast ice (sea ice connected to land).

[2] Plankton.

Table 2. List of ciliate species recorded in sea ice (endopagial) and pelagial of the Weddell Sea, Antarctica: + found; ++ frequently found; – not found.

Species	Sea ice[1]					Pl[2]
	Gr	Ni	Pc	Ms	Mf	
Aspidisca antarctica CORLISS & SNYDER, 1986	–	–	+	++	–	–
Chaenea teres (DUJARDIN, 1841) KENT, 1881	–	–	+	+	+	–
Chaenea sp.	–	–	+	+	–	–
Chlamydonella pseudochilodon (DEROUX, 1970) nov. gen., nov. comb.	–	–	–	++	–	–
Codonellopsis gaussi (LAACKMANN, 1907) LAACKMANN, 1910	–	–	–	–	–	+
Codonellopsis glacialis (LAACKMANN, 1907) KOFOID & CAMPBELL, 1929	+	–	–	–	–	++
Condylostoma granulosum BULLINGTON, 1940	–	+	+	++	–	–
Condylostoma sp.	–	–	–	+	–	–
Cryptochilum reniforme nov. spec.	–	–	+	–	+	–
Cymatocylis calyciformis (LAACKMANN, 1907) LAACKMANN, 1910	–	–	–	–	–	+
Cymatocylis convallaria LAACKMANN, 1910	–	–	–	–	–	++
Cymatocylis vanhoeffeni (LAACKMANN, 1907) LAACKMANN, 1910	–	–	–	–	–	+
Cytharoides balechi TUFFRAU, 1974	–	–	+	+	+	–
Didinium gargantua MEUNIER, 1910	–	–	+	+	–	+
Diophrys appendiculata (EHRENBERG, 1838) LEVANDER, 1894	–	–	+	+	–	–
Dysteria monostyla (EHRENBERG, 1838) KAHL, 1931	–	–	–	+	+	–
Euplotes acanthodus nov. spec.	–	–	–	+	+	–
Euplotes antarcticus FENCHEL & LEE, 1972	–	–	+	++	+	–
Euplotes rariseta CURDS et al., 1974	–	–	++	++	+	–
Frontonia frigida nov. spec.	–	–	+	+	–	–
Fuscheria marina nov. spec.	–	–	+	–	–	–
Gymnozoum sympagicum nov. spec.	+	–	++	+	+	–
Gymnozoum viviparum MEUNIER, 1910	+	–	++	+	+	–
Gymnozoum sp.	–	–	+	+	+	–
Holosticha foissneri nov. spec.	–	–	+	++	–	–
Holosticha pullaster (MUELLER, 1773) FOISSNER et al. 1991	–	–	+	++	+	–
Holosticha spindleri nov. spec.	–	–	+	+	–	–
Kentrophyllum antarcticum nov. gen., nov. spec.	–	–	–	+	+	–
Kentrophyllum sp.	–	–	–	+	–	–
Laackmanniella naviculaefera (LAACKMANN, 1907) KOFOID & CAMPBELL, 1929	–	–	–	–	–	+
Lacrymaria lagenula CLAPARÈDE & LACHMANN, 1859	–	–	+	+	+	–
Lacrymaria spiralis CORLISS & SNYDER, 1986	–	–	+	+	+	–
Leegaardiella elbraechteri nov. spec.	–	–	–	+	–	++

Table 2 continued.

Species	Sea ice[1]					Pl[2]
	Gr	Ni	Pc	Ms	Mf	
Litonotus emmerichi nov. spec.	–	–	+	+	+	–
Litonotus kopimorphus nov. spec.	–	–	–	+	+	–
Loxophyllum rostratum COHN, 1866	–	–	++	++	+	–
Monodinium sp.	–	–	+	–	–	–
Myrionecta sp.	–	–	++	+	–	+
Notocephalus parvulus (CORLISS & SNYDER, 1986) nov. gen., nov. comb.	–	–	–	+	–	–
Pelagostrobilidium neptuni (MONTAGNES & TAYLOR, 1994) nov. gen., nov. comb.	–	–	–	+	–	++
Placus antarcticus nov. spec.	–	–	+	+	+	–
Pleuronema glaciale CORLISS & SNYDER, 1986	–	–	–	+	–	–
Pleuronema puytoraci GROLIÈRE & DETCHEVA, 1974	–	–	–	+	–	–
Porpostoma grassei (CORLISS & SNYDER, 1986) nov. comb.	–	–	+	+	–	–
Pseudocohnilembus sp.	–	–	–	+	–	–
Pseudotrachelocerca trepida (KAHL, 1928a) SONG, 1990	–	–	+	+	+	–
Rhabdoaskenasia sp.	–	–	++	+	–	–
Rimostrombidium glacicolum nov. spec.	+	–	+	+	–	++
Spirostrombidium pseudocinctum (WANG, 1934) nov. comb.	–	–	+	–	–	–
Spirostrombidium rhyticollare (CORLISS & SNYDER, 1986) nov. comb.	–	–	+	+	–	–
Strombidium antarcticum (BUSCH, 1930) KAHL, 1932	–	–	+	+	–	–
Strombidium crassulum (LEEGAARD, 1915) KAHL, 1932	–	–	+	+	–	–
Strombidium emergens (LEEGAARD, 1915) KAHL, 1932	–	–	–	+	–	–
Strombidium glaciale nov. spec.	–	–	+	++	+	–
Strombidium kryale PETZ, 1994	+	–	+	–	–	–
Strombidium sp. 1	–	–	+	–	–	–
Strombidium sp. 2	–	–	–	–	+	–
Thigmokeronopsis antarctica PETZ, 1995	–	+	+	+	+	–
Thigmokeronopsis crystallis PETZ, 1995	–	–	+	+	+	–
Tontonia antarctica nov. spec.	–	–	–	–	–	++
Uronema acutum BUDDENBROCK, 1920	–	–	+	+	–	–
Uronema antarcticum (THOMPSON, 1972) nov. comb.	–	–	–	–	+	–
Uronema paramarinum nov. spec.	–	–	+	+	+	+
Uronychia transfuga (MUELLER, 1776) STEIN, 1859c	–	–	+	+	+	–
Uropedalium sp.	–	–	+	–	–	–
Zosterodasys kryophilus nov. spec.	–	–	+	–	+	–
Suctoria gen. sp.	–	–	–	–	+	–
Total: 68	5	2	43	48	28	13

Order Prostomatida SCHEWIAKOFF, 1896

Pseudotrachelocerca trepida (KAHL, 1928a) SONG, 1990

Morphology and infraciliature (Figs. 4a-h, Table 3): In vivo 90-110 x 30-37 µm. Body elongate club- to spindle-shaped, anteriorly narrowed, widest at or behind mid-body, frontal end straight, posteriorly rounded; contractile (Figs. 4a, b). Cross section elliptical to circular. Cytostome apical, not protruding, very likely circular. Pellicle thin, slightly grooved by kineties. Cortical granules colourless. Single macronucleus sausage- to U-shaped, located in mid-body, contains spherical (up to 3 µm across) and, rarely, elongate nucleoli. Once 3 micronuclei, globular, in indentation of macronucleus, usually not impregnated with protargol. Single contractile vacuole terminally. Cortical granules in rows along somatic kineties (Fig. 4e). Cytoplasm colourless, contains many greenish shining globules (1.5-4 µm across) and food vacuoles with unidentified contents; specimens usually appear rather dark. Movement slow.

Somatic kineties meridional, extending over entire length of body, especially anterior portions composed of very densely spaced monokinetids, cilia about 10 µm long (Figs. 4c, d, f); parasomal sac adjacent to each basal body in silver nitrate slides (cf. FOISSNER 1983). Argentophilic structure (fibres?) immediately beneath each kinety (Fig. 4g). Somatic kineties terminate anteriorly with single dikinetid forming circumoral kinety. Adoral organelle (FOISSNER et al. 1994; formerly brosse) parallel to somatic kineties, i.e. aklitolophic (HILLER & BARDELE 1988), 28-51% of body length ($\bar{x}$ = 41%, n = 7), composed of numerous irregularly arranged dikinetids, distally indistinctly 2- to 3-rowed, proximally single-rowed, continued posteriad in 1 row of monokinetids (short somatic kinety); cilia about 10 µm long (Figs. 4d, f). Extrusomes spindle-shaped, usually slightly bent, about 0.5 µm thick, sometimes with thread-like process, scattered in body, not found surrounding cytostome (not impregnated?), once, however, observed outside cytostome (preparation artifact?); in protargol slides, extruded extrusomes very fine, ca. 20 µm long (Figs. 4f, h). Nematodesmata fine, about 23 µm long.

2 slides of protargol impregnated specimens have been deposited for reference.

Occurrence and ecology: Infrequently found in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 69° 07'-70° 30' S and longitude 07° 19'-12° 08' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters (generally 1 measurement) in brine: temperature ca. -3.0 to -1.4°C, salinity 32.3-52.0‰, PO_4 1 µmol/l, NO_2 0.2 µmol/l; in melted ice: PO_4 0.5 µmol/l, NO_2 0.05 µmol/l, NO_3 1 µmol/l, NH_4 0.4 µmol/l, Si 4 µmol/l, chlorophyll *a* 1.5-57.5 µg/l. In raw cultures also at +1°C. Biomass of 10^6 individuals: 63 mg.

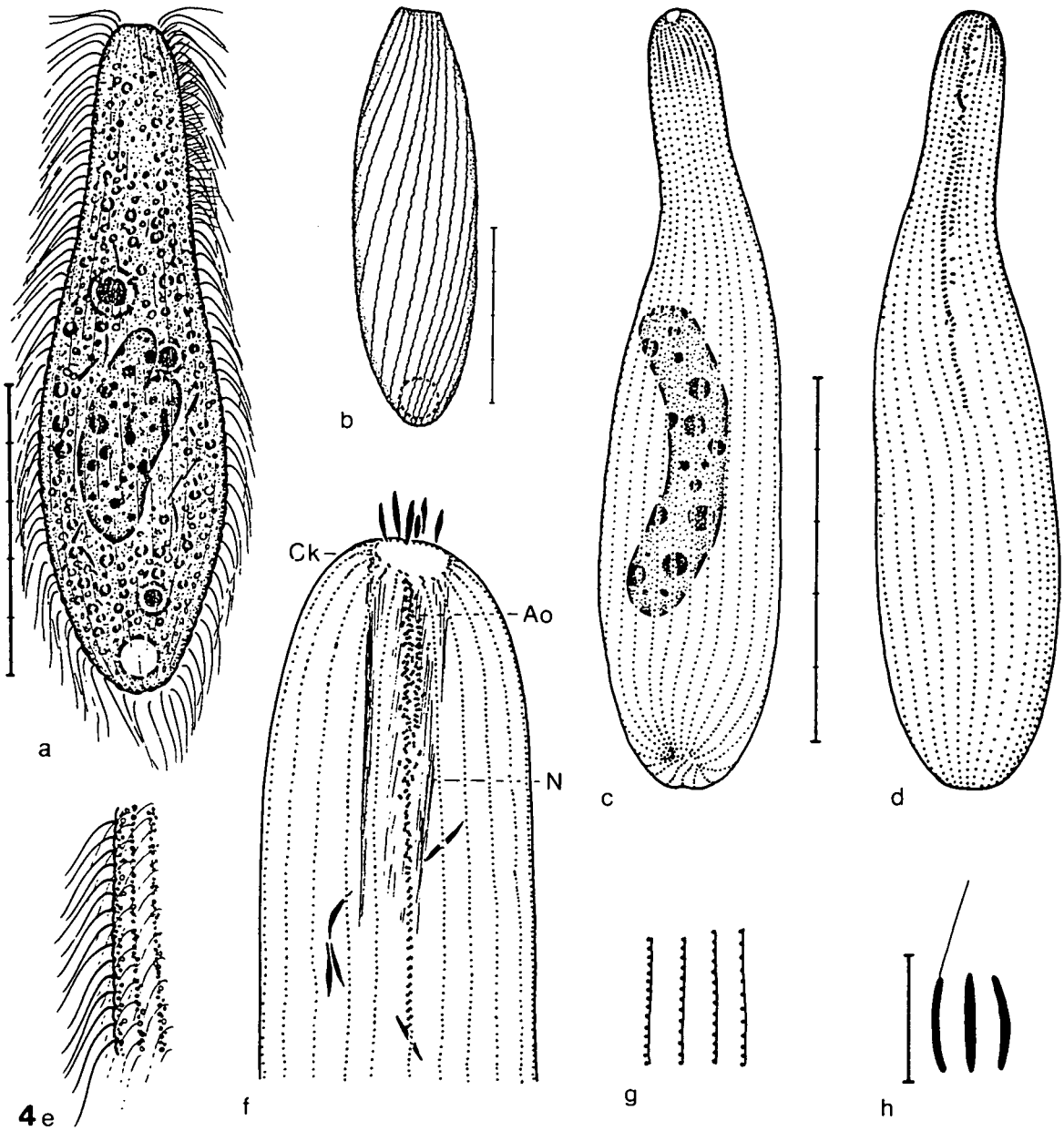
Table 3. Morphometric characteristics of *Pseudotrachelocerca trepida* (n = 12); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	107.7	105.5	23.2	6.70	21.5	62.0	144
Body, width	39.1	39.5	10.8	3.11	27.6	20.0	57
Macronuclear figure, length	35.1	30.0	11.6	4.09	33.0	26.0	56
Macronucleus, width	11.3	12.0	2.3	0.76	20.2	8.0	15
Adoral organelle, length	48.9	46.5	14.7	5.20	30.1	30.0	70
Extrusomes, length	5.5	5.0	0.9	0.23	16.5	4.5	8
Cytostome, diameter	4.6	4.3	1.3	0.42	29.1	3.0	7
Somatic kineties, number	23.9	24.5	2.7	0.77	11.2	19.0	27

Comparison with related species and systematic considerations: The irregularly arranged adoral organelle is a main character of the monotypic genus *Pseudotrachelocerca* (SONG 1990). The Antarctic specimens are quite similar to *P. trepida* (AGAMALIEV 1983; BORROR 1965; KAHL 1928a; SONG 1990; WILBERT & KAHAN 1981). They differ slightly in the possession of cortical granules (perhaps a variable character) and a longer adoral organelle (1/3-1/2 vs. 1/6-1/4 of body length; AGAMALIEV 1983; KAHL 1928a, 1932; SONG 1990; WILBERT & KAHAN 1981). The latter depends, however, on the contraction of the specimens. The population studied by BORROR (1965) also has a long adoral organelle, thus we identify the present organisms with *P. trepida*.

The adoral organelle arrangement and the meridional somatic kineties suggest that *Pseudotrachelocerca* is related to holophryids (FOISSNER et al. 1994; HILLER & BARDELE 1988). This genus is thus transferred from the Spathidiida to the Prostomatida. The family Holophryidae PERTY, 1852 is, however, distinguished from Pseudotrachelocercidae SONG, 1990 in the 3-rowed adoral organelle (FOISSNER et al.

1994; HILLER & BARDELE 1988). [Due to the rather complicated nomenclature and taxonomy in prostomatids, Prorodontidae of HILLER & BARDELE (1988) are Holophryidae (FOISSNER et al. 1994)].



Figs. 4a-h: *Pseudotrachelocerca trepida* from life (a, b, f) and after protargol impregnation (c-e, g, h). a: Side view. b: Side view of slightly contracted specimen. c, d: Dorsal and ventral view of same specimen. e: Cortical granulation. f: Detail of anterior area. g: Detail of somatic kineties. h: Extrusomes. Scale bar divisions = 10 µm. Ao, adoral organelle; Ck, circumoral kinety; N, nematodesmata.

***Placus antarcticus* nov. spec.**

Diagnosis: In vivo 85-110 x 40-60 µm. Outline elliptical. 36-40 meridional to slightly spiralling somatic kineties. Single macronucleus usually ellipsoid. 1 terminal contractile vacuole. Marine.

Type location: Pancake sea ice of Weddell Sea, Antarctica, 69° 46' S, 11° 00' W (core number AN 103115a).

Type specimens: 1 holotype as a slide of protargol impregnated cells and 1 paratype of silver nitrate stained specimens have been deposited.

Derivatio nominis: „antarcticus", Lat., Antarctic.

Description (Figs. 5a-h, 62, Table 4): Outline elliptical to obconic, asymmetrical, distinctly indented in area of subapical cavity (defining ventral side); anteriorly usually slightly oblique, straight in oral area, broadest generally in anterior portion, posteriorly broadly rounded, sometimes tapering; often deformed due to large prey (Figs. 5a, d). Laterally flattened about 2:1, well fed specimens roundish. Pellicle meridionally ribbed along kineties, structured like in other *Placus* spp. (e.g. FOISSNER et al. 1994). Macronucleus ellipsoid (in vivo 40-46 x 20-32 µm) to slightly sausage-shaped (in vivo up to 75 x 16 µm), contains small and few large spherical (in protargol slides 2-22 µm across) and, rarely, ribbon-like nucleoli. Single micronucleus spherical, ca. 4 µm in diam., in indentation of macronucleus; usually not impregnated with protargol or silver nitrate. Contractile vacuole terminally, in vivo up to 20 µm in diam.; excretory pore slightly subterminally, on posterior end of postcavity kineties (Fig. 5e). Subapical cavity in anterior 1/3 of body, in vivo 13-15 µm long, contains cilia and extrusomes. Cytoplasm with many pale greenish lipid droplets (3-5 µm across) and food vacuoles (up to 50 x 30 µm) containing ciliates (e.g. *Gymnozoum* sp., *Dysteria* sp., euplotids), dinoflagellates, rarely pennate diatoms (9-27 µm long) and undefinable green contents. Specimens, especially in posterior portions, black at low magnification. Movement not fast, rotate about main body axis when swimming.

Somatic kineties almost meridional on left side, very indistinctly to slightly spiralling on right (variable!); composed of single basal bodies, each associated with smaller argentophilic granule (Figs. 6g, h); cilia about 8 µm long; few, usually 3-4, rows right of subapical cavity slightly shortened, terminate at adoral organelle; 2 rows extend

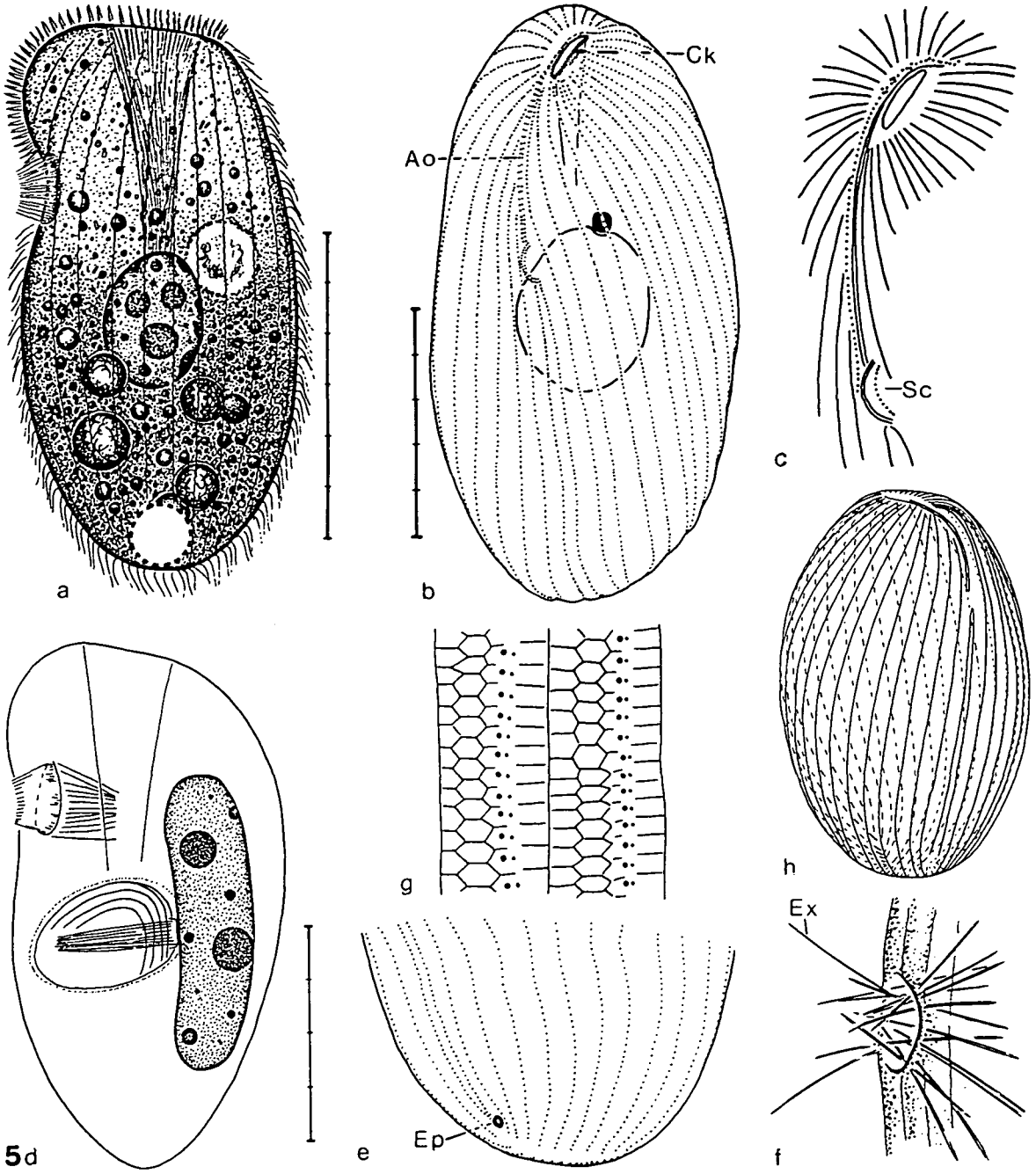
from posterior portion to subapical cavity (postcavity kineties, SONG & WILBERT 1989; Fig. 62). 2 C-shaped rows of ciliated basal bodies and apparently 1 row of densely spaced extrusomes in subapical cavity (Figs. 5b, c). 1 row of extrusomes parallel to adoral organelle (Fig. 5c). Extrusomes rod-shaped, in vivo about 14 µm long, distinctly elongated when extruded (Fig. 5f). Silverline system hexagonal, interrupted by longitudinal lines (Fig. 5g).

Adoral organelle (brosse, GRAIN et al. 1978) extends from subapical cavity anteriad and along right side of mouth (parabuccal segment, GRAIN et al. 1978), composed of basal body pairs, cilia about 10 µm long. Circumoral kinety composed of about 52 basal body pairs, very likely non-ciliated (Fig. 5b). Cytostome apical, elongate elliptical in top view; nematodesmata 46-90 µm long.

Table 4. Morphometric characteristics of *Placus antarcticus* (n = 30); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	112.1	111.0	16.6	2.98	14.8	80	153
Body, width	66.6	65.0	12.3	2.25	18.5	45	92
Macronucleus, length	51.6	48.0	17.0	3.63	33.0	26	99
Macronucleus, width	30.1	28.0	9.1	2.04	30.3	13	53
Cytostome, length	16.9	16.5	2.4	0.56	14.1	12	21
Subapical cavity, length	12.3	13.0	2.3	0.41	18.3	8	17
Apex to beginning of subapical cavity, distance	18.5	17.0	3.4	0.62	18.4	14	26
Somatic kineties, number	38.2	38.0	1.1	0.23	3.0	36	40

Occurrence and ecology: Sporadically found mainly in the brown layer of pancake and multiyear sea ice of the Weddell Sea, between latitude 68° 38'-71° 00' S and longitude 06° 05'-12° 08' W. 786 active ind./l melted ice were found (biomass 0.09 mg/l) comprising 16.7% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature <-1.8°C, salinity >33.7‰, Si >2.6 µmol/l; chlorophyll *a* >2.2 µg/l melted ice. In raw cultures also at +1°C and a salinity of 15.6-16.4‰. Do not burst at higher, e.g. room, temperature. Biomass of 10^6 individuals: 116 mg.



Figs. 5a-h: *Placus antarcticus* from life (a, c, e), after protargol (b, d, f) and silver nitrate impregnation (g, h). a: Left lateral view. b: Frontoventral view. c: Extrusome position (dotted) in subapical cavity and along adoral organelle. d: Left lateral view of other shape. e: Detail of posterior portion showing position of contractile vacuole pore. f: Extrusomes of subapical cavity. g: Detail of silverline system. h: Specimen having distinctly spiralling kineties, superposition of right and left lateral kineties. Scale bar divisions = 10 µm. Ao, adoral organelle; Ck, circumoral kinety; Ep, excretory pore of contractile vacuole; Ex, extrusomes; Sc, subapical cavity.

Comparison with related genera and species: The general organization, e.g. infraciliature and subapical cavity, clearly shows that this species belongs to *Placus*. The spiralling of the somatic kineties, which is also characteristic for this genus, is, however, often indistinct and rather variable. *Spathidiopsis socialis* FABRE-DOMERGUE, 1889, type of this genus, also has more or less distinctly spiralling kineties and a subapical cavity (FABRE-DOMERGUE 1889). Thus, *Spathidiopsis* FABRE-DOMERGUE, 1889, which is still considered valid by a number of authors, should best be synonymized with *Placus* as already suggested by KAHL (1930). This is in contrast to SMALL & LYNN (1985) and CAREY (1992) who erroneously synonymized *Placus* with *Spathidiopsis*, the latter author attributing this nomenclatural act to CORLISS (1979). FOISSNER et al. (1994) suggested a synonymy of *Spathidiopsis* with *Plagiopogon* STEIN, 1859b which is also inappropriate.

Most species of *Placus* are distinctly smaller, have fewer and markedly spiralling somatic kineties, e.g. *P. dogieli* BURKOVSKY, 1970, *P. luciae* (KAHL, 1926) KAHL, 1930, *P. marinus* (KAHL, 1927) FOISSNER et al., 1994, *P. ovum* KAHL, 1926, *P. striatus* COHN, 1866, and/or differ in a long macronucleus, viz. *P. longinucleatus* SONG & WILBERT, 1989, *P. salinus* DIETZ, 1964 (BORROR 1972b; BURKOVSKY 1970; COHN 1866; DIETZ 1964; FOISSNER 1972; FOISSNER et al. 1994; FRYD-VERSAVEL et al. 1975; GRAIN et al. 1978; KAHL 1927, 1930; PÄTSCH 1974; SONG & WILBERT 1989).

Placus buddenbrocki (SAUERBREY, 1928) KAHL, 1930 and *P. eforianus* TUCOLESCO, 1962a are similar in size and number of somatic kineties (35-40 and 40, respectively) but the former occurs in freshwater, has a horseshoe-shaped to very irregular macronucleus and spiralling somatic kineties (SAUERBREY 1928). The latter species differs from *P. antarcticus* in shape (viz. anteriorly tapering), spiralling rows and possession of 2 long caudal cilia (TUCOLESCO 1962a).

Order Spathidiida FOISSNER & FOISSNER, 1988

Didinium gargantua MEUNIER, 1910

Remarks: The termination of the species-name „gargantua" does not agree with *Didinium* (neuter gender). We could find no Latin or Greek word from which

„gargantua" might be derived. There exists a Cape Gargantua in Canada which is, however, very far from MEUNIER's (1910) study area. Thus, „gargantua" might be a noun of a different language which is also indicated by MEUNIER's (1910) original spelling, viz. with a capital letter. Consequently, the termination is not changed (art. 31b, ICZN 1985).

Improved diagnosis: In vivo 70-200 x 50-120 µm. Body barrel-shaped. 50-75 somatic kineties, 2 ciliary bands. Brosse 2- to 3-rowed. Macronucleus sausage-shaped. Marine.

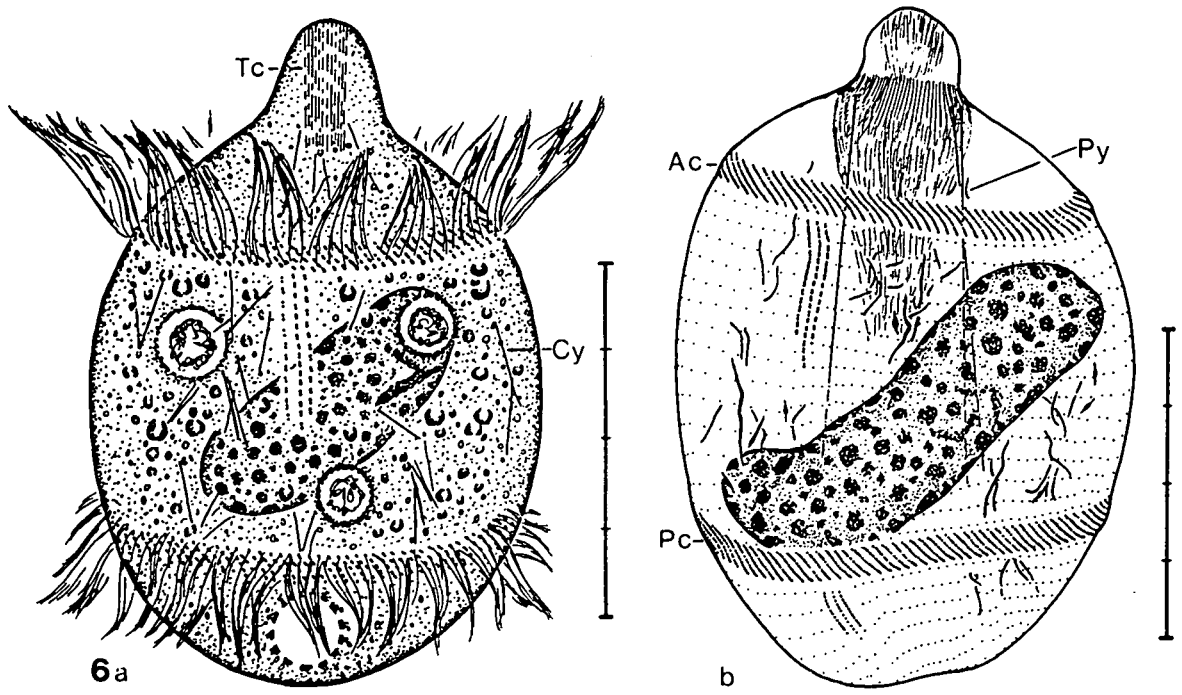
Neotype specimens: 1 neotype and a 2nd slide of protargol impregnated cells have been deposited.

Table 5. Morphometric characteristics of *Didinium gargantua* (n = 7); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	85.1	89.0	24.5	9.24	28.7	52.0	114
Body, width	60.8	57.5	14.8	6.04	24.3	41.0	79
Proboscis, length	9.2	9.0	1.8	0.80	19.4	7.0	12
Proboscis, width	15.6	16.0	2.1	0.93	13.3	13.0	18
Macronucleus, length	42.3	37.0	15.9	6.03	37.7	26.5	70
Macronucleus, width	16.6	16.0	4.2	1.60	25.6	12.0	22
Cyrtocysts, length	13.6	15.0	3.3	1.25	24.4	8.0	17
Apex to posterior margin of anterior ciliary band, distance	26.4	27.0	5.5	2.07	20.7	18.0	34
Apex to posterior ciliary band, distance	64.1	69.0	16.0	6.06	25.0	39.0	82
Brosse, number of rows	2.8	3.0	0.5	0.25	18.2	2.0	3

Redescription (Figs. 6a, b, Table 5): Outline ellipsoid to barrel-shaped, distinct proboscis anteriorly, posteriorly broadly rounded (Fig. 6a). Cross section circular. Specimens rather fragile, i.e. burst easily. Single, very likely contractile vacuole terminally, pulsation, however, not observed. Single macronucleus sausage-shaped, usually oblique in mid-body, with numerous spherical (1.5-3 µm across) or ribbon-like nucleoli. Micronucleus not impregnated with protargol. Cytoplasm contains globules (2-5 µm in diam.) and food vacuoles with, very likely, flagellates and dinoflagellates; specimens appear rather dark at low magnification. Swims moderately fast.

50-75 somatic kineties, extending from posterior pole anteriad, terminating in anterior ciliary band; posterior ciliary band in rear 1/4 of body. Ciliary bands composed of basal body rows (pectinelles), about 15 kinetosomes per row, cilia 16-25 µm long; basal bodies between ciliary bands non-ciliferous (Fig. 6b). Brosse posterior of each ciliary band, usually composed of 3 rows of apparently dikinetids, cilia not recognized (lacking?); row 1 of anterior brosse 9-17 µm long, row 2: 13-20 µm, row 3: 16-21 µm; rows of posterior brosse about 6 µm long. Cyrtocysts rod-like, scattered in body, in protargol slides often curved; other extrusomes (developmental stages, pexicysts?) fusiform, 4-6 µm long (Fig. 6b). Toxicysts 40-50 µm long, between nematodesmata (25-50 µm long).



Figs. 6a, b: *Didinium gargantua* from life (a) and after protargol impregnation (b); dorsal views. Scale bar divisions = 10 µm. Ac, anterior ciliary band; Cy, cyrtocysts; Pc, posterior ciliary band; Py, pexicysts; Tc, toxicysts.

Occurrence and ecology: Rarely found in the endopagial of pancake and multiyear sea ice and also in the pelagial of the Weddell Sea, between latitude 69° 26'-70° 22' S and longitude 07° 19'-09° 00' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine (1 measurement): temperature -2.3°C, salinity 41.5‰, PO_4 1.1 µmol/l, NO_2 0.2 µmol/l, NO_3 20.2 µmol/l, NH_4 17.5 µmol/l, Si 27.9 µmol/l; chlorophyll *a* 30.1 µg/l melted ice. Biomass of 10^6 individuals: 121 mg.

Comparison with related species: These specimens correspond in size, shape and macronucleus with the original description of which infraciliary data are not available (MEUNIER 1910). This species was originally found in the Arctic ocean but it was also repeatedly recorded from Antarctica (e.g. GARRISON 1991; HADA 1970; PALMISANO & GARRISON 1993). We thus identify the present specimens with *D. gargantua*. If a future investigation of the Arctic population shows that it differs markedly from that of Antarctica, the latter has to be separated at species level.

Didinium nasutum (MUELLER, 1786) STEIN, 1859b differs in the freshwater habitat, has more brosse rows (5-9), a considerably longer macronucleus and the posterior ciliary band is situated near mid-body (DRAGESCO 1966; FOISSNER 1984a). The marine records of this species are doubtful (KAHL 1930).

Didinium balbianii (FABRE-DOMERGUE, 1888) KAHL, 1930, which was also reported from the Antarctic (e.g. GARRISON 1991; GARRISON & BUCK 1989a,b; HADA 1966, 1970; PALMISANO & GARRISON 1993; SUDZUKI 1979), possesses only 1 ciliary band. This is considered sufficient difference for a separation from *Didinium* (e.g. CORLISS 1979; DRAGESCO 1970; FAURÉ-FREMIET 1924; FOISSNER 1979a). The species should thus be left in *Monodinium*, viz. *M. balbianii* FABRE-DOMERGUE, 1888.

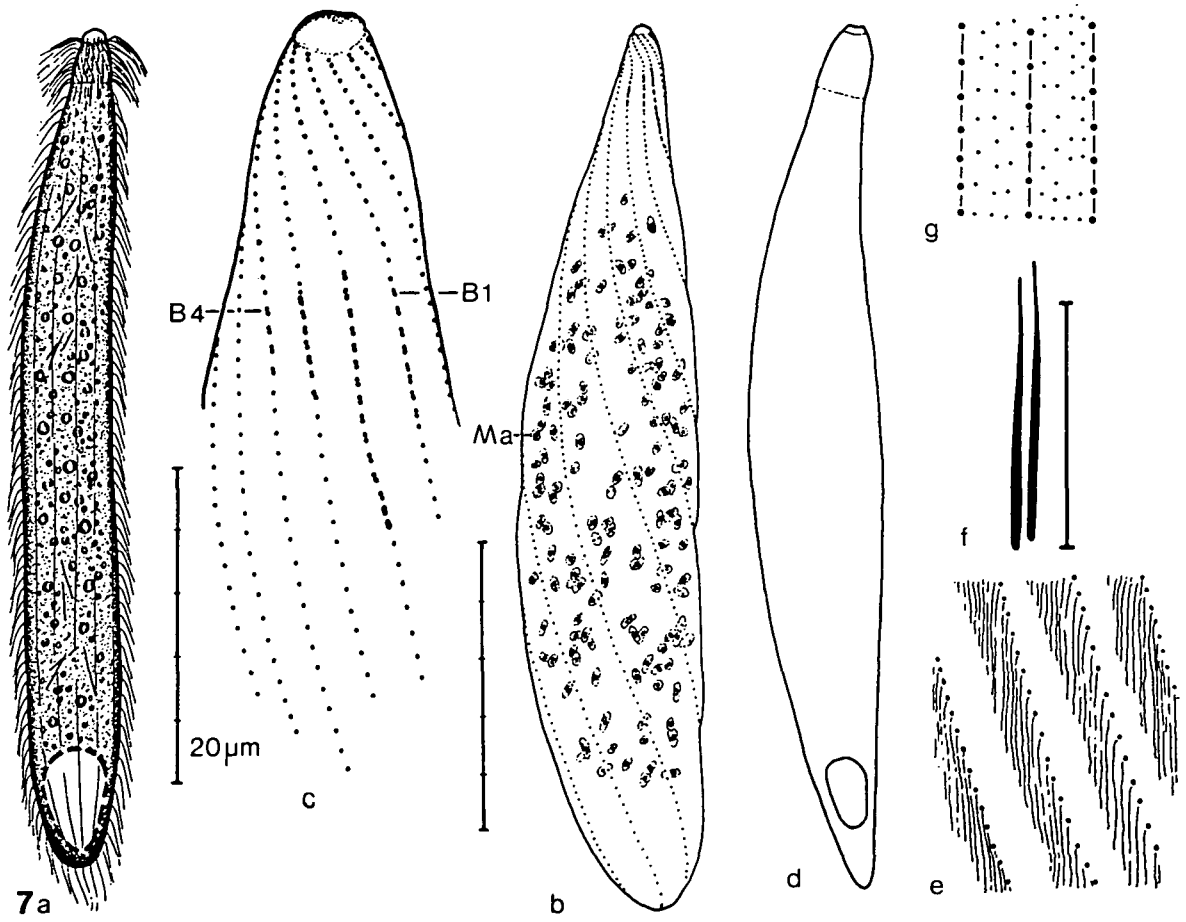
Chaenea teres (DUJARDIN, 1841) KENT, 1881

Morphology and infraciliature (Figs. 7a-g, Table 6): In vivo 120-270 x 20-30 µm. Shape elongate cylindrical to fusiform, posteriorly tapering to rounded; slightly contractile; oral region in vivo head-like set off, often slightly bent and usually indistinct after impregnation (Figs. 7a, d). Cross section circular. Oral bulge round, protruding about 2 µm. Extrusomes rod-like and fine in vivo, indistinctly thorn-like in protargol slides; in oral bulge and scattered in body; in cytoplasm very rarely fusiform and short (developmental stages?; Fig. 7f; Table 6). Macronuclear nodules scattered in body, spherical, rarely ellipsoid, each usually with single, large central nucleolus. Micronuclei not impregnated with protargol. 1 contractile vacuole in posterior end. Cortical granules colourless, in longitudinal rows between kineties (Fig. 7g). Cytoplasm with small globules, 2-12 µm across, and food vacuoles containing small pennate diatoms, flagellates and ciliates; specimens often yellowish-

brown (due to food?). Movement slowly gliding, rotating about main body axis when swimming.

Somatic kineties longitudinal, in contracted specimens slightly spiralling, on „head" distinctly spiralled and associated with conspicuous fibres, 100-220 basal bodies per row, cilia 12-15 µm long (Figs. 7b, c, e). Brosse typical for genus, composed of 4 rows of paired basal bodies, row 3 distinctly elongate, each kinetosome with 10-11 µm long cilium (Fig. 7c, Table 6). Circumoral kinety very indistinct, very likely composed of 1 dikinetid at anterior end of each somatic row.

A slide of protargol impregnated specimens of *C. teres* has been deposited for reference.



Figs. 7a-g: *Chaenea teres* from life (a, d, g) and after protargol impregnation (b, c, e, f). a: Side view. b: Dorsal view of slightly contracted specimen. Macronuclear nodules exemplified. c: Detail of anterior area. d: Different shape. e: Fibres associated with somatic kineties. f: Extrusomes. g: Detail of cortical granulation. a, scale bar divisions = 20 µm; b, f, scale bar divisions = 10 µm. B1, B4, brosse kineties 1, 4; Ma, macronucleus.

Occurrence and ecology: Regularly found in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 69° 07'-70° 31' S and longitude 07° 19'-12° 08' W. Up to 891 active ind./l melted ice (biomass 0.05 mg/l) were found, comprising up to 5% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -4.5 to -2.3°C, salinity 41.5-70.5‰, PO_4 1.1-1.4 µmol/l, NO_2 0.2 µmol/l, NO_3 20.2-24.8 µmol/l, NH_4 7.2-17.5 µmol/l, Si 27.9-57.0 µmol/l; chlorophyll *a* 30.1-49.3 µg/l melted ice. In raw cultures also at a salinity of 21.3-32.3‰ and +1°C. Biomass of 10^6 individuals: 54 mg.

Comparison with related species: Compared with current standards, the rather superficial descriptions of *C. teres* are consistent with the Antarctic population, i.e. size (150-300 µm long), extrusome length (6-10 µm), shape, number of macronuclei, number (10-12) and arrangement of somatic kineties (meridional on body, spiralling on „head"; e.g. KAHL 1927, 1928a, 1930, 1933; LIPSCOMB & RIORDAN 1990). The identification is thus fairly certain. The 3-rowed brosse described by LIPSCOMB & RIORDAN (1990) is very likely incorrect. The specimens determined as *C. teres* by BORROR (1963) differ in having smaller extrusomes (about 5 µm long), a marked contractility (ca. 50%), spiralling kineties (contracted specimen?) and the bacterivorous life. *Lagynus elongatus* MAUPAS, 1883 and *C. elongata* found by MORGAN (1925) are very similar to *C. teres* and can be synonymized with this species; *Enchelyodon elongatus* CLAPARÈDE & LACHMANN, 1859 possesses a single ellipsoid macronucleus and is thus not conspecific.

Chaenea simulans KAHL, 1930 is rather similar in size, shape and number of somatic kineties, but differs in shorter extrusomes (3 µm) and in the brosse, i.e. 1 row of cilia longer (12-15 µm), others shorter (5 µm) than in *C. teres*.

The well-studied *C. vorax* QUENNERSTEDT, 1867 differs from *C. teres* mainly by its short (4-5 µm), wedge-shaped extrusomes, the composition of the brosse (5-9 dikinetids/row with 2 µm long cilia vs. 3-15 dikinetids/row with 10 µm long cilia; DRAGESCO 1966; FAURÉ-FREMIET & GANIER 1969; FOISSNER 1984a; FRYD-VERSAVEL et al. 1975; KAHL 1930, 1933; QUENNERSTEDT 1867; WANG 1934). *Chaenea stricta* (DUJARDIN, 1841) FOISSNER et al., 1995 is distinguished by its smaller size (90-130 µm in vivo), fewer macronuclei (20-30), shorter extrusomes (ca. 4 µm) and brosse-cilia (2-3 µm), and the freshwater habitat. *Chaenea psammophila* DRAGESCO, 1960 also has longitudinal kineties, but differs by having distinctly more

ciliary rows (about 34) and macronuclear nodules (several hundred), the greater length (350-650 µm) and *Trachelocerca*-like shape.

Table 6. Morphometric characteristics of *Chaenea teres* (upper line, n = 31) and *Chaenea* sp. (lower line, n = 7); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	182.9 241.0	177.0 242.0	59.6 72.2	10.37 27.27	32.6 29.9	72.0 159.0	319 362
Body, width	49.2 53.1	43.0 51.0	21.5 18.0	3.85 6.79	43.7 33.8	20.0 33.0	97 81
Macronuclear nodule, length	6.1 6.2	5.0 4.0	3.3 4.3	0.60 1.11	55.0 69.6	2.5 2.0	15 15
Macronuclear nodule, width	3.4 3.4	3.0 3.0	1.1 0.9	0.19 0.23	31.6 26.6	2.0 2.0	5 5
Extrusome, length in body	9.2 14.5	10.0 14.0	2.3 4.7	0.41 1.26	24.8 32.5	4.0 6.5	12 24
Extrusome, length in oral area	9.0 12.3	7.0 12.5	3.0 0.8	0.66 0.37	33.1 6.8	6.0 11.0	12 13
Brosse, max. length	14.9[1] 25.3	16.0 27.0	4.5 3.8	0.89 2.19	30.0 14.9	8.0 21.0	24 28
Number of somatic kineties	12.4 18.2	12.0 18.5	0.6 1.8	0.10 0.75	4.5 10.1	12.0 16.0	14 20
Number of dikinetids, brosse row 1	3.1 –[2]	3.0 –	0.3 –	0.07 –	8.7 –	3.0 22.0	4 28
Number of dikinetids, brosse row 2	6.6 26.7	7.0 25.0	0.7 2.9	0.20 1.67	11.2 10.8	5.0 25.0	8 30
Number of dikinetids, brosse row 3	15.3 28.3	15.0 28.0	0.8 3.5	0.24 2.03	5.2 12.4	14.0 25.0	17 32
Number of dikinetids, brosse row 4	5.6 –[2]	6.0 –	0.6 –	0.16 –	11.3 –	5.0 24.0	7 29

[1] Row 3 in *C. teres*.
[2] Not enough data.

Chaenea sp.

R e m a r k s : Very likely, specimens of a second species of *Chaenea* were found in protargol slides. Living observations are, however, not available, i.e. important informations (e.g. shape, extrusomes, cortical granulation) might be lacking. We have thus refrained from establishing a new species, but nevertheless provide drawings of

protargol impregnated specimens because these are distinctly different from *C. teres*. It is thus unlikely that *Chaenea* sp. is conspecific with *C. teres* although both species are sometimes found together.

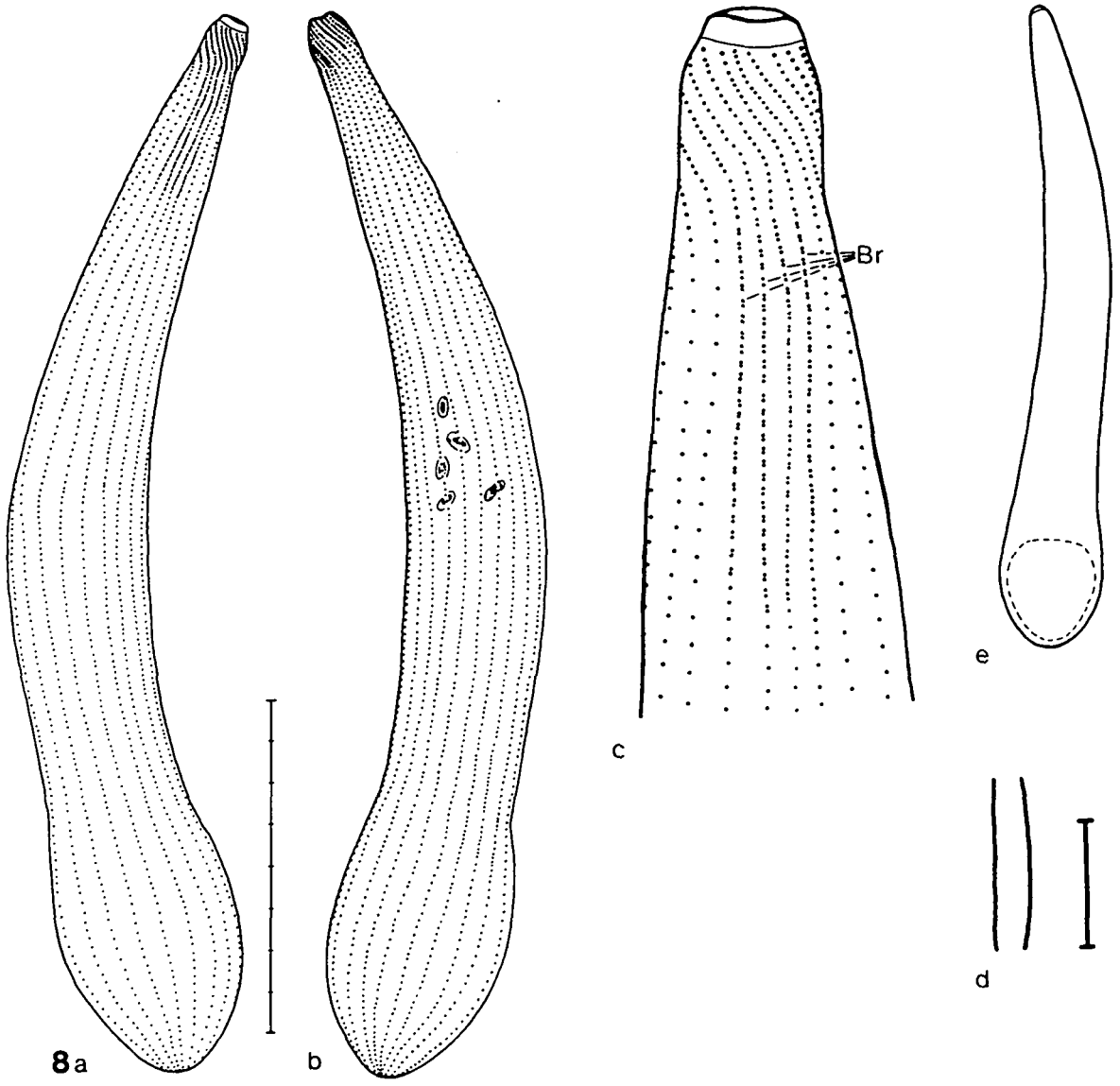
Morphology and infraciliature (Figs. 8a-e, Table 6): Shape elongate, slim; anteriorly head-like (about 12 µm long), often posteriorly enlarged bubble-like (Figs. 8a, b; in vivo also dilated posteriorly as indicated by sketch of, very likely, *Chaenea* sp. from life (Fig. 8e). Cross section circular. About 150 macronuclear nodules, ellipsoid to spherical. Single contractile vacuole terminally (Fig. 8e). Cortical granules argentophilic, in longitudinal rows between somatic kineties. Food vacuoles contain, very likely, flagellates.

Somatic kineties longitudinal or slightly spiralling, composed of about 65-290 basal bodies per row, cilia 12-14 µm long; rows on „head" distinctly spiralling, composed of very densely spaced kinetids, circumoral kinety thus not distinct (Fig. 8c). Brosse consists of 4 approximately equally long rows of paired basal bodies, cilia 5-7 µm long (Figs. 8a, c). Extrusomes rod-shaped, fine, about 13 µm long, as in *C. teres* (Fig. 8d).

2 slides of protargol impregnated specimens of *Chaenea* sp. have been deposited for reference.

Occurrence and ecology: Found in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 69° 07'-70° 21' S and longitude 07° 19'-12° 08' W. Occurs sometimes together with *Chaenea teres*. Environmental parameters in brine: temperature -2.4 to -2.1°C, salinity 38-43‰, PO_4 1.5 µmol/l, NO_2 0.1-0.2 µmol/l, NO_3 2.6 µmol/l, NH_4 2-15 µmol/l, Si 7.7-25 µmol/l. Chlorophyll *a* about 50 µg/l melted ice. Biomass of 10^6 individuals (from fixed specimens): 96 mg.

Comparison with related species: Protargol impregnated specimens of *Chaenea* sp. are distinguished from *C. teres* in having more somatic kineties (16-20 vs. 12-14), longer extrusomes (on average 12-15 µm vs. 9 µm), greater length (25 µm vs. 15 µm) and a different brosse composition (equally long rows, 22-32 dikinetids), shorter brosse-cilia (5-7 µm vs. 10-11 µm) and kinetosomes on „head" more tightly spaced. This species is unlike any other known *Chaenea* spp.



Figs. 8a-e: *Chaenea* sp. after protargol impregnation (a-d) and from life (e). a, b: Dorsal and ventral view of same specimen. Macronuclear nodules exemplified. c: Detail of anterior area. d: Extrusomes. e: Outline from life. Scale bar divisions = 10 µm. Br, brosse.

Fuscheria marina nov. spec.

Diagnosis: In vivo about 100 x 40 µm. Shape ellipsoidal. 34-39 somatic kineties. Macronucleus ellipsoid. 1 terminal contractile vacuole. Extrusomes about 11 µm long. Marine.

Type location: Pancake sea ice of Weddell Sea, Antarctica, 69° 49' S, 08° 02' W (core number AN 103106).

Type specimens: 1 holotype as a slide of protargol impregnated cells has been deposited.

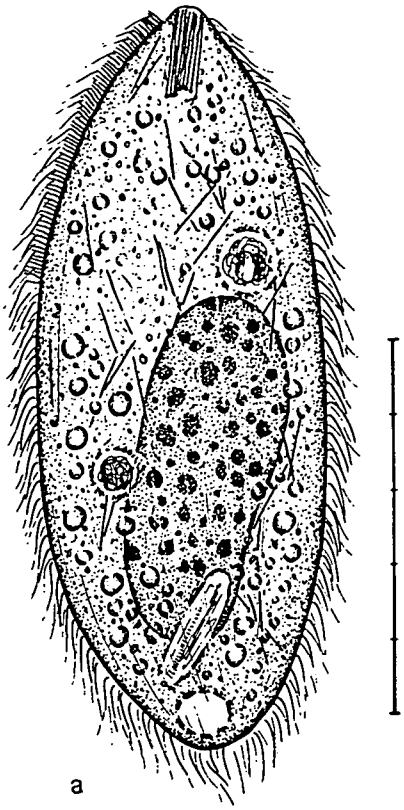
Derivatio nominis: „marinus", Lat., living in the sea.

Description (Figs. 9a-d, Table 7): Outline elliptical, anteriorly slightly tapering, posteriorly rounded. Mouth apical, opening circular, pharyngeal plug about 2 µm long (Figs. 9a, c). Cross section circular to slightly flattened. Single macronucleus long ellipsoid, longitudinally oriented, usually in posterior half of body, with spherical nucleoli. Micronucleus not impregnated with protargol. Single contractile vacuole terminally, excretory pore on antapical pole. Cytoplasm colourless, sometimes rather hyaline; contains many greenish globules (3-7 µm across), numerous small granules and food vacuoles with indeterminate contents and, rarely, pennate diatoms; specimens thus usually appear almost black. Movement moderately fast.

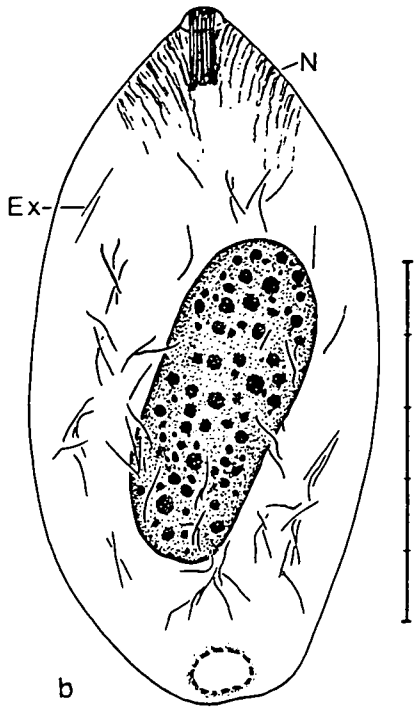
Somatic kineties meridional, bipolar, extending over entire length of cell, composed of monokinetids, cilia 14-16 µm long (Figs. 9c, d). 1 circumoral kinety, composed of dikinetids. Brosse formed by anterior portions of 2 somatic kineties, longer row about 33% of body length, 2nd row distinctly shorter, composed of ciliated dikinetids, cilia about 5-6 µm long. Extrusomes (toxicysts) typical for genus, long, nail-shaped, centrally in cytostome; rod-like in body. Nematodesmata originate from circumoral kinety and anterior basal bodies of somatic rows (Fig. 9b).

Occurrence and ecology: Rarely found in the endopagial of pancake sea ice of the Weddell Sea, between latitude 69° 26'-69° 49' S and longitude 07° 19'-08° 02' W. Occurs together with diatoms, flagellates and ciliates. Environmental parameters in brine (1 measurement): temperature -3.0 to -1.4°C, salinity 52.0‰, PO_4 0.6 µmol/l, NO_2 0.2 µmol/l, NO_3 7.9 µmol/l, NH_4 12.3 µmol/l, Si 19.2 µmol/l; chlorophyll *a* 2-15.5 µg/l melted ice. In raw cultures also at +1°C. Biomass of 10^6 individuals: 67 mg.

Figs. 9a-d: *Fuscheria marina* from life (a) and after protargol impregnation (b-d). a: Right lateral view. b: Outline showing extrusomes and nematodesmata. c, d: Left and right lateral view of same specimen. Scale bar divisions = 10 µm. Br, brosse; Ck, circumoral kinety; Ex, extrusomes; N, nematodesmata.



a



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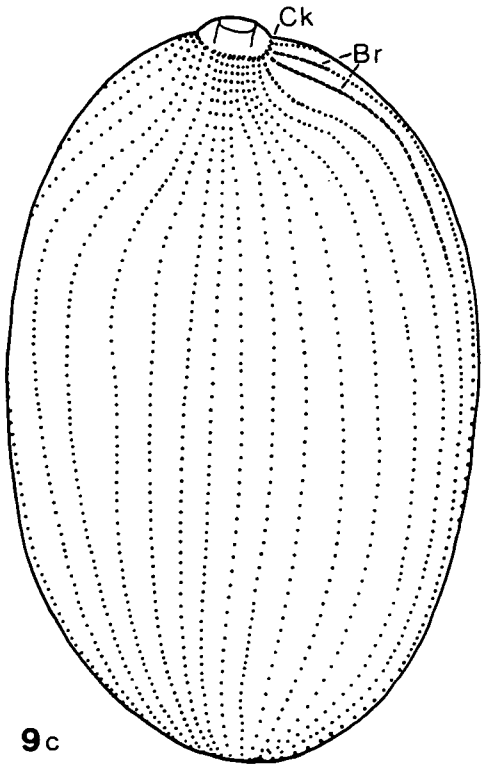
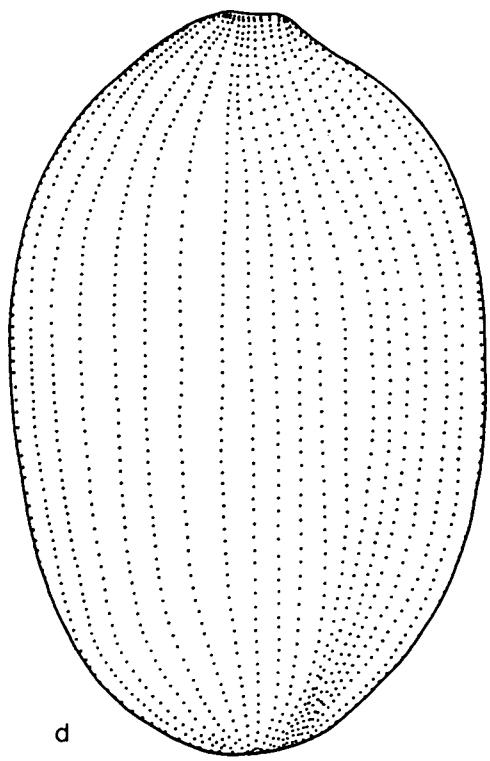


9c



d

Table 7. Morphometric characteristics of *Fuscheria marina* (n = 3); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	104.0	105.0	9.5	5.51	9.2	94	113.0
Body, width	60.3	60.0	4.5	2.60	7.5	56	65.0
Macronucleus, length	48.7	48.0	2.1	1.20	4.3	47	51.0
Macronucleus, width	21.0	21.0	1.0	0.58	4.8	20	22.0
Cytostome, diameter	5.5	5.0	0.9	0.50	15.8	5	6.5
Extrusome, length	11.1	11.0	1.3	0.45	11.4	9	13.0
Somatic kineties, number	36.0	35.0	2.7	1.53	7.4	34	39.0

Comparison with related species: Nail-shaped extrusomes centrally in the cytostome and a 2-rowed brosse are main characters of *Fuscheria* (FOISSNER 1983, 1984a). We could find no species of *Fuscheria* in the literature which has characters like *F. marina*. In addition, species of this genus have previously only been found in freshwater and soil (e.g. BERGER et al. 1983; FOISSNER 1983; FOISSNER & O'DONOGHUE 1990; SONG & WILBERT 1989). E.g., the limnetic *Fuscheria lacustris* SONG & WILBERT, 1989 differs in the smaller size, fewer somatic kineties (22-30 vs. 34-39), shape of macronucleus (more compact) and composition of brosse (row 1: about 9 vs. 38 dikinetids; row 2: 2-3 vs. about 9 dikinetids).

Lacrymaria spiralis CORLISS & SNYDER, 1986

Improved diagnosis: In vivo 80-700 µm, usually about 180-260 x 65-120 µm. Shape bottle-like, contractile. 14-49 somatic kineties. 1 spiral macronucleus. 1 subterminal contractile vacuole. Cortical granules ruby. Marine.

Morphology and infraciliature (Figs. 10a-j, 64, Table 8): Bottle- to club-shaped, fusiform, broadest at or behind mid-body, posteriorly always pointed; caudal constriction 30-40 µm long, hyaline; pharyngeal plug conspicuous; head broad, distinct from neck, frequently detaches under cover slip; neck inconspicuous,

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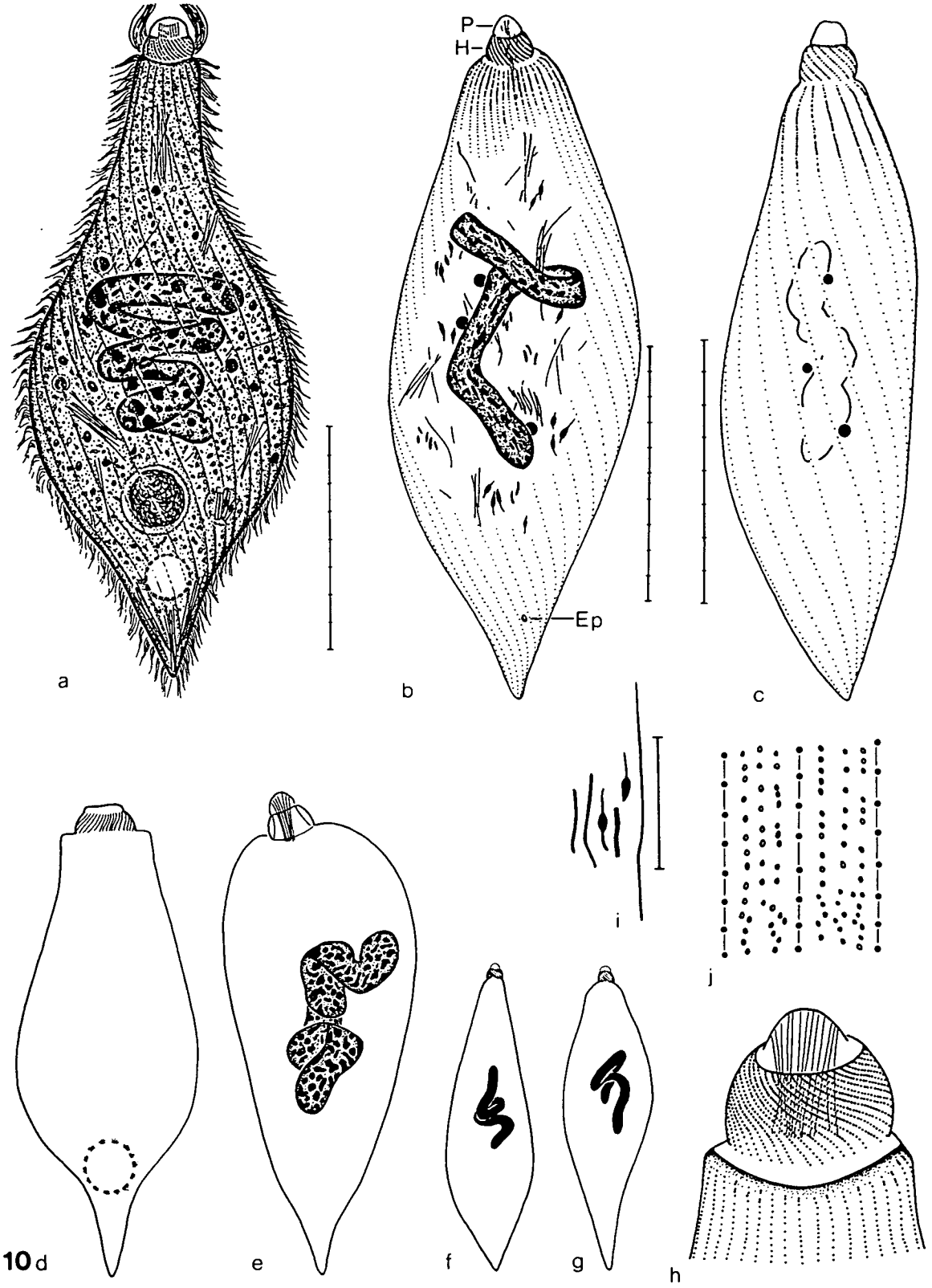
Figs. 10a-j: *Lacrymaria spiralis* from life (a, d) and after protargol impregnation (b, c, e-j); form I except where noted. a: Side view of elongated specimen. b, c: Side view of form I and form II. d: Side view of contracted specimen. e-g: Different shapes of body and macronucleus. h: Detail of anterior portion. i: Extrusomes. j: Cortical granulation. Scale bar divisions = 10 µm. Ep, excretory pore of contractile vacuole; H, head; P, pharyngeal plug.



about 30 µm wide; longitudinally contractile (especially neck), contracted specimens plump (Figs. 10a, d, 64). Cross section circular. Single macronucleus long, string-like, irregularly spiralled, about in mid-body, contains spherical to ribbon-like nucleoli (Figs. 10a-c, e-g, 64). 1-3 (always 3?) micronuclei, spherical, in indentation of macronucleus. 1 contractile vacuole subterminally at beginning of caudal constriction, pulsation not observed. Excretory pore of contractile vacuole in silver nitrate slides at beginning of caudal constriction (Fig. 10b). Cortical granules ruby (rarely almost colourless), in longitudinal rows between kineties, sometimes irregularly arranged, also scattered in entoplasm, <1 µm in diam. (Fig. 10j). Cytoplasm often reddish brown (due to digested diatoms?), contains many lipid droplets (3-5 µm across), shining green globules (ca. 4-7 µm in diam.) and deeply red, rarely yellow-green food vacuoles (up to 30 µm across) with small pennate diatoms (up to 12 µm long), flagellates and undefinable contents; this renders specimens darkly reddish brown to almost black at low magnification, rarely orange or greenish. Movement rather slow, short distances back and forth between detritus, rotates about long axis when swimming.

Somatic kineties spiralling; in anterior portion longitudinal, basal bodies densely spaced, brosse thus usually not recognizable (sometimes apparently formed by 1 to few dikinetids at anterior ends of rows); cilia in vivo about 10 µm long; about 35 ciliary rows on head (Figs. 10b, c, h). Extrusomes rod-shaped, fine, in oral area and scattered in entoplasm (often in bundles), in vivo about 22 µm long; distinctly smaller extrusomes usually thickened knot-like, very likely developmental stages (Fig. 10i).

Several slides of protargol impregnated specimens of form I and II have been deposited for reference.

Occurrence and ecology: Common in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 68° 44'-71° 00' S and longitude 06° 04'-12° 08' W. Up to 886 active ind./l melted ice were found (biomass 0.5 mg/l), comprising up to 33.3% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -4.5 to -1.8°C, salinity 32.3-59.1‰, PO_4 1.1-6.0 µmol/l, NO_2 0.2-0.6 µmol/l, NO_3 15.5-45.8 µmol/l, NH_4 4.6-18.0 µmol/l, Si 27.9-54.9 µmol/l; chlorophyll *a* 0.9-120.2 µg/l melted ice. In raw cultures also at a salinity of 14.5-23.2‰ and +1°C. Biomass of 10^6 individuals: 550 mg.

Table 8. Morphometric characteristics of *Lacrymaria spiralis* form I (upper line, n = 30), *L. spiralis* form II (middle line, n = 30) and *L. lagenula* (lower line, n = 4); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	255.4	251.0	90.4	16.24	35.4	138.0	490
	148.4	149.0	31.2	7.15	21.0	76.0	214
	109.8	103.5	37.2	18.59	33.9	78.0	154
Body, width	97.1	91.0	26.7	4.80	27.5	48.0	174
	57.4	54.5	12.2	2.22	21.2	35.0	96
	42.3	42.5	12.3	6.14	29.1	28.0	56
Macronucleus, length[1]	97.0	90.0	34.1	6.22	35.2	36.0	164
	64.9	63.5	18.1	3.30	27.9	32.0	112
	29.3	32.0	7.4	4.26	25.1	21.0	35
Macronucleus, width	20.1	19.0	5.4	0.99	27.0	11.0	32
	13.7	12.0	4.5	0.82	32.7	8.0	29
	13.7	11.0	4.6	2.67	33.8	11.0	19
Micronucleus, diameter	3.2	3.0	0.6	0.14	19.1	2.5	5
	2.8	3.0	0.5	0.10	17.0	2.0	4
	–[2]	–	–	–	–	2.5	2
Extrusome in body, length	13.9	16.0	6.7	1.20	47.9	4.0	24
	10.2	11.0	2.8	0.51	27.7	4.0	14
	8.3	9.0	3.7	1.50	44.0	4.0	12
Extrusome in oral area, length	21.5	21.0	5.2	1.02	24.3	12.0	37
	–[3]	–	–	–	–	–	–
	–[3]	–	–	–	–	–	–
Head, length	11.9	12.0	3.4	0.61	28.6	6.0	20
	7.3	7.0	0.9	0.20	11.6	6.0	9
	5.8	6.0	0.8	0.37	14.4	5.0	7
Head, width	20.0	17.0	7.1	1.28	35.7	12.0	44
	9.2	8.0	2.0	0.45	21.6	7.0	14
	6.1	6.0	0.6	0.24	9.0	5.5	7
Macronuclei, number	1.0	1.0	0.2	0.03	17.7	1.0	2
	1.0	1.0	0.0	0.00	0.0	1.0	1
	1.0	1.0	0.0	0.00	0.0	1.0	1
Micronuclei, number	–[4]	–	–	–	–	1.0	3
	–[4]	–	–	–	–	1.0	3
	–[3]	–	–	–	–	1.0	1
Somatic kineties, number	30.3	29.0	6.1	1.09	20.0	22.0	49
	16.2	16.0	1.0	0.17	5.9	14.0	19
	13.0	13.0	1.0	0.45	7.7	12.0	14

[1] Macronuclear figure in *L. spiralis*.
[2] Not enough data.
[3] Not determined.
[4] Perhaps incompletely impregnated, statistics thus not given.

Comparison with related species: The unique spiralling macronucleus is the species character of *L. spiralis* (CORLISS & SNYDER 1986). The specimens found by us are, however, usually larger and have more somatic kineties than in the original description (96 x 35 µm, 14 somatic kineties, n = 2; CORLISS & SNYDER 1986). The number of micronuclei, the indistinct neck and the rather broad head are further indications for conspecificity with *L. spiralis*. Information on extrusomes, colouration and cortical granules are not available from the original population (CORLISS & SNYDER 1986).

According to body size and number of somatic kineties, 3 groups of *L. spiralis* could be distinguished in the Antarctic material: form I large, 22-36 somatic kineties; form II small, 14-19 rows; form III small and large specimens (n = 3), 42-49 somatic rows. Members of these groups are frequently found together. All of these have the characteristic spiralled macronucleus and the caudal constriction. These „forms" are thus very likely only variations of the same species.

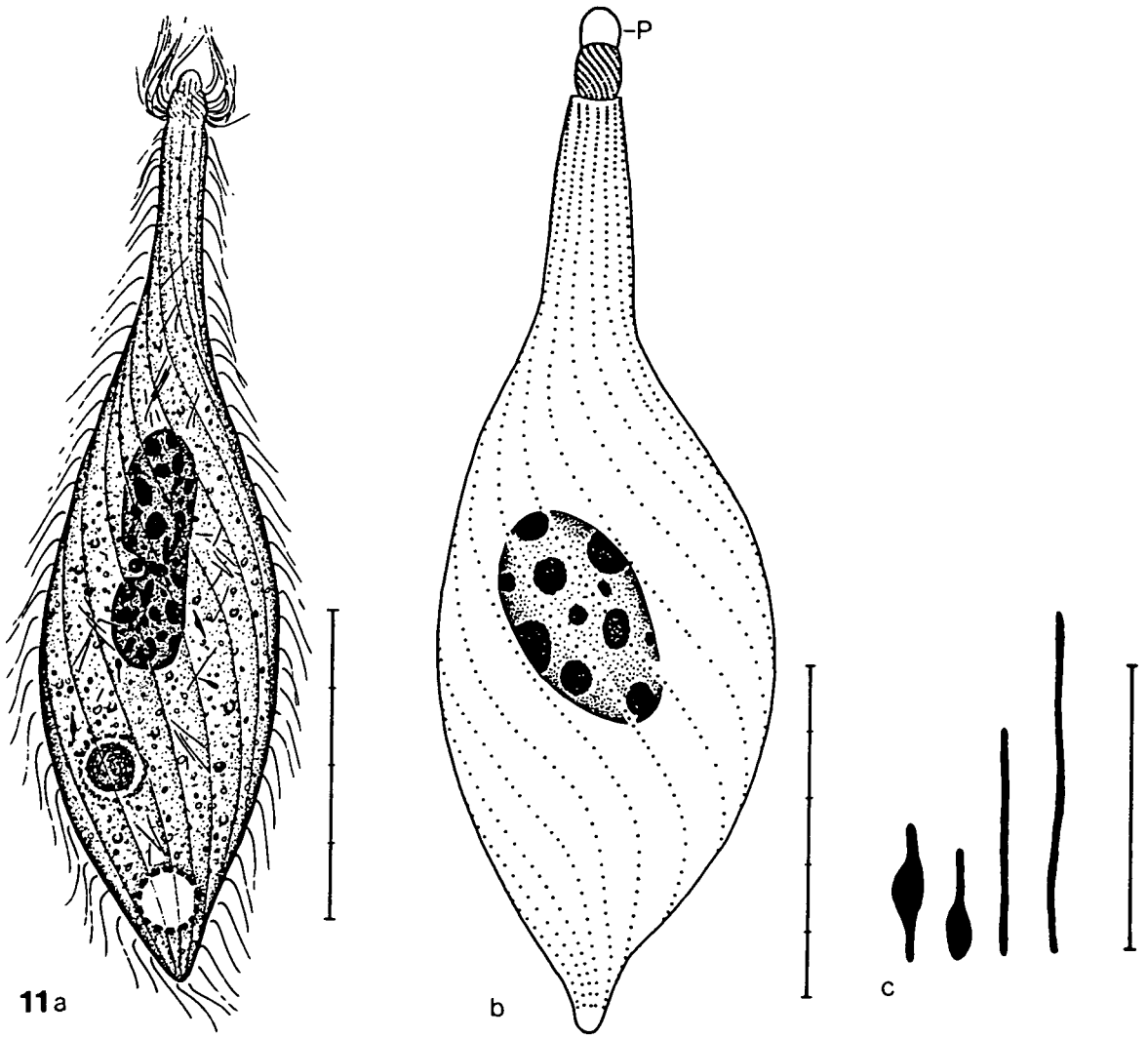
Lacrymaria lagenula CLAPARÈDE & LACHMANN, 1859

Improved diagnosis: In vivo 80-150 x 20-30 µm. Body club-shaped, longitudinally slightly contractile. 12-14 somatic kineties, longitudinally arranged on neck. Extrusomes rod-shaped, 4-12 µm long. 1 ellipsoid macronucleus. 1 terminal contractile vacuole. Marine.

Neotype material: 1 neotype and a 2nd slide of protargol impregnated specimens have been deposited.

Redescription (Figs. 11a-c, Table 8): Specimens club-shaped, anteriorly tapering, posteriorly pointed; longitudinally slightly contractile (Fig. 11a). Cross section circular. Pharyngeal plug conspicuous, about 5 x 5 µm; head rather broad. Pellicle grooved along kineties, delicate. Macronucleus elongate to broadly ellipsoid, about in mid-body, nucleoli spherical to elongate. Single micronucleus, globular, 2-2.5 µm across, in deep indentation of macronucleus. 1, very likely, contractile vacuole subterminally, pulsation, however, not observed. Cytoplasm colourless, sometimes yellowish, contains few to numerous globules (2-3 µm in diam.) and food vacuoles with flagellates and indeterminate contents; specimens rather transparent to quite dark. Movement straight ahead, usually slow to moderately fast, rotating about main body axis.

Somatic kineties longitudinally on neck, in anterior portion basal bodies densely spaced, frontal ends of rows probably composed of dikinetids (difficult to discern); distinctly spiralling posteriorly; cilia about 10 µm long (Fig. 11b). Extrusomes rod-shaped, fine, scattered in body; short extrusomes thickened knot-like, very likely developmental stages (Fig. 11c).



Figs. 11a-c: *Lacrymaria lagenula* from life (a) and after protargol impregnation (b, c). a, b: Side views. c: Extrusomes. Scale bar divisions = 10 µm. P, pharyngeal plug.

Occurrence and ecology: Rarely found in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 69° 07'-71° 00' S and longitude 07° 59'-12° 08' W. Up to 2 111 active ind./l melted ice were found

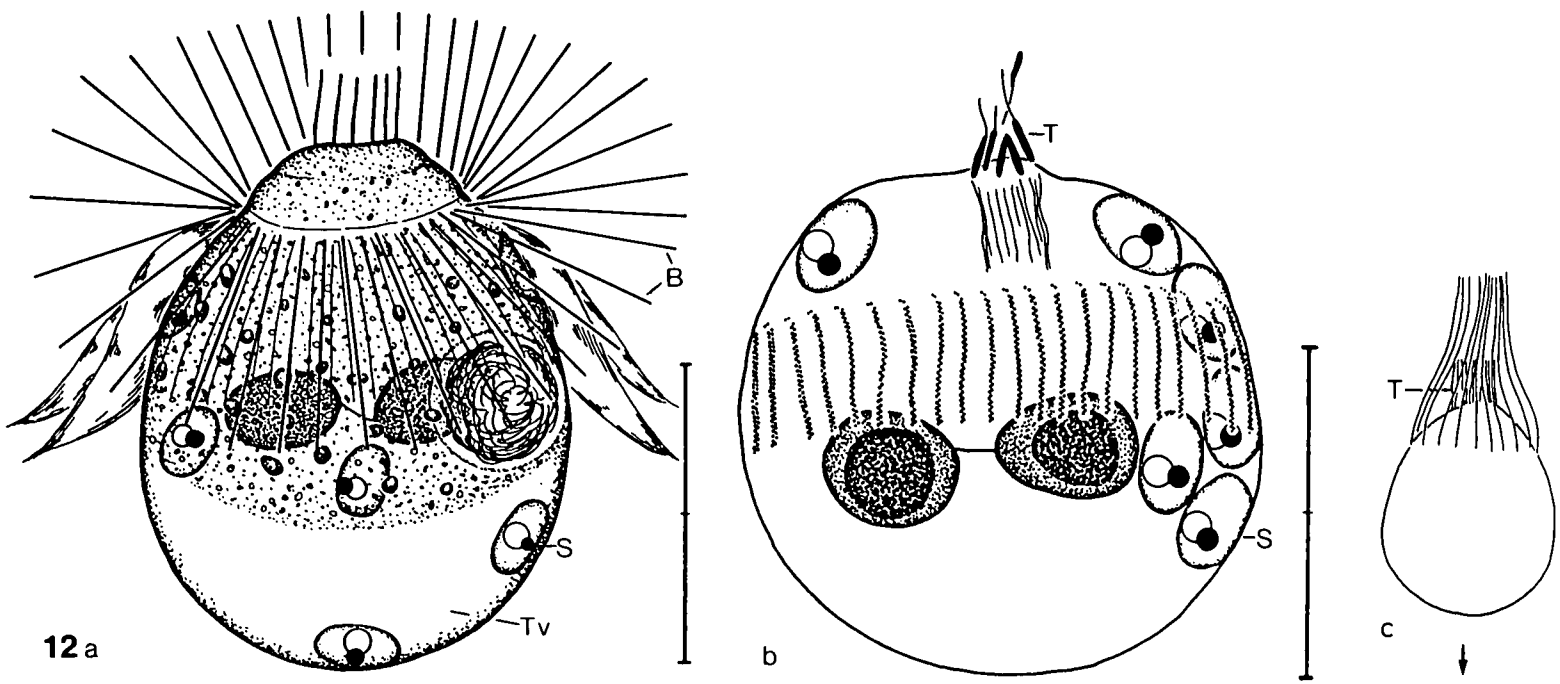
(biomass 0.05 mg/l), comprising up to 6.3% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates, e.g. *Lacrymaria spiralis*. Environmental parameters in brine: temperature -3.4 to -2.6°C, salinity 51.8-59.1‰; in melted ice: PO_4 1.7-2.8 µmol/l, NO_2 0.1 µmol/l, NO_3 2.6-6.1 µmol/l, NH_4 3.5 µmol/l, Si 7.7-14.8 µmol/l, chlorophyll *a* 49.3-80.1 µg/l. In raw cultures also at a salinity of 15.6-21.3‰ and +1°C. Biomass of 10^6 individuals: 26 mg.

Comparison with related species: There are numerous lacrymariid species many of which are rather superficially described or obviously incorrectly determined. This Antarctic population corresponds well with the original and subsequent descriptions of *L. lagenula* in size (about 70-125 µm), bottle-shaped body, moderately contractile neck, ellipsoid macronucleus, arrangement of somatic kineties and marine habitat (CLAPARÈDE & LACHMANN 1859; GOURRET & ROESER 1888; KENT 1881; QUENNERSTEDT 1867). The identification is thus fairly certain.

Lacrymaria lagenula described by KAHL (1927, 1930), however, differs distinctly in shape and the band-like macronucleus. The population studied by COHN (1866) evidently belongs to *Phialina*. *Lacrymaria versatilis* (MUELLER , 1786) DUJARDIN, 1841 sensu KAHL (1930, 1935) and QUENNERSTEDT (1867) is rather similar and thus very likely conspecific with *L. lagenula*. According to the original and other descriptions (DUJARDIN 1841; KENT 1881; MÜLLER 1786), however, the former species is rather similar to *L. olor* (MUELLER, 1786), with which it was synonymized (FROMENTEL 1876).

Lacrymaria coronata CLAPARÈDE & LACHMANN, 1859 is slightly larger (150-200 µm) than *L. lagenula* and possesses a band-like macronucleus (CLAPARÈDE & LACHMANN 1859; KAHL 1930). However, it cannot be clearly distinguished from the latter species and might thus be conspecific with it (CAREY 1992; KAHL 1930). *Lacrymaria lagenula* differs from the rather similar *L. filiformis* (MASKELL, 1886) FOISSNER, 1983 mainly in the distinctly spiralling kineties on the neck, a smaller head and the freshwater habitat. *Lacrymaria pumilio* VUXANOVICI, 1962 is slightly shorter (viz. 40-80 µm), has a smaller macronucleus (18 x 5 µm vs. 29 x 14 µm), a reniform micronucleus, distinctly fewer cilia per kinety (about 35 vs. ca. 90) and occurs in freshwater (FOISSNER 1983; VUXANOVICI 1962).

Lacrymaria sp. found by THOMPSON (1972) in tidal pools of the Antarctic Peninsula possesses an ellipsoid macronucleus but is markedly longer (fixed specimens 188-265 µm) and has twice as many somatic kineties, viz. 25-30, indicating that it belongs to a different species.



Figs. 12a-c: *Myrionecta* sp. from life (a, c) and after protargol impregnation (b); lateral views. Symbionts exemplified. c: Moving specimen; arrow indicates direction. Scale bar divisions = 10 µm. B, bristles; S, symbiont; T, tentacular process; Tv, terminal vacuole.

Order Cyclotrichida JANKOWSKI, 1980

Myrionecta sp.

Morphology and infraciliature (Figs. 12a-c): In vivo 30-40 x 25 µm; in protargol slides 31-45 x 31 µm (n = 2). Shape ovoid to rarely barrel-like; posterior portion wider than anterior, antapically broadly rounded; terminal vacuole crescent-shaped, hyaline; oral area often slighty bulging, 3 µm across. In protargol slides, about 6 extrusome-like structures with filamentous protrusion on apex (tentacular processes?); in vivo rather distinct (Fig. 12a). Specimens very fragile, burst easily. 2 macronuclei, about in mid-body, globular to ellipsoid, 6-9 x 5-7 µm (n = 4), connected by funiculus. Micronucleus not impregnated with protargol. Cytoplasm apparently with numerous (about 13-31) symbionts, green, immediately below pellicle, often lying side by side, ellipsoidal, 5 x 3.5 µm; specimens appear green. Movement jerking short distances to and fro; darting very fast over longer distances, with rear end forward, cirri flexible, folded towards apex; rests motionlessly, cirri stiffly spread (Figs. 12a, c).

38 kinety belt rows (n = 2), longitudinal, about 5 µm long, composed of paired basal bodies, anteriorly 1 dikinetid often slightly displaced; pre-equatorial and equatorial kineties not separated by gap; cilia and cirri about 16-18 µm long (Fig. 12b). Distance from apex to posterior margin of kinety belt about 16 µm. No circumoral kinety. Pharyngeal fibres about 6 µm long.

Occurrence and ecology: Common in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 67° 47'-70° 33' S and longitude 06° 04'-12° 08' W. Up to 7 125 active ind./l melted ice ($\bar{x}$ = 1 919, n = 15) were found (up to 0.07 mg biomass/l) comprising up to 100% ($\bar{x}$ = 30.1%, n = 15) of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates, e.g. *Rhabdoaskenasia* sp. Environmental parameters in brine: temperature -7.3 to -2.1°C, salinity 38.2-102.0‰, PO_4 0.6-1.8 µmol/l, NO_2 0.2-0.8 µmol/l, NO_3 9.1-34.2 µmol/l, NH_4 5.8-48.1 µmol/l, Si 25.6-71.0 µmol/l; chlorophyll *a* 2.2-45.7 µg/l melted ice. In raw cultures also at a salinity of 14.4-29.6‰ and +1°C. Biomass of 10^6 individuals: 10 mg.

Generic position and comparison with related species: The shape is characteristic for *Mesodinium* STEIN, 1863, the infraciliature, however, resembles that of the insufficiently diagnosed genus *Myrionecta* JANKOWSKI, 1976 (BORROR 1972b; GRAIN et al. 1982; KAHL 1930; KRAINER & FOISSNER 1990; LINDHOLM 1985; TAMAR 1986, 1992; TAYLOR et al. 1971). This species differs from *Myrionecta rubra* in shape and its green colour (GRAIN et al. 1982; LINDHOLM 1985; TAYLOR et al. 1971).

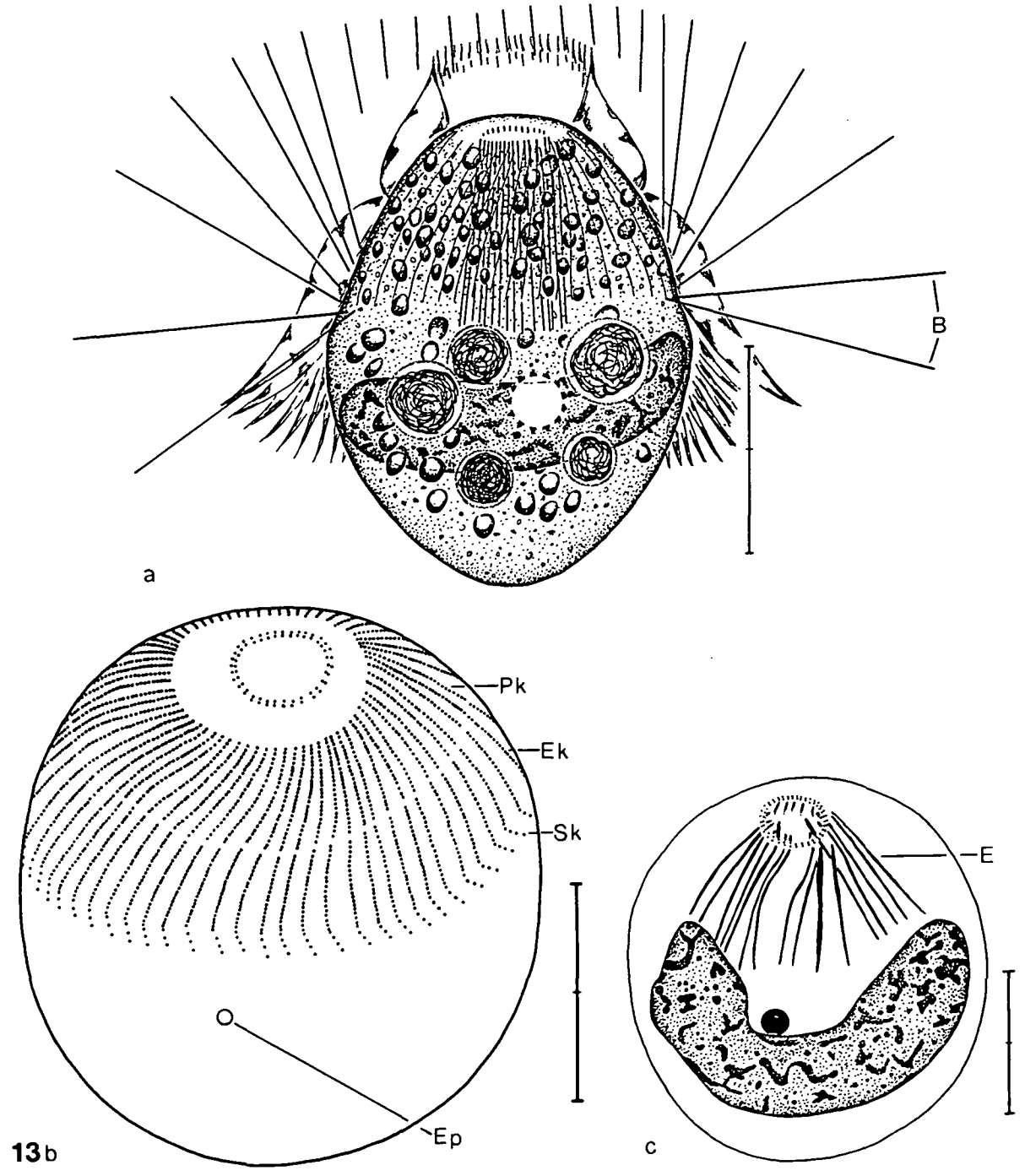
Only very few specimens were found in the slides, hence we refrain from a further determination. Active specimens were, however, regularly encountered in the ice samples.

***Rhabdoaskenasia* sp.**

Description (Figs. 13a-c): Shape ellipsoidal, equatorially constricted, slightly wider in posterior portion, gently tapering antapically, anteriorly transversely truncate or slightly bulging (about 12 µm across, apparently retractable; Fig. 13a). Cross section circular. Specimens fragile, burst easily. In protargol slides spherical, 48 x 47 µm (n = 2). Macronucleus C-shaped, 43-44 x 11-12 µm (n = 2), in posterior half of body, with small globular and ribbon-like nucleoli (Fig. 13c). Micronucleus spherical, not always impregnated with protargol. At least 1, perhaps 2 contractile vacuoles on opposite sides of cell, pulsation, however, not observed; excretory pore subequatorial. Extrusomes rod-shaped, ca. 20-27 µm long, in oral area, extending to centre of cell (Fig. 13c). Cytoplasm contains reddish and some green inclusions (very likely algae), spherical, 3-5 µm across, mainly in posterior half of cell; specimens usually appear red, well fed ones rather dark at low magnification. Movement darting very fast over longer distances, in straight line, alternating with periods of resting (cirri stiffly spread).

About 63-65 kinety belt rows in anterior body half (n = 2); pre-equatorial and equatorial kineties composed of densely spaced monokinetids, separated by very inconspicuous gap or continuous, in vivo cilia distinctly separate, 17-26 µm long; subequatorial rows oblique, consist of 3 single basal bodies each, cirri in vivo about 36 µm; distance from apex to posterior margin of subequatorial kinety belt about 23 µm. Circumoral kinety consists of non-ciliated dikinetids (Fig. 13b).

2 slides of protargol impregnated specimens have been deposited for reference.



Figs. 13a-c: *Rhabdoaskenasia* sp. from life (a) and after protargol impregnation (b, c); lateral views. Scale bar divisions = 10 µm. B, bristles; E, extrusomes; Ek, equatorial kinety belt; Ep, excretory pore of contractile vacuole; Pk, pre-equatorial kinety belt; Sk, subequatorial kinety belt.

Occurrence and ecology: Frequently found in the endopagial of mainly pancake sea ice, also recorded in the brown layer of multiyear sea ice of the Weddell Sea, between latitude 67° 47'-70° 33' S and longitude 06° 04'-12° 01' W. Occurs together with diatoms, flagellates and ciliates (often *Myrionecta* sp.). Up to 2 642 active ind./l melted ice ($\bar{x} = 1\ 099$, $n = 6$) were found (up to 0.04 mg biomass/l), comprising up to 33% ($\bar{x} = 18.5\%$, $n = 6$) of the total ciliate community. Environmental parameters in brine: temperature -7.3 to -2.1°C, salinity 38.2-100.0‰, PO_4 0.5-1.8 µmol/l, NO_2 0.2-0.8 µmol/l, NO_3 9.1-21.9 µmol/l, NH_4 12.0-48.1 µmol/l, Si 26.1-58.3 µmol/l; chlorophyll *a* 2.2-31.2 µg/l melted ice. In raw cultures also at a salinity of 14.4-20.7‰ and +1°C. Biomass of 10^6 individuals: 15 mg.

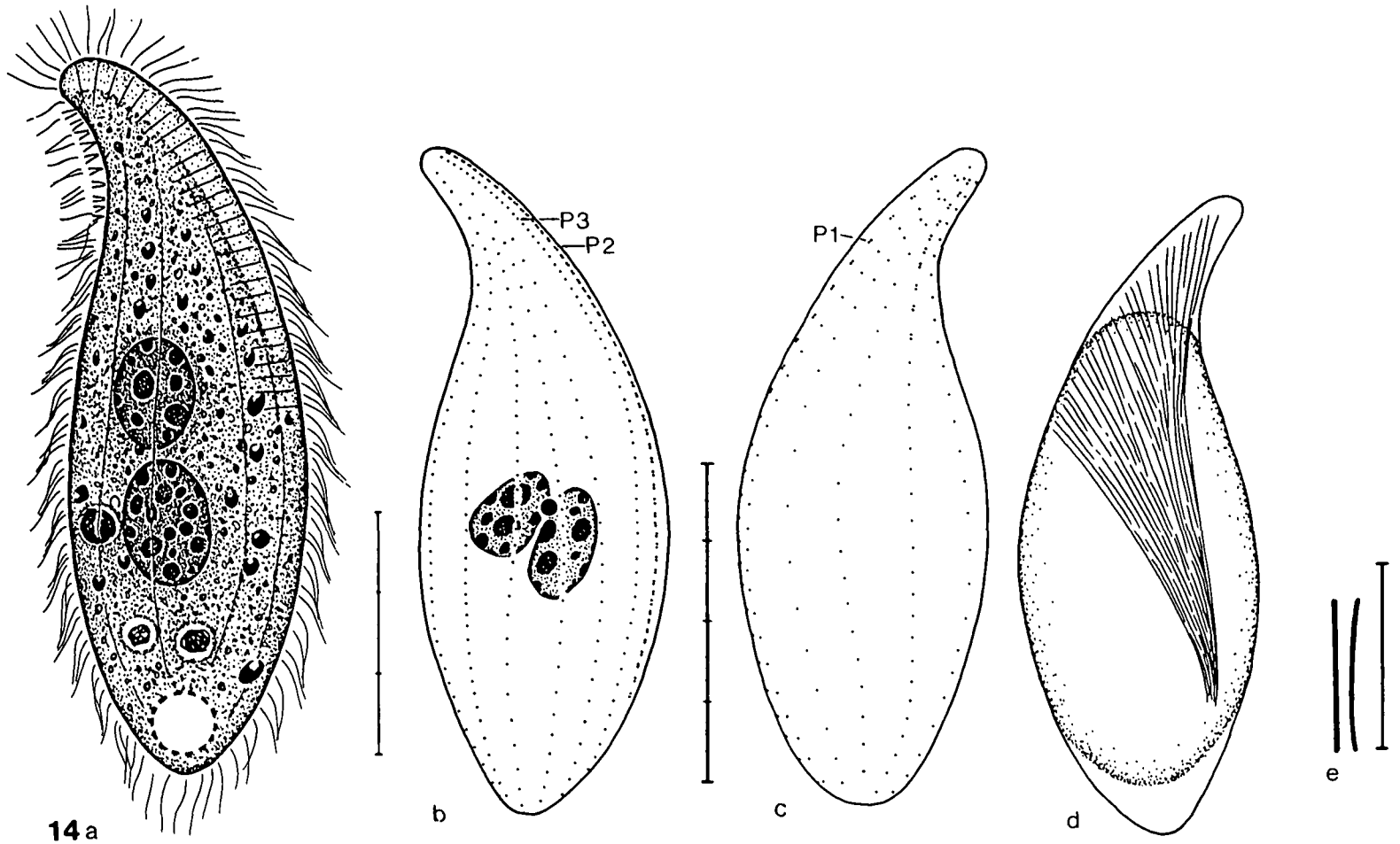
Generic position and comparison with related species: Only very few specimens have been found in the protargol slides. We thus refrain from the establishment of a new species. The monokinetidal composition of the equatorial belt kineties is a main character of *Rhabdoaskenasia* and the present specimens are thus included here (KRAINER & FOISSNER 1990). The subequatorial rows, however, consist of 3 basal bodies each as in *Askenasia*; in *Rhabdoaskenasia*, these are composed of 2 each (KRAINER & FOISSNER 1990). However, this is very likely not a reliable genus character. The only other congener, *R. minima* KRAINER & FOISSNER, 1990, differs from *Rhabdoaskenasia* sp. mainly in the freshwater habitat and the club-shaped extrusomes.

On account of its red inclusions, *Rhabdoaskenasia* sp. might have previously been confused with *Myrionecta rubra* (LOHMANN, 1908) JANKOWSKI, 1976. The latter species occurs in several faunal lists from Antarctic sea ice (e.g. GARRISON & BUCK 1986, 1989b, 1991; STOECKER et al. 1993) but was never found in the numerous cores investigated in the present study.

Order Pleurostomatida SCHEWIAKOFF, 1896

Litonotus emmerichi nov. spec.

Diagnosis: In vivo 60-90 x 25-30 µm. Outline broadly lanceolate. 5 right, 4-5 left lateral somatic kineties. 1 terminal contractile vacuole. 2 macronuclear nodules, 1 micronucleus. Extrusomes rod-shaped, in vivo 3-5 µm long. Marine.



Figs. 14a-e: *Litonotus emmerichi* from life (a) and after protargol impregnation (b-e). a: Right lateral view. b, c: Right and left lateral view of same specimen. d: Left lateral view. e: Extrusomes. a-d, scale bar divisions = 10 μm; e, scale bar = 5 μm. P1-P3, perioral kineties 1-3.

Type location: Multiyear sea ice of Weddell Sea, Antarctica, 70° 21' S, 08° 53' W (core number AN 103107b).

Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Dedication: I dedicate this species to my father, Emmerich PETZ, a passionate hobby-ornithologist, who roused my enthusiasm for zoology.

Description (Figs. 14a-e, Table 9): Shape broadly lanceolate, widest below mid-body, anteriorly and posteriorly tapering. Laterally compressed about 2:1, right side flat, left convex, dorsal body slightly vaulted, slightly grooved along kineties (Figs. 14a, d). Pronounced contractility not observed. 2 macronuclear nodules, in mid-body, ellipsoid, with several small spherical or single large nucleolus. Micronucleus between macronuclear nodules. Contractile vacuole terminally, pulsates in long intervals. Cytoplasm colourless, with many greasily shining globules rendering main part of body dark at low magnification, specimens often hyaline anteriorly and in area of mouth; food vacuoles contain green inclusions (ca. 3 µm across) and pennate diatoms. Movement slowly gliding on substrate.

Right somatic kineties anteriorly gradually shortened, left extend along whole length of cell; cilia of right side about 9 µm long, of left about 2.5 µm long. Brosse composed of about 10 basal body pairs, each basal body with short bristle-like cilium, continues posteriorly in row of single basal bodies. Kinety left of brosse with short cilia. 3 perioral kineties, i.e. 2 on right, 1 on left of mouth; kinety 2 and anterior half of row 1 composed of dikinetids, anterior basal body each with cilium, perioral kinety 2 almost extending over entire length of body; row 3 with single basal bodies, slightly more densely spaced than in somatic rows (Figs. 14b, c). Oral slit about half of body length. Nematodesmata fine, apparently originate from perioral kinetids, about 80% of body length (Fig. 14d).

Extrusomes rod-shaped, straight, inconspicuous, in vivo 3-5 µm long; located in oral region and scattered in body, rarely few on dorsal side (Fig. 14e).

Occurrence and ecology: Regularly found in the endopagial of pancake, multiyear sea and multiyear land-fast sea ice of the Weddell Sea, between latitude 69° 07'-71° 00' S and longitude 07° 59'-12° 08' W. Up to 1 056 active ind./l melted ice (biomass 0.02 mg/l) were found amounting up to 4% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates

and ciliates. Environmental parameters in brine: temperature -6.0 to -2.6°C, salinity 51.8-100.0‰, PO_4 1.7-2.8 µmol/l, NO_2 0.1-0.8 µmol/l, NO_3 2.6-9.1 µmol/l, NH_4 3.5-48.1 µmol/l, Si 7.7-14.8 µmol/l; chlorophyll *a* 46.4-80.1 µg/l melted ice. In raw cultures also at a salinity of 17.8-21.3‰ and +1°C. Biomass of 10^6 individuals: 20 mg.

Table 9. Morphometric characteristics of *Litonotus emmerichi* (upper line, n = 3) and *L. kopimorphus* (lower line, n = 6); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	86.3	85.0	14.1	8.11	16.3	73	101.0
	289.8	274.5	55.0	22.43	19.0	240	392.0
Body, width	34.0	31.0	5.2	3.00	15.3	31	40.0
	68.8	66.0	8.8	3.92	12.7	61	80.0
Macronucleus, length	14.3	13.0	3.2	1.86	22.4	12	18.0
anterior nodule	37.0	36.0	5.1	2.07	13.7	32	44.0
Macronucleus, width	10.0	11.0	1.7	1.00	17.3	8	11.0
anterior nodule	26.2	25.5	4.6	1.89	17.7	20	32.0
Macronucleus, length	17.3	16.0	6.1	3.53	35.3	12	24.0
posterior nodule	36.0	34.5	6.1	2.48	16.9	31	47.0
Macronucleus, width	10.3	11.0	3.1	1.76	29.6	7	13.0
posterior nodule	26.3	27.0	2.6	1.05	9.8	22	29.0
Micronucleus, length	–[1]	–	–	–	–	–	–
	6.5	6.5	0.5	0.29	7.7	6	7.0
Micronucleus, width	–[1]	–	–	–	–	–	–
	4.8	5.0	0.8	0.44	15.8	4	5.5
Extrusomes, total length	7.8	8.5	1.7	0.70	22.0	6	10.0
	15.4	15.0	1.6	0.49	10.6	13	19.0
Extrusome body, length[2]	9.2	9.5	1.0	0.30	10.9	8	11.0
Somatic kineties, number[3]	5.0	5.0	0.0	0.00	0.0	5	5.0
right side	21.8	22.0	2.6	1.05	11.7	19	25.0
Somatic kineties, number[3]	4.3	4.0	0.6	0.33	13.3	4	5.0
left side	11.5	10.0	1.6	0.72	13.9	9	15.0

[1] Not impregnated.
[2] In *L. kopimorphus*.
[3] Without perioral kineties.

Comparison with related species: The infraciliature of *L. emmerichi* is typical for the genus (FOISSNER 1984b). The species is distinguished from most other congeners in size, number and position of the contractile vacuole, number of macronuclei and somatic kineties and the habitat (e.g. KAHL 1931).

None of the few litonotids previously investigated with modern silver impregnation can be identified with it (cf. BLATTERER & FOISSNER 1988; FOISSNER 1978, 1984b; FOISSNER & O'DONOGHUE 1990; SONG 1991; SONG & WILBERT 1989; WILBERT & KAHAN 1981). *Litonotus fasciola* (EHRENBERG, 1830) SONG & WILBERT, 1989 differs in shape, arrangement of perioral kinety 2 (dikinetids only anteriorly), subterminal contractile vacuole and smaller macronuclei (4-7 µm vs. 12-24 µm; SONG & WILBERT 1989). *Litonotus triqueter* (PENARD, 1922) SONG & WILBERT, 1989 (anteriorly and posteriorly distinctly tapering, freshwater species) and *L. obtusus* (MAUPAS, 1888) SONG & WILBERT, 1989 have a conspicuous longitudinal ridge on the left side, a subterminal contractile vacuole and a perioral kinety 2 consisting mainly of monokinetids and extending over the entire body length (PENARD 1922; SONG & WILBERT 1989). *Litonotus yinae* SONG, 1991 is distinctly smaller (30-56 µm), has shorter (1.5-2.5 µm) and thicker extrusomes and occurs ectocommensally on fish and periphytic in fish ponds.

Litonotus sp. from the marine Antarctic is not as wide as *L. emmerichi* (90 x 18 µm, n = 25) and possesses distinctly more (about 25) somatic kineties (THOMPSON & CROOM 1978). *Litonotus lamellus* from the marine Antarctic is too superficially described to allow a definitive identification (HADA 1970).

Litonotus kopimorphus nov. spec.

Diagnosis: In vivo about 200-260 x 55-70 µm. Body knifeblade-shaped. 19-25 right, 9-15 left lateral somatic kineties. Extrusomes graver-shaped, along entire ventral margin and scattered in body. 1 subterminal contractile vacuole near ventral margin. 2 macronuclear nodules connected by funiculus, 1 micronucleus. Cortical granules colourless. Marine.

Type location: Multiyear land-fast sea ice of Weddell Sea, Antarctica, 70° 31' S, 07° 59' W (core number AN 103100).

Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Derivatio nominis: „he kopis", the knife; „he morphe", the shape; Greek.

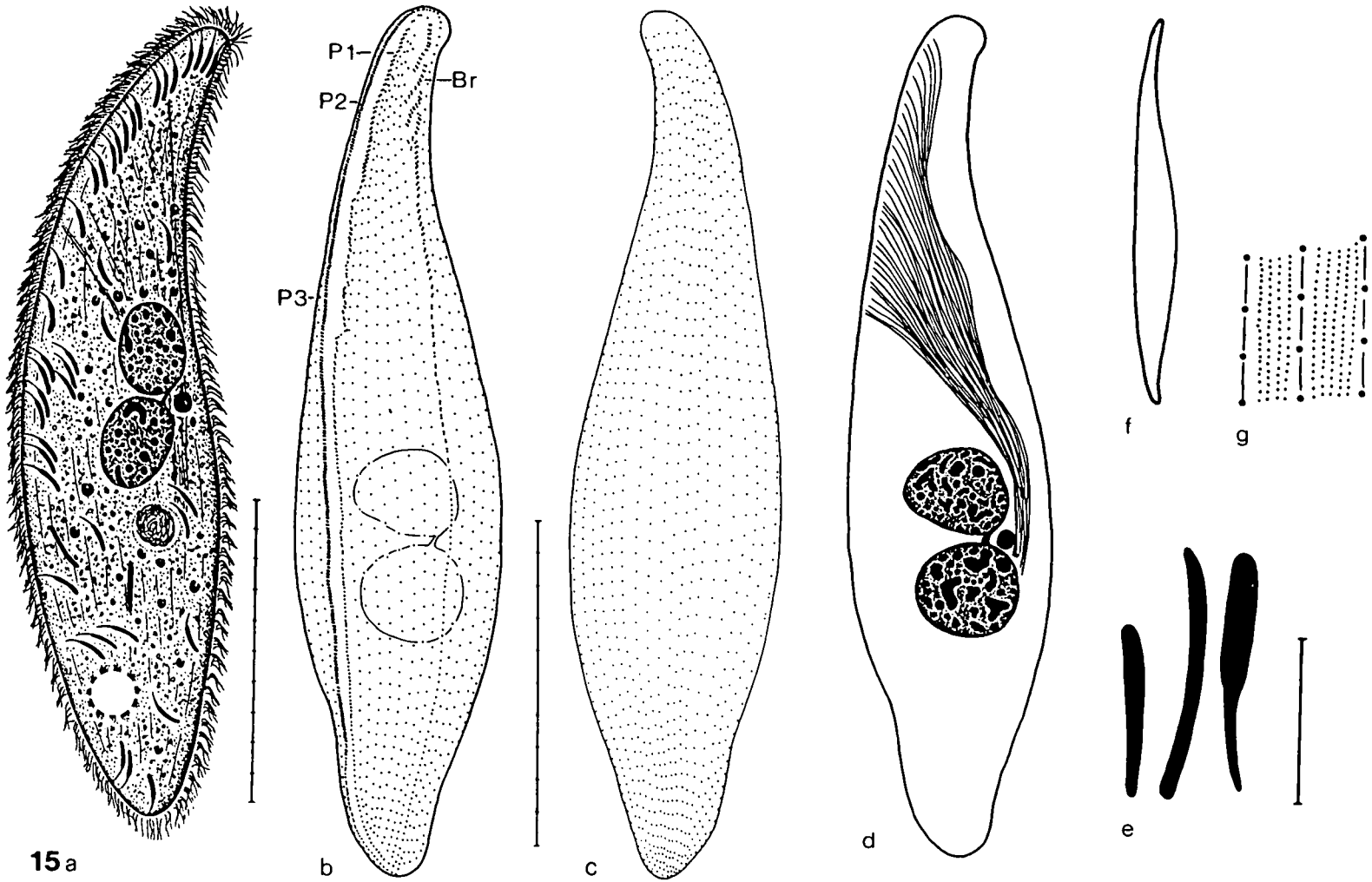
Description (Figs. 15a-g, 61, Table 9): Body slim, neck not distinctly separate, anteriorly and posteriorly tapering, rear portion narrowly rounded (Fig.

15a). Laterally compressed about 2:1; right side almost flat, often slightly grooved by kineties, left convex (Fig. 15a). 2 macronuclear nodules closely spaced, connected by short funiculus, in mid-body near right side, globular to slightly ellipsoid, with spherical to ribbon-like nucleoli. Micronucleus ellipsoid, between macronuclear nodules. Contractile vacuole subterminal, near ventral margin, in vivo about 15 µm across. Cortical granules colourless, densely spaced, in longitudinal rows between somatic kineties, not impregnated with protargol (Fig. 15g). Cytoplasm colourless, contains greasily shining globules and food vacuoles with green algae (ca. 15 µm in diam.), dinoflagellates, ciliates and small pennate diatoms; specimens rather dark at low magnification. Movement slowly gliding on substrate.

Somatic kineties meridional; on left side anteriorly slightly shortened, perhaps only partially ciliated (fixation artifact?), on right apparently not shortened anteriorly; cilia 10-12 µm long on right side, on left 5-6 µm (Figs. 15b, c). 3 perioral kineties, viz. 2 on right, 1 on left of mouth; row 1 (on left) with dikinetids in anterior 1/3-1/2 of body, slightly irregular, posteriorly with single basal bodies, densely ciliated; kinety 2 composed almost entirely of basal body pairs, extends over whole length of cell; perioral kinety 3 close to row 2, otherwise indistinct from somatic rows, consists of monokinetids (Fig. 15b). Brosse about in anterior body half, usually frontally fragmented, i.e. 2-5 slightly overlapping rows; formed by approximately 80 dikinetids, densely ciliated, cilia 5-6 µm long; posteriorly continued with monokinetids (Fig. 15b). Oral slit about 1/3 of body length, with inconspicuous rope-like structure. Nematodesmata apparently originate from basal bodies of perioral rows, about 60% of body length (Fig. 15d).

Extrusomes curved, usually graver-like, i.e. sausage-shaped body and spine-like anteriorly, very rarely rod-like (developmental stages?), in vivo 13-16 µm long; insert along entire ventral margin, some always on antapical pole, also scattered in entoplasm, not found on dorsal margin (Figs. 15a, e, 61, Table 9).

Occurrence and ecology: Rarely recorded in the endopagial of mainly multiyear land-fast sea and multiyear pack ice of the Weddell Sea, between latitude 69° 58'-71° 00' S and longitude 07° 27'-11° 54' W. Found together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine (1 measurement): temperature -2.3°C, salinity 41.5‰, PO_4 1.1 µmol/l, NO_2 0.2 µmol/l, NO_3 20.2 µmol/l, NH_4 17.5 µmol/l, Si 27.9 µmol/l; chlorophyll *a* 30.1 µg/l melted ice. Biomass of 10^6 individuals: 195 mg.



Figs. 15a-g: *Litonotus kopimorphus* from life (a, f, g) and after protargol impregnation (b-e). a: Left lateral view. b, c: Ventro-leftlateral and dorso-rightlateral view of same specimen. d: Ventro-leftlateral view. e: Extrusomes. f: Ventral view. g: Cortical granulation. Scale bar divisions = 10 μm. Br, brosse; P1-P3, perioral kineties 1-3.

Comparison with related species: The arrangement of the extrusomes in *L. kopimorphus*, viz. inserting along the entire ventral margin, is rather similar in *Loxophyllum*. The infraciliature is, however, litonotid, i.e. perioral kinety 2 posteriorly apparently with monokinetids and dorsolateral kineties not evident (also indicated by only longitudinal grooves on right side).

Litonotus trichocystiferus FOISSNER, 1984b differs in the freshwater habitat, extrusome shape (rod-like, straight), has fewer somatic kineties (9-12 rows on right and 4-6 on left), a shorter brosse and lacks cortical granules (FOISSNER 1984b). *Litonotus trichocystus* STOKES, 1885 is distinctly shorter (125-170 µm) and occurs also in freshwater (KAHL 1931; STOKES 1885).

***Kentrophyllum* nov. gen.**

Diagnosis: Medium-sized to large Amphileptidae, very flat. Having spines along ventral and dorsal margins. Right perioral kinety surrounding almost entire body.

Type species: *Kentrophyllum antarcticum* nov. spec.

Derivatio nominis: „to kentron", the spine; „to phyllon", the leaf; Greek. Neuter gender.

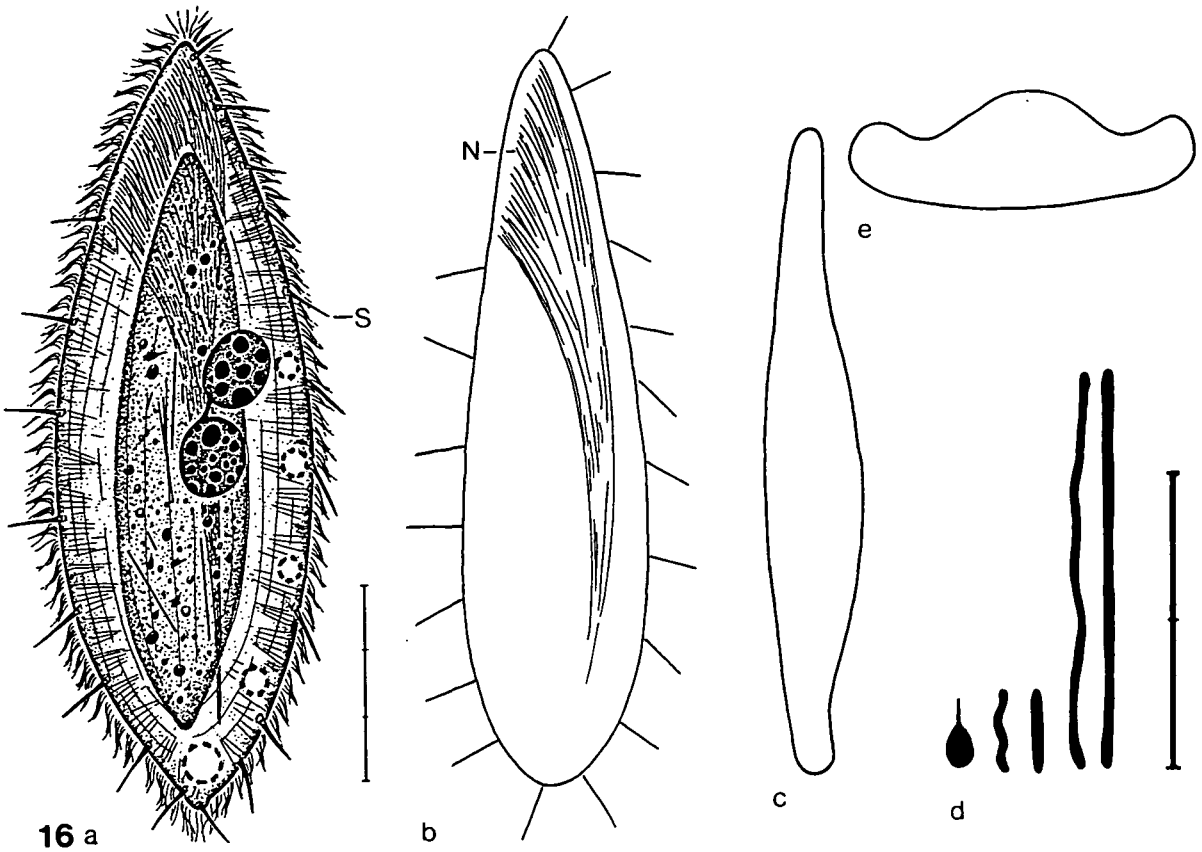
***Kentrophyllum antarcticum* nov. spec.**

Diagnosis: In vivo about 200-310 x 70-100 µm. Body leaf-shaped. 29-40 right somatic kineties. Left side evidently only with perioral kinety 1 and brosse (extending over entire length of body). Short and long extrusomes. No peribuccal papillae. 3-5 contractile vacuoles in dorsal row. 2 macronuclear nodules connected by funiculus.

Type location: Multiyear sea ice of Weddell Sea, Antarctica, 70° 21' S, 08° 53' W (core number AN 103107b).

Type specimens: 1 holotype as a slide of protargol impregnated cells has been deposited.

Derivatio nominis: „antarcticus", Lat., Antarctic.



Figs. 16a-e: *Kentrophyllum antarcticum* from life (a, c, e) and after protargol impregnation (b, d). a, b: Left lateral views. c: Ventral view. d: Extrusomes. e: Transverse section. a, scale bar divisions = 20 µm; d, scale bar divisions = 10 µm. N, nematodesmata; S, spines.

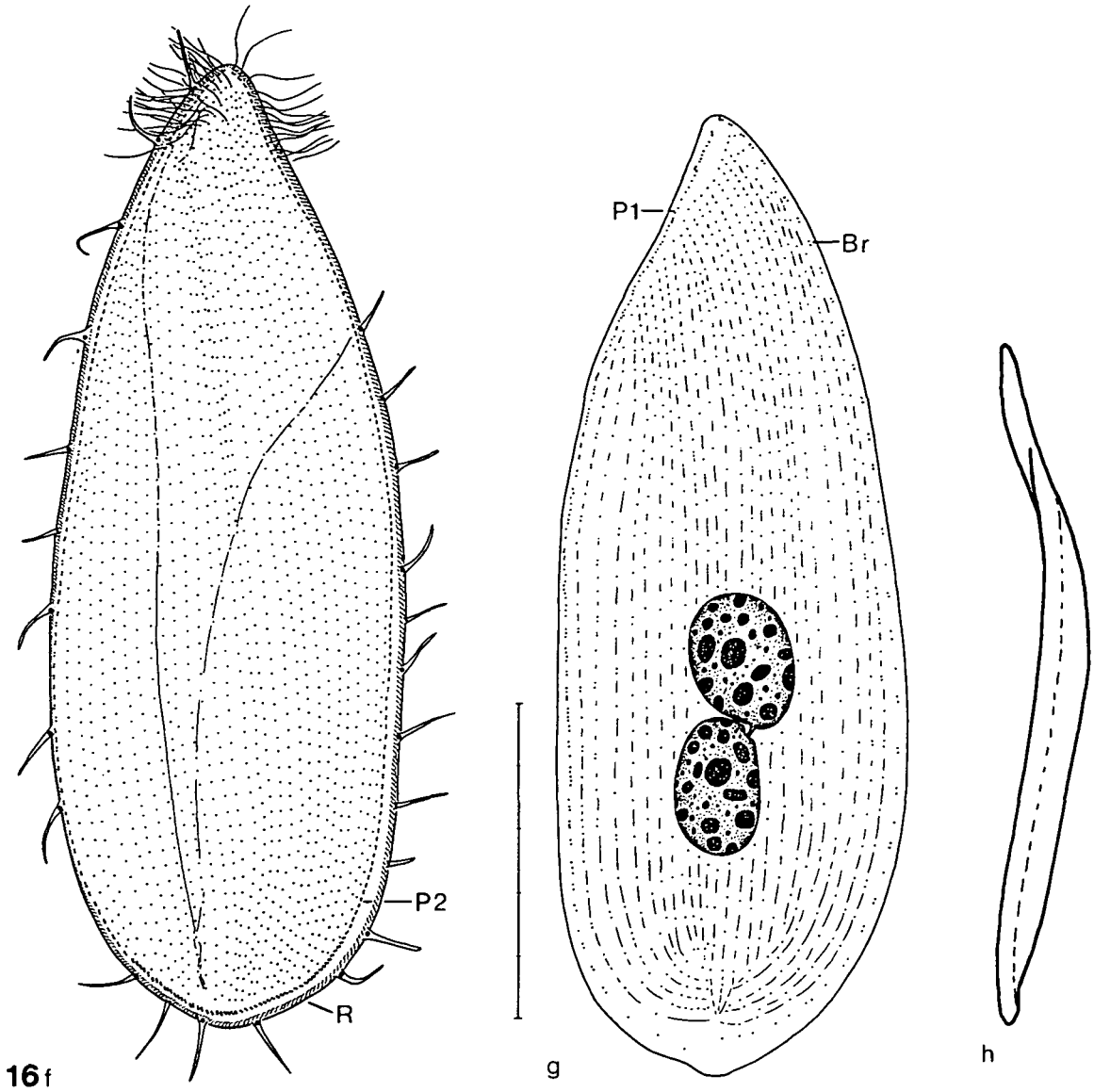
Description (Figs. 16a-h, Table 10): Outline broadly to slim leaf-shaped, variable, anteriorly and posteriorly tapering, rear portion sometimes broadly rounded; flexible, sometimes twisted (Figs. 16a-c). Laterally distinctly compressed, about 25 µm thick, right side almost flat, left slightly vaulted, with shallow longitudinal grooves; transverse section hat-like (Figs. 16c, e, h). Rope-like structure along ventral and dorsal margins, ca. 1 µm wide (Fig. 16f). 19-33 spines generally evenly spaced around ventral and dorsal cell margin, usually not in area of cytostome; in vivo needle-shaped, rigid, apparently immobile, bases slightly widened (Fig. 16f). 2 macronuclear nodules, in mid-body, spherical to slightly ellipsoid, connected by funiculus, nucleoli round. Micronucleus not impregnated with protargol. Several (3-5) contractile vacuoles, in row along dorsal margin. Cytoplasm colourless, specimens distally transparent, centrally greenish (due to food), rarely containing numerous

indefinable spherical inclusions (up to 6 µm in diam.). Movement slowly gliding on substrate.

Table 10. Morphometric characteristics of *Loxophyllum rostratum* (upper line, n = 30) and *Kentrophyllum antarcticum* (lower line, n = 10); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	179.1	173.5	39.1	6.91	21.8	100.0	288
	245.4	241.0	67.0	17.91	27.3	157.0	345
Body, width	72.1	71.5	16.8	2.97	23.3	32.0	118
	72.8	73.5	9.5	3.01	13.1	59.0	84
Macronucleus, length	27.3	25.5	4.9	0.90	18.1	19.0	38
anterior nodule	29.7	31.0	5.1	1.54	17.2	19.0	34
Macronucleus, width	21.8	22.0	3.4	0.61	15.4	16.0	29
anterior nodule	19.7	20.0	2.6	0.80	13.4	15.0	23
Macronucleus, length	29.5	28.0	5.8	1.06	19.6	22.0	42
posterior nodule	30.9	31.0	7.0	2.10	22.5	20.0	42
Macronucleus, width	21.8	20.5	3.5	0.64	16.1	16.0	31
posterior nodule	19.9	21.0	3.4	1.01	16.9	14.0	24
Micronucleus, diameter	4.7	5.0	0.8	0.18	16.7	3.5	7
	–[1]	–	–	–	–	–	–
Extrusomes along margin,	7.7	8.0	0.7	0.18	8.7	7.0	9
length	21.7	22.5	2.6	0.82	11.9	17.0	25
Extrusomes in cytoplasm,	8.7	8.5	1.1	0.25	13.0	6.5	11
length	4.8[2]	5.0	0.7	0.24	14.7	3.5	6
	27.0[2]	25.5	5.2	1.51	19.4	19.0	36
Spines, length	0.0	0.0	0.0	0.00	0.0	0.0	0
	11.5	11.5	1.8	0.48	15.5	8.0	15
Cytostome, length	–[3]	–	–	–	–	–	–
	63.0	62.0	17.0	5.37	27.0	42.0	95
Somatic kineties, number	17.1	17.5	2.5	0.45	14.4	11.0	21
right side[4]	35.5	36.0	3.7	1.04	10.5	29.0	40
Somatic kineties, number	6.1[4]	6.0	0.8	0.20	13.7	5.0	7
left side	1.0	1.0	0.0	0.00	0.0	1.0	1
Trichocyst warts, number	12.2	12.0	2.7	0.49	22.2	7.0	18
	0.0	0.0	0.0	0.00	0.0	0.0	0
Spines, number	0.0	0.0	0.0	0.00	0.0	0.0	0
	24.3	24.0	4.4	1.56	18.1	19.0	33

[1] Not impregnated.
[2] Short and long extrusomes in *K. antarcticum*, respectively.
[3] Not determined.
[4] Without perioral and dorsolateral kineties.



Figs. 16f-h: *Kentrophyllum antarcticum* from life (h) and after protargol impregnation (f, g). f, g: Right and left lateral view of same specimen. Ciliation exemplified. h: Ventral view. Scale bar divisions = 10 µm. Br, brosse; P1, P2, perioral kineties 1, 2; R, rope-like structure.

2 kinds of extrusomes: short ones 3-5 µm long, rod-shaped, rarely graver-shaped, scattered in body (developmental stages?); long extrusomes in vivo ca. 30 µm, rod-shaped, in protargol slides slightly distorted, around periphery, some also scattered in body (Fig. 16d). No trichocyst warts.

Right somatic kineties densely ciliated, few rows anteriorly shortened, terminate at perioral row 2; rarely, very few central rows anteriorly or posteriorly slightly shortened, joining V-like, thus giving the impression of a spica (FOISSNER 1984b). About 24-27 longitudinal grooves on left side, some gradually shortened anteriorly, terminate at perioral kinety 1, join U-like in posterior portion, associated with slightly irregularly arranged argentophilic granules (basal bodies?), apparently without cilia. Brosse extending over entire length of body, composed of slightly irregularly and loosely spaced paired basal bodies, with apparently 1 cilium each, intermediately and posteriorly very likely monokinetids, cilia 3-4 µm long (Fig. 16g). 2 perioral kineties, i.e. 1 on right, 1 on left side, cilia 10-13 µm long; row 1 (left) fairly irregular (dikinetids?), along ventral margin, posteriorly almost joining brosse; row 2 (right) composed of dikinetids with 1 cilium each, surrounding entire body, frontally with inconspicuous gap (Fig. 16f). Dorsolateral kineties not evident.

Cytostome in anterior 1/4 as indicated by nematodesmata. Nematodesmata apparently originate from kinetids of perioral rows, about 88% of body length (Figs. 16a, b, f). Peribuccal papillae not observed.

Occurrence and ecology: Rarely found in the endopagial of multiyear sea and multiyear land-fast sea ice of the Weddell Sea, between latitude 69° 02'-70° 31' S and longitude 07° 41'-08° 53' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine (1 measurement): temperature -2.1°C, salinity 38.7‰, PO_4 6.0 µmol/l, NO_2 0.3 µmol/l, NO_3 15.5 µmol/l, NH_4 18.0 µmol/l, Si 40.4 µmol/l, chlorophyll *a* 49.5 µg/l. Do not burst at higher, e.g. room, temperature. Biomass of 10^6 individuals: 200 mg.

Comparison with related genera and species: This genus is very likely closely related to *Loxophyllum* and *Opisthodon*. It differs considerably from *Loxophyllum* by having spines, which is the main reason for the generic separation; in addition, a 3rd perioral kinety is not evident in *K. antarcticum* and the brosse is composed of rather widely spaced kinetosomes. The rather similarly shaped *Opisthodon* STEIN, 1859b also lacks spines, the left (vs. right) perioral kinety surrounds the body and the anterior portion of the brosse descends into a groove-like depression (FOISSNER 1984b).

There are a few loxophyllids with spines, viz. *L. fibrillatum* DRAGESCO, 1954, *L. pseudosetigerum* DRAGESCO, 1954, *L. raikovi* DRAGESCO, 1965, *L. setigerum*

QUENNERSTEDT, 1867 and *L. verrucosum* (STOKES, 1893) KAHL, 1931. Based on this character, they are combined with *Kentrophyllum*: *K. fibrillatum* (DRAGESCO, 1954) nov. comb., *K. pseudosetigerum* (DRAGESCO, 1954) nov. comb., *K. raikovi* (DRAGESCO, 1965) nov. comb., *K. setigerum* (QUENNERSTEDT, 1867) nov. comb., *K. verrucosum* (STOKES, 1893) nov. comb. Except *K. fibrillatum*, all these species mainly differ from *K. antarcticum* by having more macronuclear nodules, i.e. 3-14 vs. 2 (e.g. CZAPIK & JORDAN 1976; DRAGESCO 1954, 1960, 1965; DRAGESCO & DRAGESCO-KERNÉIS 1986; KAHL 1931, 1933; WANG & NIE 1932). In addition, *K. pseudosetigerum* and *K. setigerum* have fewer, the distinctly larger *K. raikovi* has more somatic kineties (CZAPIK & JORDAN 1976; DRAGESCO 1954, 1965; DRAGESCO & DRAGESCO-KERNÉIS 1986).

Kentrophyllum fibrillatum also has 2 macronuclei but distinctly differently shaped spines, fewer kineties (viz. ca. 24) which form a distinct spica, it is considerably smaller (about 90 µm) and possesses a single contractile vacuole (DRAGESCO 1954, 1960).

Loxophyllum rostratum COHN, 1866

Improved diagnosis: In vivo about 150-250 x 45-80 µm. Body lance-like, contractile. 11-21 right lateral, 5-7 left lateral, 2 dorsolateral and 3 perioral kineties; only very few right lateral rows anteriorly shortened. 1 type of extrusomes, rod-shaped. Trichocyst warts on dorsal side, with rope-like structure. 1 contractile vacuole subterminally. 2 macronuclear nodules connected by funiculus. 1 micronucleus. Marine.

Neotype specimens: 1 neotype and a 2nd slide of protargol impregnated cells have been deposited.

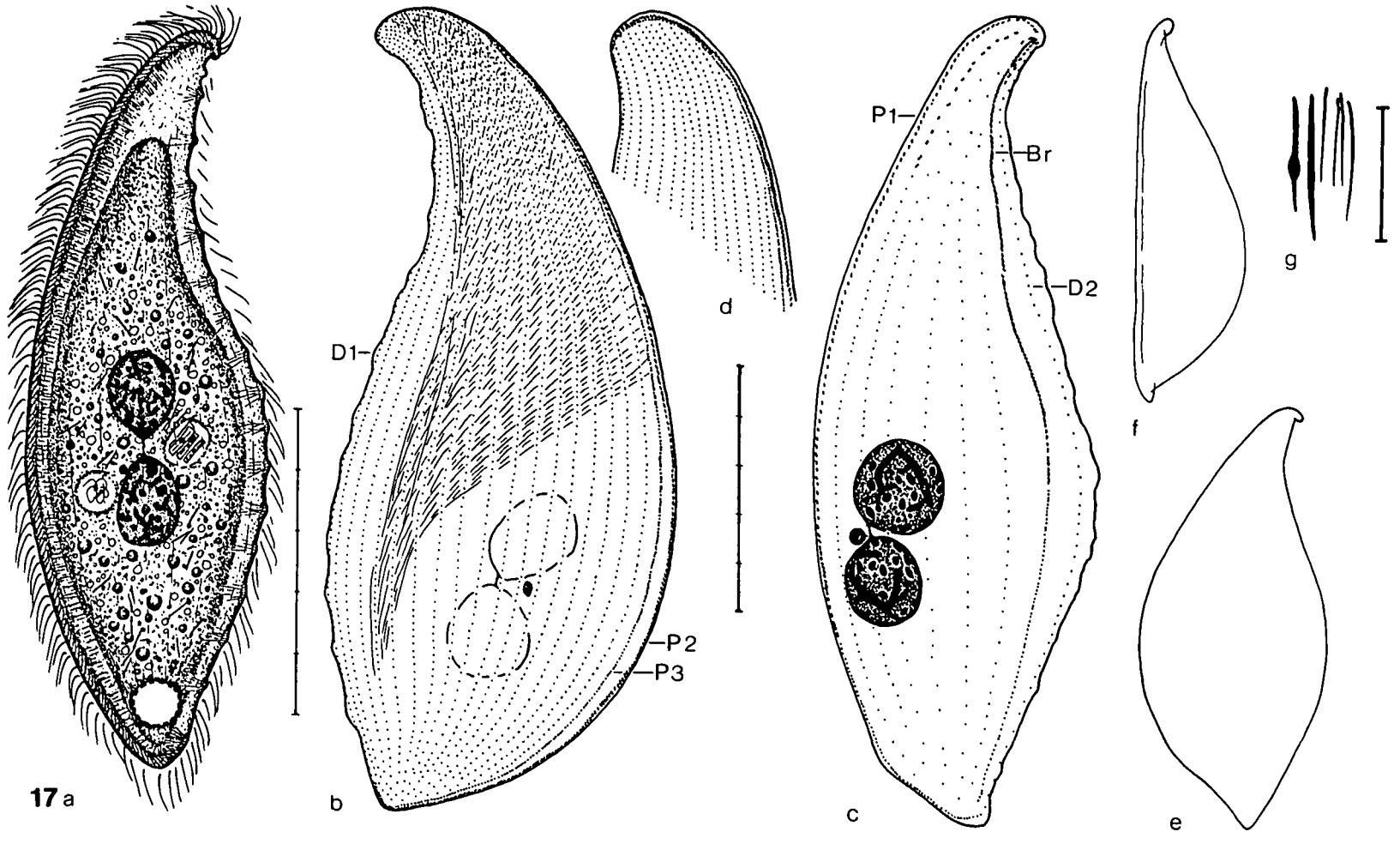
Redescription (Figs. 17a-g, 70-72, Table 10): Shape slender to broadly lance-like, frontal portion bent dorsiad, widest behind mid-body, anteriorly and posteriorly tapering, ventral margin convex, dorsal sigmoid (Figs. 17a, e). Right side flat, left distinctly vaulted, generally without ridges (Fig. 17f); starved individuals rather flat, sometimes slightly distorted, with 2-3 inconspicuous longitudinal ribs. Body contractile. 2 macronuclear nodules, slightly behind mid-body, spherical to ellipsoid, in vivo 17-26 µm long, usually connected thread-like by funiculus, with spherical and net-like nucleoli. Single micronucleus globular, between macronuclei.

1 contractile vacuole subterminally. Extrusomes (trichocysts) along ventral margin regularly arranged, dorsally grouped in warts; rod-shaped, straight to gently curved, in vivo 13-16 µm long; in protargol slides, extrusomes in cytoplasm slightly longer than in warts, often thickened knot-like (developmental stages?; Fig. 17g, Table 10). Trichocyst warts dorsally, sometimes rather indistinct, with rope-like structure (Figs. 17a, 70, 71). Cytoplasm colourless, contains numerous lipid droplets (2-5 µm across) and food vacuoles with flagellates and pennate diatoms (9-12 µm, rarely up to 26 µm long), rendering specimens almost black. Movement slowly gliding on substrate.

Right somatic kineties densely ciliated, few rows anteriorly shortened, i.e. terminate near perioral kineties; cilia 17-21 µm long (Figs. 17b, d). Left somatic kineties extending over whole body length, cilia about 2-4 µm long; leftmost row densely ciliated, anterior half with dikinetids forming brosse, fragmented in frontal portion, bristles 1.5-2 µm long; posteriorly with single kinetids; kinety n (rightmost) frontally with few dikinetids (Figs. 17c, 71). 2 dorsolateral kineties, viz. 1 on right, 1 on left side, indistinct, extending over entire length of cell. 3 perioral kineties along ventral margin, i.e. 1 on left, 2 on right of mouth; at least perioral row 2 extending short distance to dorsal side; kinety 2 and anterior 3/4 of row 1 composed of paired basal bodies, row 3 of monokinetids, densely ciliated (Figs. 17b-d). Perioral kinety 1 frontally and posteriorly apparently connected to dorsolateral row 2, cilia very short, stubby (Fig. 72); perioral kinety 2 seemingly joining dorsolateral row 1.

Rope-like structure extending along ventral margin and posteriorly short distance to dorsal side, i.e. in area of oral slit, as long as perioral kinety 2; also found dorsally on trichocyst warts (Figs. 17a, 70-72). Nematodesmata long, fine, evident only in protargol slides (Fig. 17b).

Occurrence and ecology: Regularly found in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 68° 38'-71° 00' S and longitude 06° 04'-12° 12' W. Up to 886 active ind./l melted ice (biomass 0.26 mg/l) were found comprising up to 3% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -5.3 to -2.1°C, salinity 38.7-81.8‰, PO_4 1.1-6.0 µmol/l, NO_2 0.1-0.6 µmol/l, NO_3 2.6-32.8 µmol/l, NH_4 3.5-18.0 µmol/l, Si 7.7-61.0 µmol/l; chlorophyll *a* 8.5-49.5 µg/l melted ice. In raw cultures also at a salinity of 15.6-23.2‰ and +1°C. Biomass of 10^6 individuals: 288 mg.



Figs. 17a-g: *Loxophyllum rostratum* from life (a, e, f) and after protargol impregnation (b-d, g). a, e: Left lateral views. b, c: Right and left lateral view. d: Detail of anterior right side. f: Ventral view. g: Extrusomes. a, scale bar divisions = 20 µm; b, c, g, scale bar divisions = 10 µm. Br, brosse; D1, D2, dorsolateral kineties 1, 2; P1-P3, perioral kineties 1-3.

Comparison with related species: The descriptions of *L. rostratum* found in the literature correspond well with the specimens studied in the Antarctic in size, shape and infraciliature (COHN 1866; KAHL 1928a; MORGAN 1925; SONG 1993). The only difference to the population studied by SONG (1993) being fewer ribs on the left side (2-3 vs. 5). The rope-like structure, which occurs only ventrally in other loxophyllids (FOISSNER et al. 1995), is also found on the trichocyst warts, indicating that this structure is very probably associated with extrusomes.

Loxophyllum rostratum is very similar in shape and size to *L. helus* (STOKES, 1884) KAHL, 1928a (e.g. DRAGESCO 1960, 1966; DRAGESCO & DRAGESCO-KERNÉIS 1986; FOISSNER 1978; FOISSNER et al. 1995; HARTWIG 1973; KAHL 1931; PENARD 1922; RICCI et al. 1982). KAHL (1928a, 1931) suggested a synonymy of these species which was not followed by later authors (e.g. DRAGESCO 1960; DRAGESCO & DRAGESCO-KERNÉIS 1986; FOISSNER 1978; SONG 1993). These species were apparently often confused, as is indicated by the many records of one or the other from both fresh- and saltwater localities. *Loxophyllum rostratum* was, however, originally described from a marine location whereas *L. helus* was found in freshwater indicating that these are 2 distinct species (COHN 1866; STOKES 1884). Besides habitat, *L. helus* differs considerably from *L. rostratum* in its many anteriorly shortened right lateral kineties which terminate at distinct dorsolateral rows, in 2 types of extrusomes and in the slightly dorsally shifted contractile vacuole (FOISSNER 1978).

Loxophyllum rostratum is distinguished from most other loxophyllids in shape, size, lack of spines, number of macronuclear nodules, contractile vacuoles and/or somatic kineties (e.g. BORROR 1965; DRAGESCO 1960; FOISSNER & O'DONOGHUE 1990; FOISSNER et al. 1995; HARTWIG 1973; KAHL 1928a, 1931, 1933; PENARD 1922; SONG & WILBERT 1989). *Loxophyllum carinatum* VUXANOVICI, 1959 differs by having fewer somatic rows (14-16 in total) and in its freshwater occurrence (SONG & WILBERT 1989). *Loxophyllum perihoplophorum* BUDDENBROCK, 1920 is about twice as large, has more contractile vacuoles, a dumb-bell-shaped macronucleus and trichocysts inserting uniformly along both ventral and dorsal margins.

Loxophyllum verrucosum FLORENTIN, 1901 is distinctly different from *L. verrucosum* (STOKES, 1893) KAHL, 1931, e.g. lacks spines, and is thus its junior homonym. It is, however, also considered synonymous with *L. rostratum* as already

suggested by KAHL (1928a). According to art. 60 (a) of the ICZN (1985), its name is thus not replaced.

Order Synhymeniida PUYTORAC et al., 1974b

Zosterodasys kryophilus nov. spec.

Diagnosis: In vivo about 100-170 (usually 140) x 50-60 µm. Outline elongate elliptical. About 31 ventral, 26 dorsal kineties. Synhymenium usually surrounding almost entire cell. 17-26 nematodesmata. Macronucleus ellipsoidal. Several contractile vacuoles. Marine.

Type location: Pancake sea ice of Weddell Sea, Antarctica, 69° 26' S, 07° 19' W (core number AN 103103).

Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Derivatio nominis: „to kryos", the frost, the ice; „philein", to love; Greek.

Description (Figs. 18a-f, Table 11): Outline elongate elliptical to oboval, right margin convex, left slightly sigmoidal to slightly convex, inconspicuous snout-like projection where synhymenium extends to dorsal side; anteriorly broadly rounded, posteriorly tapering, acontractile (Figs. 18a, d). Dorso-ventrally flattened about 3-4:1 (Fig. 18b). Single macronucleus slightly behind mid-body, ellipsoidal, contains net-like and small spherical chromatin bodies. 1 micronucleus, globular, in indentation of macronucleus; usually not impregnated with protargol. About 6-9, very likely contractile, vacuoles evenly spaced along left postoral and posterior right body margin, ca. 3 µm in diam.; 1 of these sometimes larger, posteriorly on left (Figs. 18a, d). Cytostome in anterior 1/10 of body, in median. Nematodesmata (cytopharyngeal rods) form funnel-shaped basket, extend dorsiad. Cytoplasm colourless, food vacuoles usually with pennate, rarely centric, diatoms and, very likely, flagellates. Movement slowly gliding; thigmotactic.

Somatic cilia about 11 µm long. Ventral kineties terminate at synhymenium, preorally curving around cytostome, postorally meridional; with longitudinal bundles of fibres (Figs. 18c, e). Dorsal kineties extend to dorsal portion of synhymenium (Fig. 18f). Synhymenium surrounds almost entire cell, extending from anterior dorsal side obliquely across ventral side to right body margin and sometimes to dorsal side again,

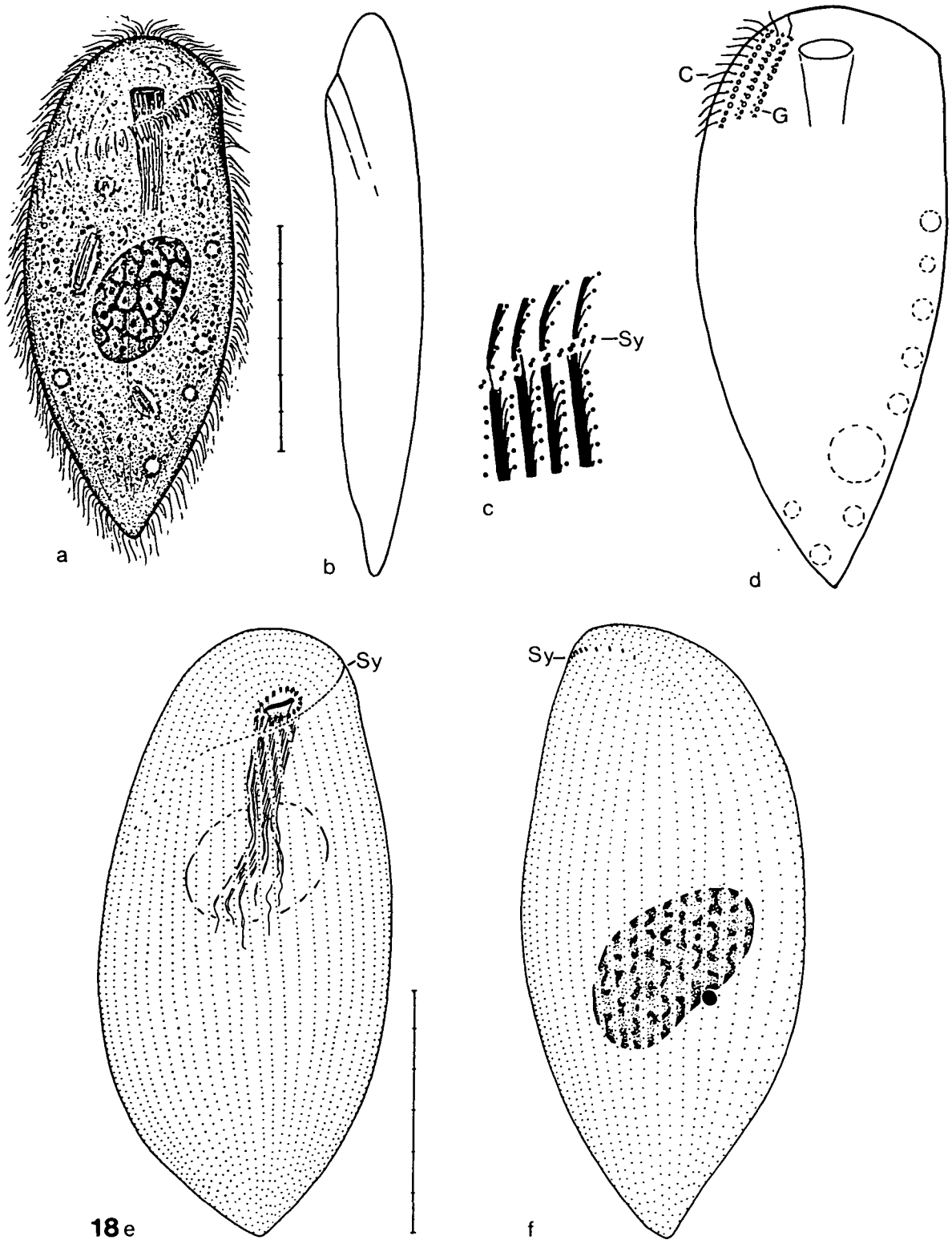
spaced anteriorly, slightly disaggregated posteriorly. Closely set cortical granules (very likely mucocysts) along kineties (Fig. 18d).

Occurrence and ecology: Occasionally found in the endopagial of multiyear and pancake sea ice of the Weddell Sea, between latitude 69° 02'-70° 31' S and longitude 07° 19'-08° 53' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine (generally 1 measurement): temperature -4.5 to -2.1°C, salinity 38.7-77.0‰, PO_4 6.0 µmol/l, NO_2 0.3 µmol/l, NO_3 15.5 µmol/l, NH_4 18.0 µmol/l, Si 40.4 µmol/l; chlorophyll *a* 49.5 µg/l melted ice. Biomass of 10^6 individuals: 80 mg.

Comparison with related species: *Zosterodasys kryophilus* differs from most other species of the genus in a distinctly higher number of nematodesmata (17-26 vs. 10-18), in the marine habitat, number of somatic kineties and contractile vacuoles (mainly 1; ALEKPEROV 1984; ALIEV 1990; SOLA et al. 1990).

Zosterodasys transversus (KAHL, 1928a) FOISSNER et al., 1994 has also several contractile vacuoles but differs by considerably more somatic kineties (79-120 vs. 57 on average), fewer nematodesmata (12-18) and the freshwater occurrence. The limnetic species *Z. serrani* FERNANDEZ-LEBORANS, 1990 has 20-24 nematodesmata, but an almost spherical macronucleus and distinctly fewer somatic kineties (on average 46). *Zosterodasys mirabilis* ALEKPEROV, 1984 possesses slightly more somatic kineties than *Z. kryophilus* (65-68 vs. 57 on average), is twice as large in vivo (300 µm vs. 100-170 µm), has distinctly fewer nematodesmata (14-15 vs. 17-26) and occurs in freshwater; nothing is known about contractile vacuoles (ALEKPEROV 1984). *Zosterodasys jankowskii* ALIEV, 1990 is rather similar to *Z. kryophilus* in size (170-180 µm), number of kineties (55-60) and contractile vacuoles (5-7). However, it occurs in freshwater, possesses fewer nematodesmata, viz. 15, and 2 fields of irregularly arranged basal bodies left and right of the cytostome (ALIEV 1990).

The single specimen of *Zosterodasys* sp. found by AGATHA et al. (1993) in Arctic sea ice differs distinctly from *Z. kryophilus* in shape (cylindrically cigar-like), slightly fewer somatic kineties (approximately 40-50 vs. 46-69), fewer nematodesmata (ca. 11 vs. 17-26) and perhaps in the composition of the synhymenium (single basal bodies vs. paired).



Figs. 18a-f: *Zosterodasys kryophilus* from life (a, b, d) and after protargol impregnation (c, e, f). a, b: Ventral and lateral view. c: Bundles of fibres along somatic kineties (detail). d: Ventral view showing contractile vacuoles. e, f: Ventral and dorsal view. Cortical granulation exemplified. Scale bar divisions = 10 µm. C, cilia; G, cortical granules; Sy, synhymenium.

Table 11. Morphometric characteristics of *Zosterodasys kryophilus* (n = 20); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	150.2	146.5	27.6	6.18	18.4	105.0	223.0
Body, width	59.7	59.0	9.9	2.47	16.5	46.0	76.0
Macronucleus, length	44.0	42.5	9.9	2.22	28.6	31.0	68.0
Macronucleus, width	26.5	25.0	5.8	1.33	21.9	17.0	40.0
Micronucleus, diameter	3.3	3.5	0.3	0.09	7.8	3.0	3.5
Cytostome, diameter	8.0	8.0	1.5	0.50	18.8	6.0	10.0
Nematodesmata, length	48.2	49.0	7.8	2.07	16.1	32.0	58.0
Nematodesmata, number	21.6	22.0	2.4	0.62	11.2	17.0	26.0
Ventral kineties, number	31.3	31.0	3.5	1.06	11.3	25.0	36.0
Dorsal kineties, number	25.9	26.0	4.6	1.38	17.6	21.0	33.0

Order Cyrtophorida FAURÉ-FREMIET in CORLISS, 1956

Genus *Chlamydonella* nov. gen.

Remarks: According to art. 13(b) of the ICZN (1985), *Chlamydonella* DEROUX, 1970 is a nomen nudum, i.e. a non-existing genus, because a type species has not been fixed. To maintain stability, we have re-established the genus *Chlamydonella*.

Diagnosis: Lynchellids with continuous perioral kinety, usually Y-shaped or composed of closely set parallel rows (1 long and 1 short) consisting of monokinetids. Preoral kineties arched. Postoral kineties slightly C-shaped, without spica.

Type species: *Chlamydonella pseudochilodon* (DEROUX, 1970) nov. comb.

The other nominal species formerly placed in the invalid genus are included again in *Chlamydonella*: *C. alpestris* (FOISSNER, 1979b) nov. comb., *C. galeata* (DEROUX, 1970) nov. comb., *C. minuta* (PAETSCH, 1974) nov. comb., *C. rostrata* (VUXANOVICI, 1963) nov. comb., *C. stricta* (DEROUX, 1976a) nov. comb.

Chlamydonella pseudochilodon (DEROUX, 1970)

Morphology and infraciliature (Figs. 19a-f, Table 12): In vivo about 75 x 35 µm. Shape elliptical, right margin convex, left slightly sigmoidal, inconspicuous snout-like projection on anterior left, frontally and posteriorly broadly rounded (Figs. 19a, b). Dorso-ventrally flattened about 2:1, ventral side flat, dorsal vaulted; dorsal hump longitudinally striated, extends to right ventral side (Figs. 19b, c, e). Nematodesmata (cytopharyngeal rods) toothed, directed rightwards and dorsiad (Fig. 19d). Pellicle rather robust. Macronucleus ellipsoid, in mid-body, slightly left of median; in protargol slides often with irregular lappet-like appendage; contains small and large, globular to elongated nucleoli (Figs. 19b, f). Micronucleus globular, 2.5 µm across, usually not impregnated with protargol. 2 contractile vacuoles, in anterior 1/3 on right and in posterior 1/3 on left, in vivo about 10 µm in diameter (Figs. 19a, b). Excretory pore of contractile vacuole anteriorly between 3rd and 4th ventral kinety from margin, posteriorly between 4th and 5th. Cytoplasm colourless, contains numerous small, pale greenish, greasily shining globules and food vacuoles usually with 7-25 µm long pennate diatoms; this renders cells slightly brownish-green. Movement very slowly gliding; thigmotactic.

Ventral kineties preorally arched, postorally slightly C-shaped; basal bodies densely spaced, in posterior 1/3 of body less so (zone de raréfaction cinétosomienne; DEROUX 1970), cilia usually short (about 2 µm), longer (5-7 µm) in posterior portion of kineties and on right and left margin of cell. 4 kineties anterior of perioral row, frontally in grooves, 3 anteriormost usually extending to dorsal side; 2-3 rows bisected by perioral kinety, rightmost row continuous; terminal fragment (brosse) dorsally on left frontal end of body, composed of 8-17 basal bodies; cilia about 9 µm long (Figs. 19d, e). Perioral kinety transversely arched, composed of 2 parallel rows, i.e. 1 short row anteriorly in left body half, posterior row extending over almost entire width of cell; rows usually distinctly separate, although only by small distance. 2 very short basal body rows near left and right end of perioral kinety, oblique (Fig. 19d). 6 postoral kineties on left gradually elongated; leftmost row about in mid-body, not extending to perioral row, very short, composed of 3-13 basal bodies. Short kinety fragment equatorially on right, composed of 3-10 kinetosomes. No dorsal cilia.

A slide of protargol impregnated specimens has been deposited for reference.

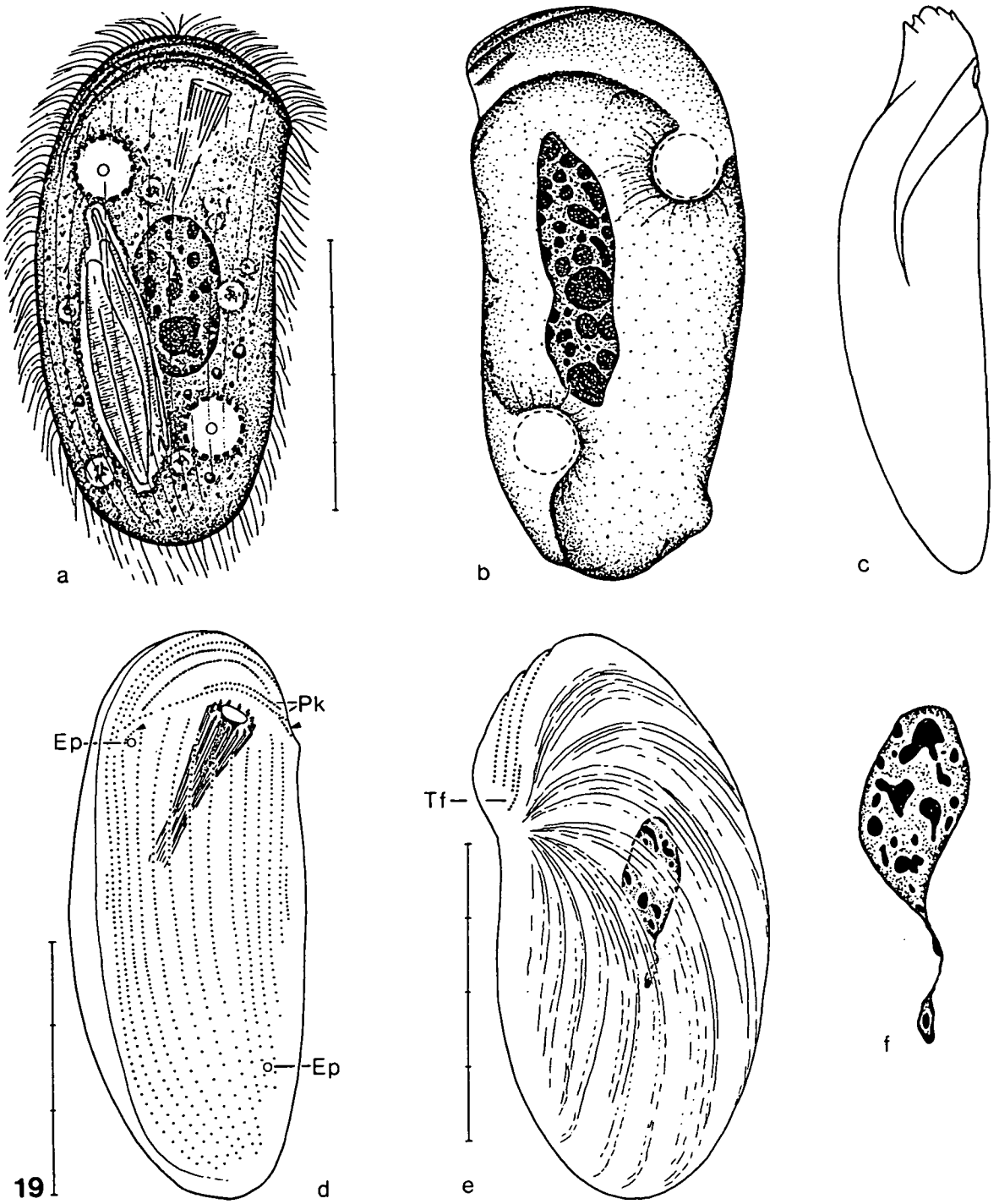
Table 12. Morphometric characteristics of *Chlamydonella pseudochilodon* (upper line, n = 30) and *Dysteria monostyla* (lower line, n = 4); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	58.3	57.0	9.4	1.71	16.1	43.0	73.0
	140.8	138.0	10.1	5.02	7.1	132.0	155.0
Body, width	28.7	28.0	4.7	0.85	16.3	24.0	38.0
	59.3	59.5	5.7	2.87	9.7	52.0	66.0
Macronucleus, length	29.0	30.0	7.1	1.29	24.4	12.5	41.0
	38.5	41.0	11.8	5.91	30.7	22.0	50.0
Macronucleus, width	10.1	10.0	1.6	0.30	16.3	7.0	12.5
	21.0	21.0	4.4	2.20	20.9	16.0	26.0
Cytostome, width	3.9	4.0	0.4	0.11	10.3	3.5	5.0
	–[1]	–	–	–	–	–	–
Cyrtos, diameter	6.4	6.5	0.5	0.16	8.4	5.5	7.0
	9.4	9.5	0.6	0.31	6.7	8.5	10.0
Cyrtos, length	17.6	18.0	5.3	1.16	30.2	6.0	26.0
	79.0	78.0	2.7	1.53	3.4	77.0	82.0
Podite, length[2]	17.8	18.0	0.5	0.25	2.9	17.0	18.0
Nematodesmata, number	14.7	15.0	1.2	0.22	8.0	12.0	18.0
	–[3]	–	–	–	–	–	–
Ventral kineties, number	14.0[4]	14.0	0.0	0.00	0.0	14.0	14.0
	5.0	5.0	0.0	0.00	0.0	5.0	5.0

[1] Not determined.
[2] In *D. monostyla*.
[3] Numbers indeterminable.
[4] Postoral rows, without right kinety fragment.

Occurrence and ecology: Common in 1 location in the endopagial of multiyear sea ice of the Weddell Sea, latitude 70° 21' S and longitude 08° 53' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature about -3°C, salinity about 55‰. Biomass of 10^6 individuals: 32 mg.

Comparison with related species: The original description of *C. pseudochilodon* is very similar. It differs only slightly in the smaller size (30-45 µm vs. 43-73 µm), the Y-shaped perioral kinety (vs. 1 long and 1 short parallel row) and it apparently lacks the short basal body row near the left end of the perioral kinety (DEROUX 1970). These are considered minor differences. The Antarctic population is thus identified with this species.



Figs. 19a-f: *Chlamydonella pseudochilodon* from life (a-c) and after protargol impregnation (d-f). a, b: Ventral and dorsal view. c: Lateral view. d, e: Ventral and dorsal view. Arrowheads mark short rows near perioral kinety. f: Macronucleus with lappet-like appendage. Scale bar divisions = 10 µm. Ep, excretory pore of contractile vacuole; Pk, perioral kinety; Tf, terminal fragment.

Chlamydonella sp. found by AGATHA et al. (1993) in Arctic sea ice is about twice as large, has more than twice as many ventral kineties on average (29 vs. always 14), more nematodesmata (20-28 vs. 12-18), a Y-shaped perioral kinety and lacks the short „equatorial" kinety on the left; observations concerning contractile vacuoles and excretory pores are not available. This species is evidently not conspecific with *C. pseudochilodon*.

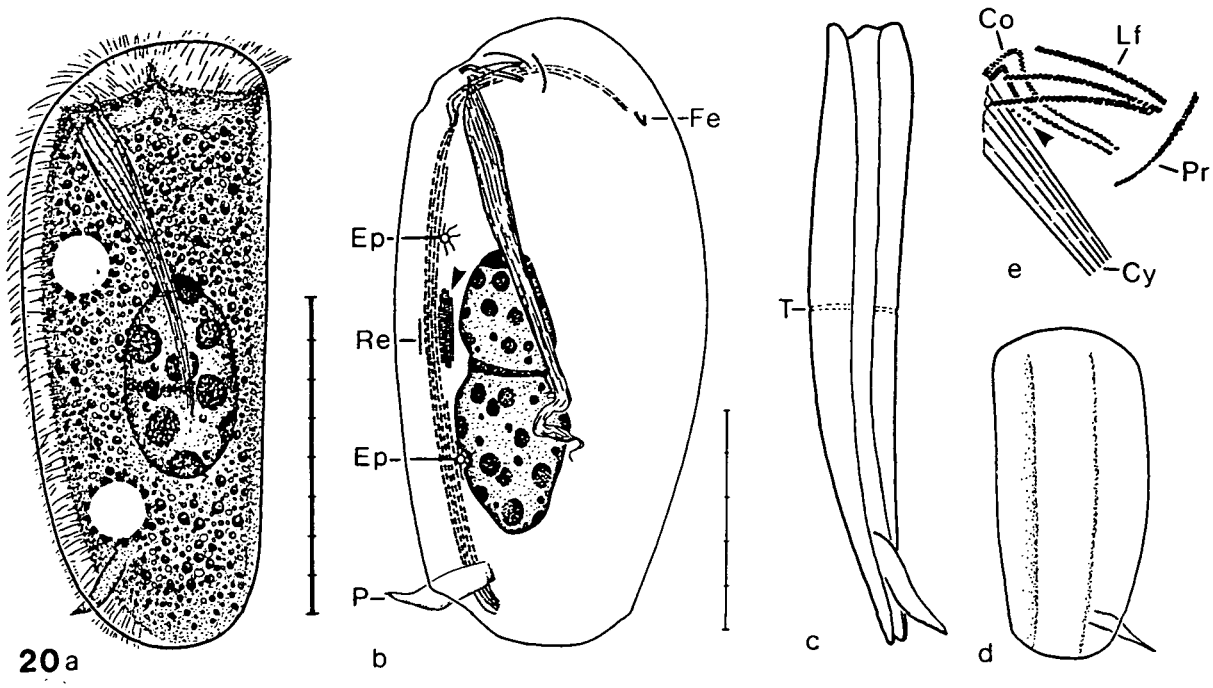
Chlamydonella polonica FOISSNER et al., 1981 possesses only 1 perioral kinety which consists of dikinetids. It was thus transferred to *Chlamydonellopsis* BLATTERER & FOISSNER, 1990 (BLATTERER & FOISSNER 1990).

Dysteria monostyla (EHRENBERG, 1838) KAHL, 1931

Morphology and infraciliature (Figs. 20a-e, Table 12): In vivo about 145 x 65 µm. Shape elongate, slender, ventral margins almost parallel, right slightly convex, left straight, posteriorly slightly narrowed; anteriorly and posteriorly broadly rounded (Fig. 20a). Dorso-ventrally flattened about 3:1. Dorsal plate slightly convex, 2 inconspicuous longitudinal ridges; ventral plate smooth, apparently slightly concave; plates equally sized; slit between plates very narrow, only anteriorly gaping (Figs. 20c, d). In protargol slides, ventral and dorsal plate longitudinally striated, with inconspicuous transverse groove in mid-body (Fig. 20c). Podite (attachment organelle) distally pointed, posteriorly on right ventral side. Macronucleus about in mid-body, ellipsoid, once almost spherical, with constriction and argentophilic „transverse" band; argentophilic „cap" on anterior end (micronucleus?); nucleoli globular, ca. 5 µm across (Figs. 20a, b). 2 contractile vacuoles (pulsation not observed), in anterior and in posterior 1/3 on right; excretory pores adjacent to right field of kineties, excretory canal lined by few argentophilic fibres. Cytoplasm contains many greasily shining globules (ca. 3 µm in diam.) and, rarely, food vacuoles (ca. 11 µm) with undetermined contents. Movement slowly crawling; thigmotactic.

Right field of kineties very narrow, extends hook-like from anterior left to posterior right, composed of 5 kineties of variable length, formed by groups of 3-8 basal bodies; 2 kineties extending over entire length of body, others gradually shortened, cilia about 13 µm long; short row of about 15 basal bodies (double-rowed?), hook-like, anteriorly on left (fragment of external right kinety). Few (about 6) short rows of

densely spaced basal bodies in mid-body forming left equatorial field, perhaps non-ciliated; probably only 1 external right equatorial kinety (Fig. 20b).



Figs. 20a-e: *Dysteria monostyla* from life (a, c, d) and after protargol impregnation (b, e). a, b: Ventral views. Arrowhead marks left equatorial field of kineties. c: Right lateral view. d: Dorsal view. e: Detail of oral ciliature. Arrowhead marks short basal body row. Scale bar divisions = 10 µm. Co, circumoral kinety; Cy, cyrtos; Ep, excretory pore of contractile vacuole; Fe, fragment of external right kinety; Lf, left frontal field of kineties; P, podite; Pr, preoral kinety; Re, external right equatorial kinety; T, transverse groove.

Cytostome in anterior 1/6-1/8 on right. Cyrtos narrow, diagonally oriented, nematodesmata not well impregnated, anterior tooth-like structure not evident. 6 short membranelles near cytostome (1 preoral, 3 forming left frontal field, 2 circumoral), ca. 10 µm long, double-rowed; very short row of 3-4 single basal bodies between circumoral kineties and cyrtos (Figs. 20b, e).

Occurrence and ecology: Rarely found in the endopagial of multiyear sea ice of the Weddell Sea, between latitude 70° 21'-70° 31' S and longitude 08° 01'-08° 53' W. Environmental parameters in brine: temperature -4.5 to -2.0°C, salinity 51.8-58.8‰; in melted ice: PO_4 0.3-2.8 µmol/l, NO_2 0.1 µmol/l, NO_3 0.6-6.1 µmol/l,

NH_4 1.1-3.5 µmol/l, Si 2.1-14.8 µmol/l, chlorophyll *a* 11.1-80.1 µg/l. Biomass of 10^6 individuals: 65 mg.

Comparison with related species: This population corresponds well with *D. monostyla* in oral and somatic infraciliature and in number and position of contractile vacuoles (e.g. DEROUX 1976b; DRAGESCO & DRAGESCO-KERNÉIS 1986; FAURÉ-FREMIET 1965; KAHL 1931; STEIN 1859a). The Antarctic specimens are slightly larger (132-155 vs. about 40-110 µm), posteriorly slightly tapering (vs. elliptical) and have very similarly sized ventral and dorsal plates (vs. 1 plate distinctly smaller; DEROUX 1976b; DRAGESCO & DRAGESCO-KERNÉIS 1986; FAURÉ-FREMIET 1965). KAHL (1931) also observed that these plates are almost equally sized. We thus do not separate this population from *D. monostyla*.

Dysteria procera KAHL, 1931 apparently differs from *D. monostyla* only in body shape, i.e. posteriorly tapering vs. elliptical (KAHL 1931). Its shape corresponds, however, to the population studied here, which indicates that *D. procera* is conspecific with *D. monostyla*.

Family Kryoprorodontidae ALEKPEROV & MAMAJEVA, 1992

Improved diagnosis: Small to medium sized phyllopharyngiids with ellipsoid to spherical body, no distinct dorso-ventral differentiation. Cytostome apical, slightly protruding, with conspicuous cyrtos. Somatic ciliation fairly complete, composed of longitudinal and few spiralling kineties. Several short adoral membranelles. No podite.

Type genus: *Gymnozoum* MEUNIER, 1910

Remarks: According to art. 40 of the ICZN (1985), the name of the family is not replaced although it is not the name of its type genus, viz. *Gymnozoum*. The family-name Kryoprorodontidae is, however, unfortunate because it suggests relationship with prorodontids.

Genus *Gymnozoum* MEUNIER, 1910

Synonymy: *Kryoprorodon* ALEKPEROV & MAMAJEVA, 1992; *Spiroprorodon* FENCHEL & LEE, 1972; *Spiroporodon* FENCHEL & LEE, 1972 – SNIEZEK & SMALL (1993), incorrect subsequent spelling.

Improved diagnosis: Kryoprorodontidae with somatic ciliation composed of several longitudinal rows of variable length and 4-5 spiralling kineties curving semicircularly around oral area and terminating in longitudinal posterior portion; 1 spiral kinety often shortened (kinetofragmon), also lacking?. Several short adoral membranelles right of mouth. Free-living, marine.

Type species: *Gymnozoum viviparum* MEUNIER, 1910 (by monotypy).

Systematic position: *Gymnozoum* was previously included in Enchelyidae and Prorodontidae, respectively (ALEKPEROV & MAMAJEVA 1992; FENCHEL & LEE 1972). This is inappropriate because a brosse is lacking and the somatic kineties are not bipolar (cf. CORLISS 1979; FOISSNER 1984a; FOISSNER et al. 1994; HILLER & BARDELE 1988). An ultrastructural study indicates that *Gymnozoum* belongs to the subclass Phyllopharyngia PUYTORAC et al., 1974b, probably in a separate order (SNIEZEK & SMALL 1993).

A relationship to cyrtophorids is suggested by the silverline system, which resembles that of, e.g., chilodonellids (e.g. FOISSNER et al. 1991). Furthermore, the apically protruding cyrtos of *Gymnozoum* is rather similar to that of *Aegyriana minuta* DEROUX, 1974 which also has 4 spiral and several longitudinal kineties. The oral infraciliature of *Gymnozoum*, i.e. adoral membranelles composed of very few kinetosomes on right and few slightly separated basal bodies on left of cytostome, the curved and longitudinal somatic kineties and the small cilia-free area between these resemble *Trichopodiella elongata* DEROUX, 1976b. This species is related to *Aegyriana* and included in the family Hartmannulidae, Dysteriina, Cyrtophorida (DEROUX 1976b). The members of this family have, however, an adhesive organelle (podite) which is lacking in *Gymnozoum*. It is thus justified to place the latter genus in a family of its own, Kryoprorodontidae.

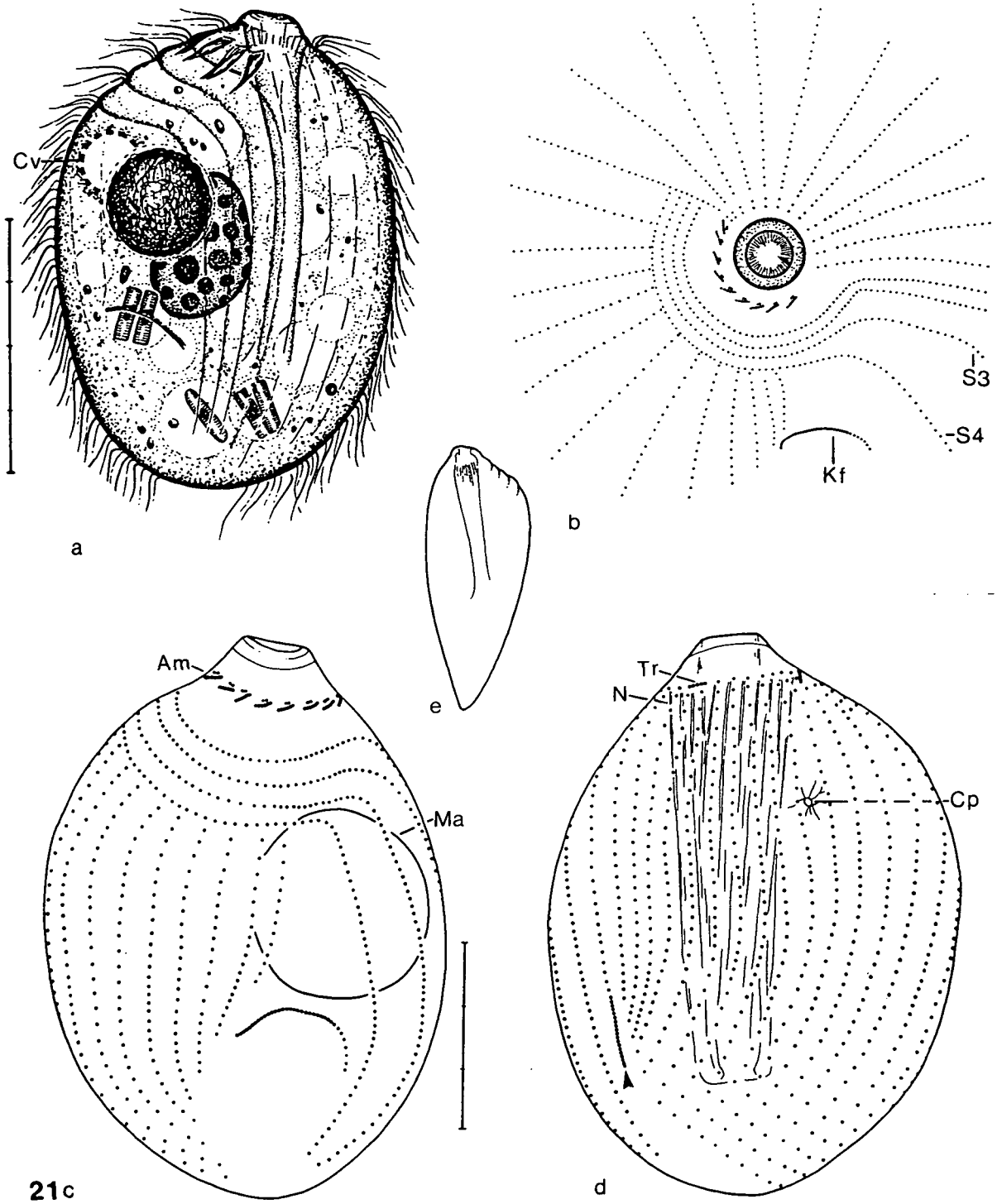
Gymnozoum viviparum MEUNIER, 1910

Synonymy: *Gymnosoum viviparum* – AGAMALIEV (1976), incorrect subsequent spelling; *Spiroprorodon garrisoni* CORLISS & SNYDER, 1986; *Kryoprorodon garrisoni* (CORLISS & SNYDER, 1986) ALEKPEROV & MAMAJEVA, 1992.

Improved diagnosis: In vivo 65-100 x 50-60 µm. Outline usually elliptical, asymmetrical. 24-40 somatic kineties, i.e. 19-35 longitudinal, 4 long and 1 very short spiral row. Spiral kinety 4 posteriorly not shortened. Few kineties anteriorly between spiral row 4 and 5. Usually 9 adoral membranelles. Single contractile vacuole about in anterior 1/3 of body. 1 macro-, 1 micronucleus. Silverline system fine-meshed.

Redescription (Figs. 21a-e, Table 13): [Numbering of kineties is according to CORLISS & SNYDER (1986), viz. clockwise, starting with spiral rows 1-4]. Outline variable, elliptical to spherical, asymmetrical, dorsal margin more convex than ventral; anterior protrusion distinct in vivo, 1.5-8 µm long, retractable, slightly acentric thus defining ventral side; posteriorly usually broadly rounded (Fig. 21a). Cell surface slightly grooved by somatic kineties. Laterally flattened about 2:1 to circular, depending on nutritional state (Fig. 21e). Single macronucleus ellipsoid to globular, with numerous spherical nucleoli (up to 4 µm across). 1 micronucleus globular, close to macronucleus. Single contractile vacuole on left, anterior of mid-body; excretory pore usually near kinety 20-23, distance from apex about 36% of body length, excretory canal framed by few argentophilic fibres (Fig. 21d). Cytoplasm colourless, often rather transparent, contains food vacuoles with ciliates, i.e. frequently *Gymnozoum* spp. (cannibal), small (ca. 8 µm long) and large (up to 54 µm) pennate diatoms and flagellates. Movement slow.

Usually 24-31 (once 35 and 40) somatic kineties, viz. 4 spiral, 1 kinetofragmon and 19-35 longitudinal rows; most extending almost to posterior pole, i.e. only small cilia-free area on rear; composed of single basal bodies, cilia about 13 µm long. Spiral kineties 1-4 (CORLISS & SNYDER 1986) curve semicircularly around oral area, posterior portion meridional, terminate anteriorly at longitudinal row. Kinetofragmon (CORLISS & SNYDER 1986) is very likely reduced spiral kinety 5, on right in posterior half of cell, on otherwise cilia-free area (about 39% of body width); short, transversely arched, composed of approximately 38 basal bodies. Longitudinal kineties composed of 9-43 basal bodies; about 12-16 rows gradually elongated, terminate at spiral kinety 4, 1-2 of these anteriorly between kinetofragmon and spiral



Figs. 21a-e: *Gymnozoum viviparum* from life (a, e) and after protargol impregnation (b-d). a: Right lateral view. b: Top view. c, d: Right and left lateral view of same specimen. Arrowhead marks densely spaced basal bodies of kinety n. e: Flattened specimen. Scale bar divisions = 10 µm. Am, adoral membranelles; Cp, excretory pore of contractile vacuole; Cv, contractile vacuole; Kf, kinetofragmon; Ma, outline of macronucleus; N, nematodesmata; S3, S4, spiral kineties 3, 4; Tr, transverse row.

row 4, thus considerable distance between these kineties; about 12 kineties on left extending to oral area, 2 basal bodies each slightly separate at anterior ends; kinety n slightly shortened, with densely spaced basal bodies posteriorly (Figs. 21b-d). Usually, rows n-4 to n-1 terminate at kinety n. Short row of 3-5 densely spaced basal bodies immediately left of oral area, (about 2 µm long), transversely arranged (Fig. 21d). Silverline system fine-meshed, as in *G. sympagicum* nov. spec., mesh size about 1-2 µm (cp. Fig. 21c).

Adoral membranelles on right, composed of single row of about 6 basal bodies and 2 kinetosomes (pair?) near frontal end, cilia about 13 µm long. About 14-20 nematodesmata (not easy to resolve), extending over almost entire length of body, originate at basal bodies of adoral membranelles and anterior kinetosomes of somatic kineties (Fig. 21d).

1 slide of protargol impregnated cells has been deposited for reference.

Occurrence and ecology: Common in the endopagial of mainly young (grease, pancake) and also multiyear sea ice of the Weddell Sea, between latitude 69° 26'-70° 31' S and longitude 06° 18'11° 00' W. Up to 8 444 active ind./l melted ice (biomass 0.83 mg/l) were found ($\bar{x}$ = 1 692 active ind./l and 0.17 mg biomass/l, n = 40) comprising up to 100% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates, foraminiferans and ciliates. Environmental parameters in brine: temperature -7.8 to -2.1°C, salinity 37.6-100.0‰, PO_4 0.5-3.1 µmol/l, NO_2 0.2-0.9 µmol/l, NO_3 8.7-45.8 µmol/l, NH_4 5.8-48.1 µmol/l, Si 23.4-106.8 µmol/l. Chlorophyll *a* 0.4-85.6 µg/l melted ice. In raw cultures also at +1°C and a salinity of 14.3-34.4‰. Does not burst at higher, e.g. room, temperatures. Biomass of 10^6 individuals: 98 mg.

Comparison with related species: This population is very similar to the rather poor description of *Gymnozoum viviparum* (MEUNIER 1910). However, MEUNIER's (1910) illustrations depict the characteristic features of the genus, viz. shape, retractable apical oral apparatus, prominent cyrtos, constriction in macronucleus and cannibalistic feeding behavior (misinterpreted as vivipary). Although MEUNIER (1910) did not find cilia (overlooked, fixation artifact?), longitudinal and spiral kineties are indicated by lines and numbers can be estimated from the figures. The genus determination is thus fairly certain.

Table 13. Morphometric characteristics of *Gymnozoum sympagicum* (upper line, n = 31) and *G. viviparum* (lower line, n = 30); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	54.5	54.5	6.8	1.20	12.4	36	64
	74.0	73.0	13.2	2.38	17.9	52	115
Body, width	44.9	46.0	6.5	1.17	14.5	24	57
	56.2	56.0	8.5	1.55	15.1	40	72
Macronucleus, length	29.6	30.0	4.1	0.74	13.9	18	40
	29.6	30.5	5.4	0.98	18.2	20	43
Macronucleus, width	17.5	17.0	3.3	0.59	18.7	11	24
	21.0	20.5	3.6	0.66	17.1	15	33
Micronucleus, diameter	–[1]	–	–	–	–	–	–
	4.5	4.5	0.5	0.13	10.7	4	5
Apex to excretory pore,	26.7	27.0	4.1	0.75	15.4	18	34
distance	26.8	26.0	5.3	0.99	19.9	17	38
Nematodesmata, length	51.9	52.0	5.4	0.99	10.4	41	66
	58.8	60.5	10.1	1.85	17.2	37	78
Cytostome, width	6.3	6.5	1.2	0.22	19.3	4	10
	7.1	7.0	1.6	0.29	22.4	5	12
Adoral membranelles,	7.5	8.0	0.8	0.13	10.1	6	8
number	9.0	9.0	0.2	0.03	2.0	8	9
Somatic kineties, total	23.3	23.0	0.9	0.17	3.9	21	25
number	28.4	28.0	3.2	0.60	11.3	24	40
Spiral kineties, number[2]	4.0	4.0	0.0	0.00	0.0	4	4
	4.0	4.0	0.0	0.00	0.0	4	4
Nematodesmata, number	16.9	17.0	1.3	0.39	7.7	14	18
	–[3]	–	–	–	–	14	20

[1] Not impregnated.
[2] Without kinetofragmon.
[3] Not enough data.

According to MEUNIER's (1910) figures, there are approximately 16-30, on average 23 kineties; 4 spiral kineties; ca. 18-20 nematodesmata; the body measures 75-145 µm and the macronucleus about 40 x 23 µm. With the exception of the type locality, viz. Arctic ocean, this matches the description of the present specimens.

The features of *G. viviparum* are also very similar to *Spiroprorodon garrisoni* CORLISS & SNYDER, 1986. A reinvestigation of original slides (types have not yet been deposited) showed, that this species is also very similar to the specimens found by us, i.e. the spiral kineties encircle only half of the anterior pole, the excretory pore

of the contractile vacuole is located in the anterior 1/3 of the body, 1-2 basal bodies each are slightly separate frontally in the kineties of the left side and, at least in most specimens, the short transverse row left of the mouth is also present. The macronuclear shape is slightly different, viz. elongate ellipsoid (x = 24 x 9.5 µm, n = 6) vs. broad ellipsoid in the present study (x = 30 x 21 µm, Table 13). This is, however, not sufficient reason to separate the populations because the macronucleus is often quite irregularly shaped in the present specimens (preparation artifact?). *Spiroprorodon garrisoni* is thus considered junior synonym of *G. viviparum*.

The other nominal species of *Spiroprorodon*, viz. *S. glacialis* FENCHEL & LEE, 1972 and *S. intermedius* AGATHA et al., 1993, may also be included in *Gymnozoum*: *G. glaciale* (FENCHEL & LEE, 1972) nov. comb., *G. intermedium* (AGATHA et al., 1993) nov. comb. *Kryoprorodon arcticum* is also rather similar to this genus. According to ALEKPEROV & MAMAJEVA (1992), *K. arcticum* differs from *G. glaciale* only in the possession of adoral membranelles. Figure 1a by FENCHEL & LEE (1972) indicates that these are also present in *G. glaciale* but were misinterpreted as trichocysts. *Kryoprorodon arcticum* is thus also combined with *Gymnozoum*: *G. arcticum* (ALEKPEROV & MAMAJEVA, 1992) nov. comb. [Type slides of *G. glaciale* are unfortunately not available. FENCHEL (pers. comm.) is fairly certain that these were deposited at the Smithsonian Institution, Washington, where they are, however, not registered; additional slides do not exist.]

Gymnozoum glaciale and *G. arcticum* are distinctly larger than *G. viviparum*, lack a kinetofragmon and have a terminal contractile vacuole. *Gymnozoum intermedium* is distinguished by a considerably shorter spiral kinety 4, the lack of ciliary rows between this and the kinetofragmon and fewer adoral membranelles, the 2nd row of which consists of only 1 basal body each (vs. 2; AGATHA et al. 1993).

***Gymnozoum sympagicum* nov. spec.**

Diagnosis: In vivo about 35-65 x 25-35 µm. Shape usually obconic to ellipsoid. 21-25 somatic kineties, i.e. 16-20 longitudinal, 4 long and 1 rather short spiral row. Spiral kinety 4 posteriorly shortened. Short distance between spiral row 4 and 5. 6-8 adoral membranelles. Single contractile vacuole in mid-body. 1 macro-, 1 micronucleus. Silverline system fine-meshed.

Type location: Multiyear land-fast sea ice of Atka Bay, Weddell Sea, Antarctica, 70° 31' S, 07° 59' W (core number AN 103099).

Type specimens: 1 hapantotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Derivatio nominis: „syn-", together; „ho pagos", the ice, white frost; Greek.

Description (Figs. 22a-e, Table 13): (Numbering of somatic kineties as in *G. viviparum*). Shape asymmetrical, variable, obconic to ellipsoid, sometimes almost spherical, usually tapering posteriorly; anterior protrusion distinct in vivo, ca. 4 µm long, retractable, contains cytostome, situated slightly asymmetrically thus defining ventral side; ventral margin almost straight, dorsal convex, widest before mid-body; cell surface slightly grooved by somatic kineties (Figs. 22a, b). Laterally flattened about 2:1 to circular (depending on nutritional state?). Single macronucleus ellipsoid, with constriction, arranged longitudinally, near dorsal margin, with spherical and ellipsoid nucleoli (1-4 µm across); irregularly shaped in protargol slides. 1 micronucleus, globular to ellipsoid, adjacent to macronucleus, 4-5 µm across, usually not impregnated with protargol. 1 contractile vacuole on left, about in mid-body, pulsating at long intervals; excretory pore adjacent to kinety 17, distance to apex about 48% of body length, excretory canal framed by argentophilic fibres (Fig. 22e). Cytoplasm with few bright green, rarely reddish, food vacuoles, 3-7 µm across; feeds also on large (ca. 45 µm long) pennate and centric (about 23 µm across) diatoms, autotrophic flagellates and ciliates, viz. frequently *Gymnozoum* spp. (cannibal); specimens often quite transparent. Movement moderately fast, rotating about main body axis when swimming.

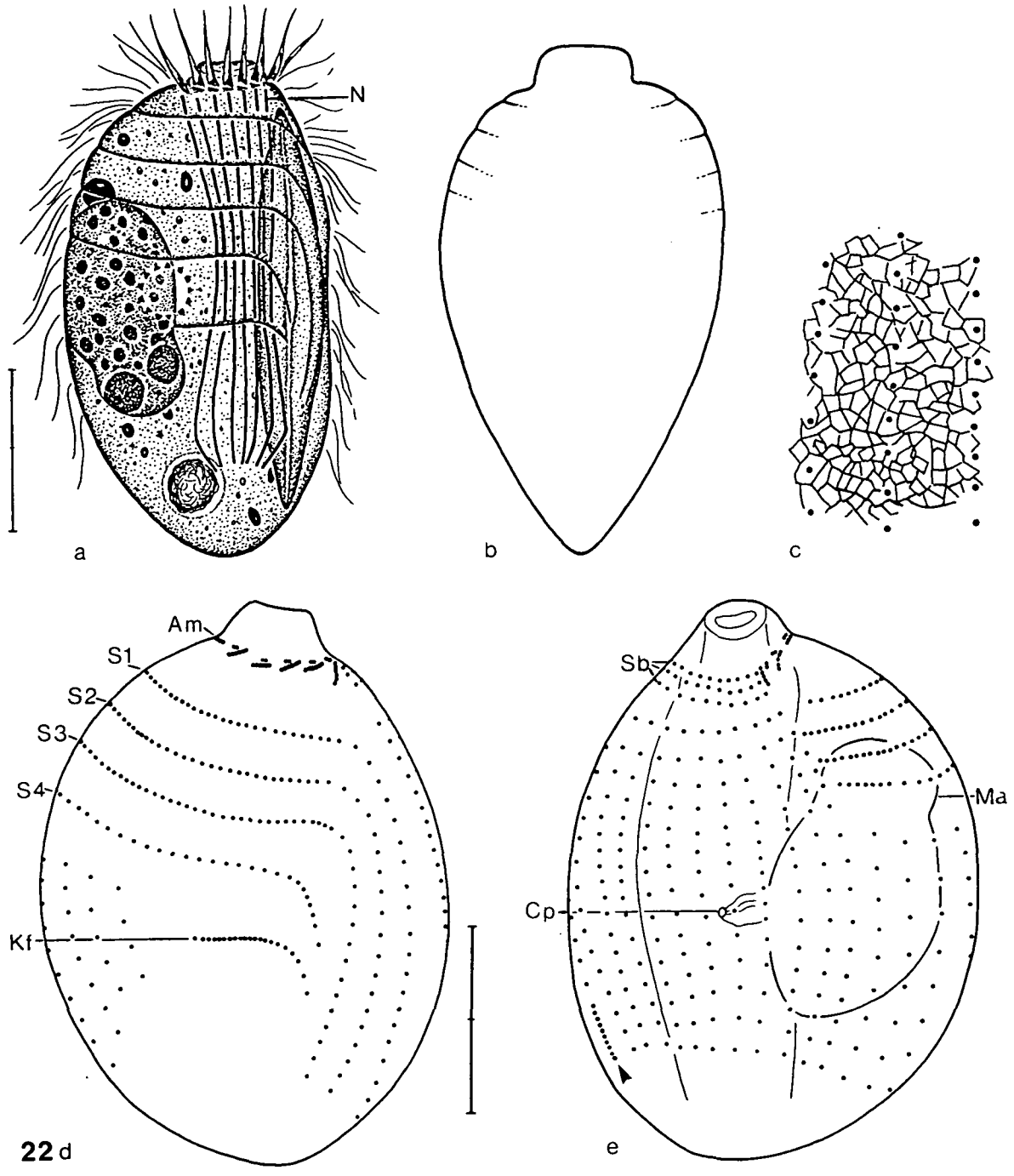
Somatic kineties (viz. 4 spiral, 1 kinetofragmon, 16-20 longitudinal rows) not extending to rear pole, i.e. conspicuous cilia-free area posteriorly; composed of single basal bodies, cilia 10-14 µm long. Spiral kineties 1-4 usually commence next to kinety 13, surround half of cell; spiral row 4 shortened posteriorly. Kinety 5 (kinetofragmon) posteriorly short distance from spiral row 4, transversely arched, short, rarely slightly lengthened, composed of about 18-24 basal bodies, cilia ca. 12 µm long. Longitudinal kineties composed of about 2-25 basal bodies; 7-8 rows (generally no. 6-13) short, gradually elongated, terminate at spiral kinety 4; about kineties 14-n extending to oral area, on left side, 3 basal bodies each slightly separate at anterior ends (Figs. 22d, e). Kinety n not shortened posteriorly, with densely

spaced basal bodies on rear. Cilia-free area between kineties about 42% of body width. Silverline system fine-meshed, irregular (Fig. 22c).

Adoral membranelles semicircular right of oral area, each consists of a row of 5-6 and a row of 2 basal bodies (pair?). Nematodesmata distinct in vivo, extending over almost entire length of body, apparently originate from basal bodies of adoral membranelles and anterior kinetosomes of longitudinal rows. Cytostomal opening elliptical in top view.

Occurrence and ecology: Widespread and regularly found, frequently dominant, in the endopagial of grease (slush), pancake, multiyear sea and multiyear land-fast sea ice of the Weddell Sea, between latitude 67° 47'-71° 00' S and longitude 06° 04'-12° 12' W. Up to 3 163 active ind./l melted ice were found (biomass 0.06 mg/l) comprising up to 32% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates, foraminiferans and ciliates. Ingested by dinoflagellates, e.g. *Peridinium* sp. Environmental parameters in brine: temperature -4.5 to -2.1°C, salinity 38.7-42.9‰, PO_4 1.1-6.0 µmol/l, NO_2 0.2-0.3 µmol/l, NO_3 13.9-20.2 µmol/l, NH_4 17.5-19.3 µmol/l, Si 24.8-40.4 µmol/l; chlorophyll *a* 13.2-49.5 µg/l melted ice. In raw cultures also at +1°C and a salinity of 21.3‰. Biomass of 10^6 individuals: 20 mg.

Comparison with related species: This species differs from *G. viviparum* in the smaller size, position of the contractile vacuole (mid-body vs. about anterior 1/3), posteriorly shortened spiral kinety 4, rows n-4 to n longer, short distance between spiral row 4 and kinetofragmon (i.e. without kineties between these), fewer basal bodies in somatic kineties, lack of short transverse row left of mouth and usually fewer adoral membranelles (8 vs. 9). *Gymnozoum intermedium* is distinguished from *G. sympagicum* in the slightly larger size, anteriorly distinctly shortened and posteriorly elongated spiral kinety 4, composition of adoral membranelles (2nd row consists of 1 basal body vs. 2) and the longer kinetofragmon (AGATHA et al. 1993).



Figs. 22a-e: *Gymnozoum sympagicum* from life (a, b), after protargol (d, e) and silver nitrate impregnation (c). a: Right lateral view. b: Other shape. c: Detail of silverline system. d, e: Right and left lateral view of same specimen. Arrowhead points to densely spaced kinetosomes of kinety n. Scale bar divisions = 10 µm. Am, adoral membranelle; Cp, excretory pore of contractile vacuole; Kf, kinetofragmon; Ma, outline of macronucleus; N, nematodesmata; S1-S4, spiral kineties 1-4; Sb, separate basal bodies.

Key to the species of *Gymnozoum* and short descriptions:

Based on present investigation and data by AGATHA et al. (1993), ALEKPEROV & MAMAJEVA (1992), CORLISS & SNYDER (1986), FENCHEL & LEE (1972), MEUNIER (1910). A further new species was recently found by DALE (in prep.).

1 Size after fixation 150-250 µm 2

– smaller than 130 µm 3

2 5 equally long spiral kineties, no kinetofragmon. Holotrichously ciliated, i.e. cilia-free area between somatic kineties lacking. About 38 somatic kineties. At least 22 nematodesmata. Macronucleus spherical. Contractile vacuole terminally. 175-250 µm. Antarctica ..... *G. glaciale*

– 4 spiral kineties. Spiral row 4 anteriorly shortened. No kinetofragmon. About 32 somatic kineties. 7-9 adoral membranelles. Cilia-free area between somatic kineties. 15-16 nematodesmata. Macronucleus ellipsoidal. 150-250 µm. Arctic ..... *G. arcticum*

3 Spiral kinety 4 anteriorly distinctly shorter than spiral rows 1-3. With kinetofragmon. 22-28 somatic kineties. 8 adoral membranelles. About 36 nematodesmata. Macronucleus ellipsoidal. 50-130 µm. Arctic ..... *G. intermedium*

– spiral kineties 1-4 anteriorly equally long 4

4 Contractile vacuole in mid-body. Spiral kinety 4 posteriorly shortened. With kinetofragmon. 21-25 somatic kineties. 6-8 adoral membranelles. 14-18 nematodesmata. Macronucleus ellipsoidal. 35-65 µm. Antarctica .. *G. sympagicum*

– contractile vacuole in anterior 1/3. Spiral kinety 4 not shortened. With kinetofragmon. 24-40 somatic kineties. 8-9 adoral membranelles. About 14-20 nematodesmata. Macronucleus elongate to broad ellipsoidal. 50-115 µm. Arctic, Antarctica ..... *G. viviparum*

Order Hymenostomatida DELAGE & HÉROUARD, 1896

Frontonia frigida nov. spec.

Diagnosis: In vivo about 190-300 x 55-70 µm. Body lanceolate. 93-129 somatic, generally 5 vestibular and 5 postoral kineties; vestibular kineties overlap peniculi. Usually 2 bean-shaped micronuclei. Single contractile vacuole in posterior 1/5-1/6 of body; 1-2 excretory pores. Marine.

Type location: Multiyear sea ice of Weddell Sea, Antarctica, 70° 21' S, 08° 53' W (core number AN 103107b).

Type specimens: 1 holotype as a slide of protargol impregnated cells and 1 paratype of CHATTON-LWOFF silver nitrate stained specimens has been deposited.

Derivatio nominis: „frigidus", Lat., cold.

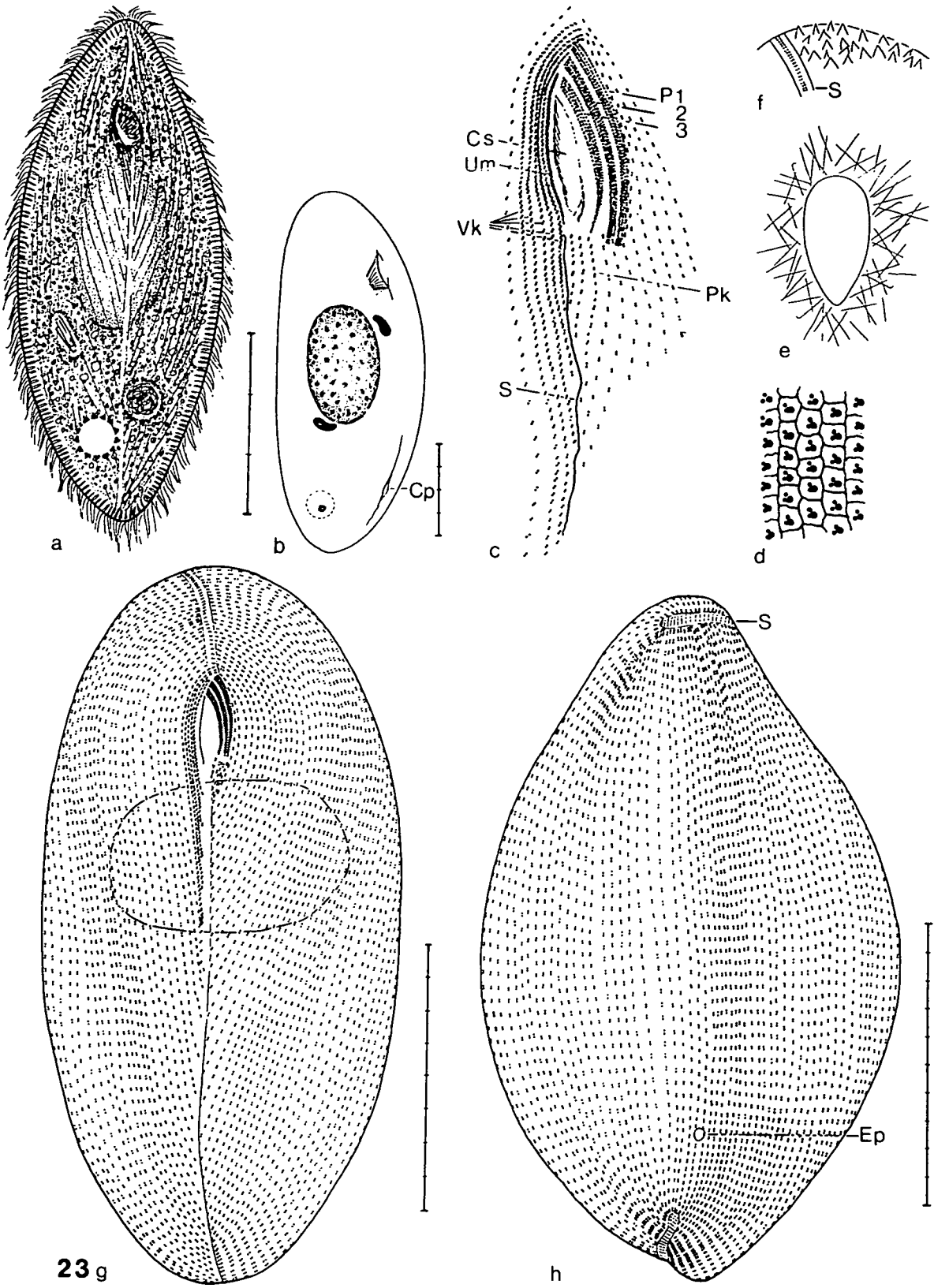
Description (Figs. 23a-h, 58, Table 14): Outline lanceolate, both ends usually narrowly rounded, sometimes anteriorly broadly rounded (Fig. 23a). Cross section flattened about 1.5:1, ventrally and dorsally convex. Pellicle quadrangularly structured, squares 2-2.5 µm across; in protargol slides with numerous thorn-like projections, ca. 3 µm long, very likely where extrusomes insert (Figs. 23f, 58). Macronucleus ellipsoidal, in protargol slides large (preparation artifact); distinctly smaller in silver nitrate impregnated specimens, with spherical to ribbon-like nucleoli (Table 14). Frequently (always?) 2 micronuclei, near macronucleus, irregularly bean-shaped in CHATTON-LWOFF slides, not well impregnated (Fig. 23b). Single contractile vacuole subterminally in posterior 1/5-1/6 of body, pulsation, however, not observed; excretory pore dorsally in extension of suture, distance to rear pole on average 19% of body length (Figs. 23a, b, h). Cytopyge on posterior ventral side in suture, distance to antapical pole about 35-50 µm. Cytoplasm contains many greenish shining globules (about 1.5 µm across), pale-greenish inclusions (up to 5 µm in diam.), food vacuoles with small pennate (20-29 µm long) and, rarely, centric (ca. 13 µm across) diatoms; specimens appear dark at low magnification and greenish-brown to olive-green, sometimes reddish (due to digested food?) at higher magnification. Pigment fleck not observed. Movement slowly gliding on bottom of petri dish.

Table 14. Morphometric characteristics of *Frontonia frigida* (n = 21); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	205.1	195.0	39.1	8.34	19.1	146.0	332.0
	243.6[1]	244.5	25.3	5.39	10.4	183.0	283.0
Body, width	103.9	101.0	13.9	3.03	13.4	81.0	135.0
	153.8[1]	151.5	21.4	4.56	13.9	114.0	190.0
Macronucleus, length	94.8	87.5	16.4	4.38	17.3	71.0	133.0
	68.8[1]	69.0	10.8	2.63	15.8	47.0	91.0
Macronucleus, width	54.5	53.0	13.1	3.39	24.1	33.0	85.0
	37.9[1]	37.0	4.7	1.14	12.4	30.0	46.0
Micronucleus, length[1]	9.0	9.0	0.8	0.21	9.3	8.0	10.5
Micronucleus, width[1]	5.2	5.0	0.4	0.10	8.4	4.5	6.0
Oral apparatus, length	27.6	27.0	1.8	0.81	6.6	26.0	30.0
Oral apparatus, width	16.4	16.0	1.0	0.37	5.9	15.0	18.0
Apex to beginning of oral apparatus, distance	29.0	29.0	7.4	2.24	25.6	18.0	43.0
Extrusomes, length	9.5	8.5	2.8	0.80	29.3	6.0	16.0
Peniculus 1, length[1]	30.1	30.0	1.2	0.39	3.9	29.0	32.0
Peniculus 2, length[1]	27.4	27.0	2.1	0.71	7.8	23.0	30.0
Peniculus 3, length[1]	23.0	23.0	1.5	0.53	6.6	20.0	25.0
Antapex to excretory pore, distance[1]	45.6	46.5	10.6	3.36	23.3	30.0	61.0
Micronuclei, number	1.7	2.0	0.5	0.10	27.0	1.0	2.0
Somatic kineties, number[2]	105.7	104.0	11.4	2.95	10.8	93.0	129.0
Postoral kineties, number	4.9	5.0	0.3	0.08	5.6	4.0	5.0
Vestibular kineties, number	4.9	5.0	0.3	0.09	6.1	4.0	5.0
Excretory pores, number	1.3	1.0	0.5	0.15	37.2	1.0	2.0

[1] From silver nitrate slides.
[2] Inclusive postoral kineties.

Figs. 23a-h: *Frontonia frigida* from life (a, e), after protargol (f-h) and silver nitrate impregnation (b-d). a, b: Ventral and right lateral view. c: Ventral view of oral apparatus. d: Detail of silverline system. e: Exploded extrusomes surrounding cell. f: Detail of pellicle showing thorn-like projections. g, h: Ventral and dorsal view. Scale bar divisions = 10 µm; a, scale bar divisions = 30 µm. Cp, cytopyge; Cs, cytostome; Ep, excretory pore of contractile vacuole; P1-3, peniculus 1-3; Pk, postoral kineties; S, suture; Um, undulating membrane; Vk, vestibular kineties.



Somatic kineties typical for genus, terminate at suture, composed of basal body pairs, 1 cilium each (9-14 µm long); in CHATTON-LWOFF slides parasomal sac sometimes impregnated. Suture distinct, preoral and postoral extend short distance to dorsal side; very rarely, argentophilic granules in preoral suture (Fig. 23h). Numerous argentophilic granules in oral area and along postoral suture in protargol slides. Extrusomes densely spaced, resting stages fusiform, in vivo about 10 µm long; exploded up to 56 µm long, rod-shaped, sometimes bent, thin, surround cell in dense layer (Fig. 23e). Silverline system quadrangular (Fig. 23d).

Oral apparatus invaginated, typical for genus; 3 peniculi, each composed of 4 basal body rows, cilia about 10 µm long. Undulating membrane inconspicuous, double-rowed, not easy to recognize. Vestibular kineties rather long, 3-4 rows overlapping peniculi anteriorly (Figs. 23c, g). Nematodesmata about 13 µm long.

Occurrence and ecology: Not rare in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 68° 44'-71° 00' S and longitude 06° 04'-11° 54' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -3.4 to -2.0°C, salinity 41.5-58.8‰, PO_4 0.3-2.7 µmol/l, NO_2 0.1-0.6 µmol/l, NO_3 0.6-114.4 µmol/l, NH_4 1.1-21.3 µmol/l, Si 2.1-61.4 µmol/l; chlorophyll *a* 0.7-30.1 µg/l melted ice. In raw cultures also at a salinity of 15.6-23.2‰ and +1°C. Biomass of 10^6 individuals: 348 mg.

Comparison with related species: *Frontonia frigida* differs from other congeners in size, number of somatic, postoral and vestibular kineties which overlap the peniculi, number and position of contractile vacuoles and often in the habitat (marine vs. freshwater, soil).

Frontonia marina FABRE-DOMERGUE, 1891 is most similar in shape, size (110-600 µm), number of somatic (40-150) and vestibular (5-8) kineties, micronuclei (1-3), contractile vacuoles (viz. 1) and excretory pores (1-2; BORROR 1963; CAREY 1992; DRAGESCO 1960; FABRE-DOMERGUE 1891; KAHL 1928a, 1931; RICCI et al. 1982; ROQUE 1961; ROQUE & PUYTORAC 1972; WILBERT & KAHAN 1981). This species differs, however, from *F. frigida* in its almost equatorially located contractile vacuole (vs. in posterior 1/5-1/6), the possession of 7 postoral kineties (vs. 4-5), the composition of the peniculi (usually 5-6 vs. constantly 4 basal body rows each), shape (spherical to ellipsoid vs. bean-shaped) and smaller size of the micronuclei

(3 µm vs. 9 x 5 µm) and a rather inconspicuous suture (BORROR 1963; DRAGESCO 1960; KAHL 1931; ROQUE 1961; ROQUE & PUYTORAC 1972).

The population described by AGAMALIEV (1968) as *F. marina* differs distinctly from this species in the subterminal position of the excretory pore. It is thus perhaps conspecific with *F. frigida*. These specimens are elliptical, slightly smaller than the Antarctic population (150-200 µm in vivo), have 6 vestibular kineties and apparently spherical micronuclei (AGAMALIEV 1968).

Two *Frontonia* spp. found by THOMPSON (1972) and THOMPSON & CROOM (1978) in Antarctic tidal pools are not conspecific with *F. frigida*, i.e. have fewer (ca. 80) or more (150-175 vs. 93-129) somatic and only 3 vestibular kineties and are markedly smaller (in silver nitrate slides 72-79 µm and 138-145 µm, respectively, vs. 183-283 µm).

Order Scuticociliatida SMALL, 1967

Genus *Cryptochilum* MAUPAS, 1883

Remarks: MAUPAS (1883) originally included several species in this genus, most of which were later transferred to *Uronema* and *Cryptochilidium* (KAHL 1931). A type species was, however, not fixed. According to art. 69 (ICZN 1985), we subsequently designate this (see below). Of the original species, *C. tortum* MAUPAS, 1883 might also belong to this genus.

Improved diagnosis: Small to medium sized scuticociliatids with elongate ellipsoid body, laterally flattened. Without frontal plate. Somatic kineties rather densely spaced, longitudinal, curving around oral apparatus. Oral apparatus uronematid, adoral membranelles inconspicuous, paroral membrane short. Buccal cavity small, invaginated, in anterior body half. Free-living.

Type species: *Cryptochilum griseolum* (PERTY, 1852) MAUPAS, 1883

***Cryptochilum reniforme* nov. spec.**

Diagnosis: In vivo 50-55 x 25-30 µm. Body reniform. 38-46 somatic kineties. Adoral membranelles composed of paired basal bodies. 1 caudal cilium. 1 macro-, 1 micronucleus. Single contractile vacuole terminally. Marine.

Type location: Sea ice of Weddell Sea, Antarctica, 70° 24' S, 06° 18' W (core number AN 103098).

Type specimens: 1 holotype as a slide of protargol impregnated cells has been deposited.

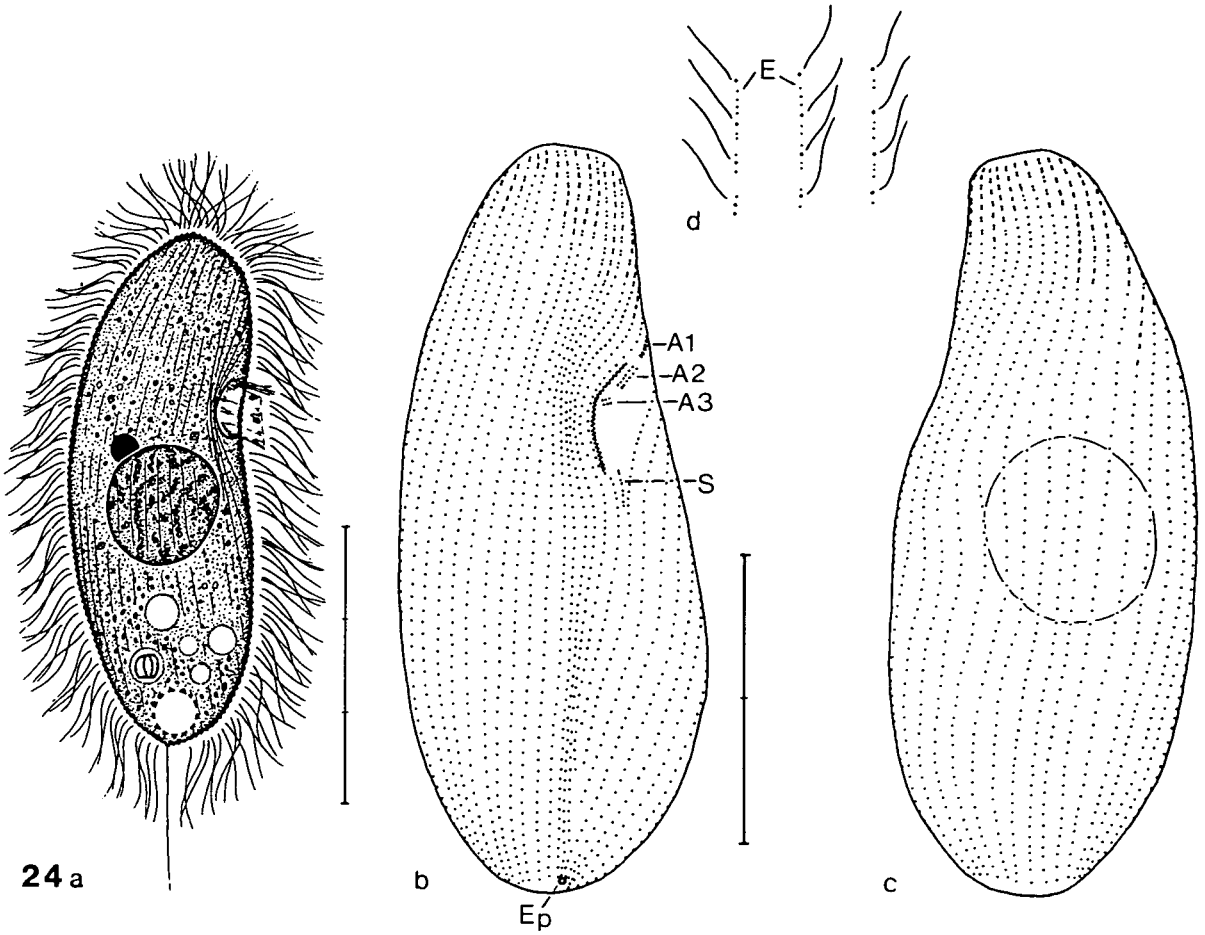
Derivatio nominis: „reniformis", Lat., kidney-shaped.

Description (Figs. 24a-d, Table 15): Ventral margin concave, dorsal convex, frontally obliquely truncate, posteriorly rounded (Fig. 24a). Laterally flattened approximately 2:1. Pellicula notched. Single macronucleus circular to ellipsoid, about in mid-body, with ribbon-like nucleoli. Single micronucleus globular, anteriorly adjacent to macronucleus. Contractile vacuole terminally, excretory pore near antapical pole. Cytoplasm colourless, hyaline, contains greasily shining globules and crystals (1-3 µm across), posteriorly often with dark particles and apparently empty vacuoles (2-5 µm across); food vacuoles contain flagellates. Swims moderately fast, rotating slightly spiralling about main body axis, rests for feeding.

Somatic kineties longitudinal, extending over entire length of cell, curving around buccal cavity on right, thus closely spaced in this area, 1-2 kineties on either side of oral area posteriorly shortened; composed mostly of monokinetids, at least in anterior portion dikinetids (perhaps variable), cilia about 8-9 µm long in vivo (Figs. 24b, c). Single caudal cilium fine, rather short, in vivo about 16 µm long. Extrusomes (mucocysts) in longitudinal rows between basal bodies (Fig. 24d). Very rarely in protargol slides, extrusomes impregnated within cell, rod-like, about 4 µm long (not illustrated).

Oral apparatus composed of curved paroral membrane and 3 short adoral membranelles: membranelle 1 anterior of oral cavity, composed of few (about 5-9), very likely paired, basal bodies, situated on narrow side of body, thus difficult to spot; membranelle 2 double-rowed; membranelle 3 transversely oriented, immediately posterior of membranelle 2, double-rowed, consists of about 6 basal bodies; cilia about 7-8 µm long. Paroral membrane extending posteriad from anterior

end of adoral membranelle 2, composed of zigzag row of basal bodies, cilia about 7-8 µm long (Fig. 24b). Oral cavity in anterior 1/3 of body, small, invaginated, contains paroral membrane on right and adoral membranelles 2 and 3. Scutica posterior of oral cavity, composed of few (ca. 5-9) basal bodies, appear paired sometimes (Fig. 24b).



Figs. 24a-d: *Cryptochilum reniforme* from life (a) and after protargol impregnation (b-d). a: Right lateral view. b, c: Right ventrolateral and dorsal view of same specimen. d: Detail of somatic kineties showing position of extrusomes. Scale bar divisions = 10 µm. A1-A3, adoral membranelles 1-3; E, extrusome positions; Ep, excretory pore of contractile vacuole (from silver nitrate impregnation); S, scutica.

Occurrence and ecology: Found only at 1 site in firstyear sea ice of the Weddell Sea, latitude 70° 24' S, longitude 06° 18' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and the ciliate *Spirostrombidium pseudocinctum* nov. comb.; temperature <-1.3°C. In raw cultures also at +1°C; do not burst at higher, i.e. room, temperature. Biomass of 10^6 individuals: 13 mg.

Table 15. Morphometric characteristics of *Uronema antarcticum* (first line, n = 31), *U. paramarinum* (second line, n = 31), *U. acutum* (third line, n = 18) and *Cryptochilum reniforme* (fourth line, n = 31); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	46.0	46.0	4.5	0.81	9.7	36.0	55.0
	42.4	43.0	4.2	0.75	9.9	35.0	49.0
	30.0	30.0	2.7	0.63	8.9	25.0	34.0
	59.6	60.0	6.3	1.12	10.5	51.0	74.0
Body, width	20.0	20.0	4.3	0.76	21.3	17.0	28.0
	20.2	20.0	2.3	0.42	11.5	16.0	25.0
	16.0	16.3	2.4	0.56	14.8	12.0	20.0
	24.2	23.0	2.9	0.52	11.9	21.0	31.5
Macronucleus, length	15.7	16.0	2.2	0.39	14.0	13.0	22.0
	15.4	15.0	2.3	0.42	15.2	12.0	24.0
	9.3	9.0	1.1	0.27	12.0	9.0	12.0
	16.4	16.0	2.3	0.41	13.9	13.0	20.0
Macronucleus, width	13.8	14.0	1.7	0.30	12.0	9.0	16.0
	11.9	12.0	2.0	0.37	17.6	9.0	16.0
	7.5	7.0	0.9	0.22	12.3	6.0	9.0
	14.3	14.0	1.5	0.26	10.1	12.0	17.5
Micronucleus, diameter	2.2	2.5	0.3	0.05	11.4	2.0	2.5
	1.9	2.0	0.2	0.09	13.1	1.5	2.0
	–[1]	–	–	–	–	–	–
	3.0	3.0	0.4	0.10	13.7	2.5	4.0
Adoral membranelle M1, length	7.6	8.0	1.3	0.24	17.4	5.0	10.0
	2.8	3.0	0.6	0.12	20.6	2.0	4.0
	4.1	4.0	0.5	0.16	12.3	3.0	5.0
	–[1]	–	–	–	–	–	–
Adoral membranelle M2, length	2.7	2.5	0.3	0.05	10.2	2.0	3.0
	4.6	4.5	0.4	0.07	8.2	4.0	5.0
	2.6	2.5	0.2	0.08	8.8	2.5	3.0
	2.6	2.5	0.4	0.08	14.9	2.0	3.5
Adoral membranelle M3, length	1.9	2.0	0.3	0.08	16.5	1.5	2.5
	2.0	2.0	0.0	0.00	0.0	2.0	2.0
	1.8	2.0	0.3	0.17	15.8	1.5	2.0
	1.6	1.5	0.4	0.09	22.7	1.0	2.0
Paroral membrane, length	10.0	10.0	0.9	0.16	8.8	9.0	13.0
	9.7	10.0	0.5	0.10	5.6	9.0	11.0
	7.9	7.8	1.0	0.36	12.8	7.0	9.0
	8.8	9.0	0.5	0.12	6.0	8.0	10.0
Apex to posterior end of M1, distance	12.1	12.5	1.4	0.26	11.8	9.0	14.0
	8.3	8.0	2.0	0.37	24.6	6.0	10.0
	5.0	5.0	0.6	0.17	11.5	4.5	6.0
	–[1]	–	–	–	–	–	–

Table 15 continued.

Character	x	M	SD	SE	CV	Min	Max
Apex to posterior end of M2, distance	16.9	17.0	1.8	0.33	11.0	13.0	20.0
	13.4	13.5	1.4	0.25	10.2	10.0	16.0
	7.9	8.0	0.6	0.21	8.0	7.0	9.0
	18.5	18.0	1.3	0.28	6.9	16.0	21.0
Apex to posterior end of M3, distance	19.2	20.0	2.0	0.37	10.6	15.0	23.0
	15.3	15.5	1.4	0.25	9.1	12.5	17.0
	9.6	9.5	0.7	0.25	7.2	9.0	11.0
	19.9	20.0	1.3	0.29	6.3	18.0	22.0
Apex to posterior end of paroral membrane, distance	24.2	25.0	1.8	0.33	7.6	20.0	27.0
	20.5	21.0	1.5	0.27	7.3	18.0	24.0
	15.2	15.0	1.1	0.35	7.3	13.5	17.0
	25.3	25.5	1.5	0.36	6.1	22.5	29.0
Somatic kineties, number	21.0	22.0	1.9	0.34	9.1	16.0	22.0
	13.6	13.0	0.9	0.16	6.6	13.0	15.0
	9.7	10.0	0.6	0.16	6.4	9.0	11.0
	42.1	42.0	1.7	0.33	4.1	38.0	46.0
M1, number of basal bodies[2]	11.5	12.0	1.5	0.27	13.4	8.0	14.0
	5.5	5.0	0.7	0.13	13.2	4.0	7.0
	8.9	9.0	0.8	0.30	9.4	8.0	10.0
	–[1]	–	–	–	–	–	–
M2, number of basal bodies[2]	5.2	5.0	0.4	0.07	7.7	5.0	6.0
	–[1]	–	–	–	–	–	–
	5.0	5.0	0.7	0.32	14.1	4.0	6.0
	5.3	5.0	0.7	0.19	12.2	4.0	6.0
Scutica, number of basal bodies[2]	4.9	5.0	1.4	0.25	28.2	4.0	11.0
	6.1	6.0	1.0	0.25	17.0	4.0	8.0
	2.0	2.0	0.0	0.00	0.0	2.0	2.0
	–[1]	–	–	–	–	–	–
Number of dikinetids in M2[3]	2.3	2.0	0.7	0.12	30.3	3.0	1.0

[1] Not determined.
[2] Single and paired basal bodies, respectively.
[3] In *U. paramarinum*.

Comparison with related species: *Cryptochilum griseolum* is rather similar to *C. reniforme* in body shape, kinety pattern and oral cavity (KAHL 1931; MAUPAS 1883; PERTY 1852). The latter species is thus included in *Cryptochilum*. *Cryptochilum griseolum* differs from *C. reniforme* in the possession of about half as many somatic kineties and the freshwater habitat (KAHL 1931; MAUPAS 1883; PERTY 1852). The marine variety of *C. griseolum* (different species?)

differs in shape, fewer somatic kineties and lack of a caudal cilium (GOURRET & ROESER 1888). Silver impregnations are, however, not available.

Cryptochilum reniforme differs markedly from other uronematids in the smaller and invaginated oral apparatus and the dense somatic ciliation. *Uronema botuliformis* WENZEL, 1961 is rather similar in body shape and arrangement of the somatic kineties. It possesses, however, a small frontal plate and occurs in marine sponges (WENZEL 1961). *Uronemopsis kenti* (KAHL, 1926) KAHL, 1931 differs from *C. reniforme* in having fewer somatic kineties, a larger oral apparatus, an apparently

U-shaped paroral membrane, a subterminal contractile vacuole and the freshwater habitat (CURDS et al. 1983; KAHL 1926, 1931).

Cryptochilum is not to be confused with *Cryptochilidium* SCHOUTEDEN, 1906. The species of the latter genus are distinguished by shape, position and structure of the oral apparatus, have a caudal prolongation and are endocommensals (FOISSNER 1985; KAHL 1931, 1933; SCHOUTEDEN 1906; YAGIU 1935). The species redescribed by FOISSNER (1985), viz. *Cryptochilum echini*, thus belongs to *Cryptochilidium* as already proposed by KAHL (1931), i.e. *Cryptochilidium echini* (MAUPAS, 1883) KAHL, 1931.

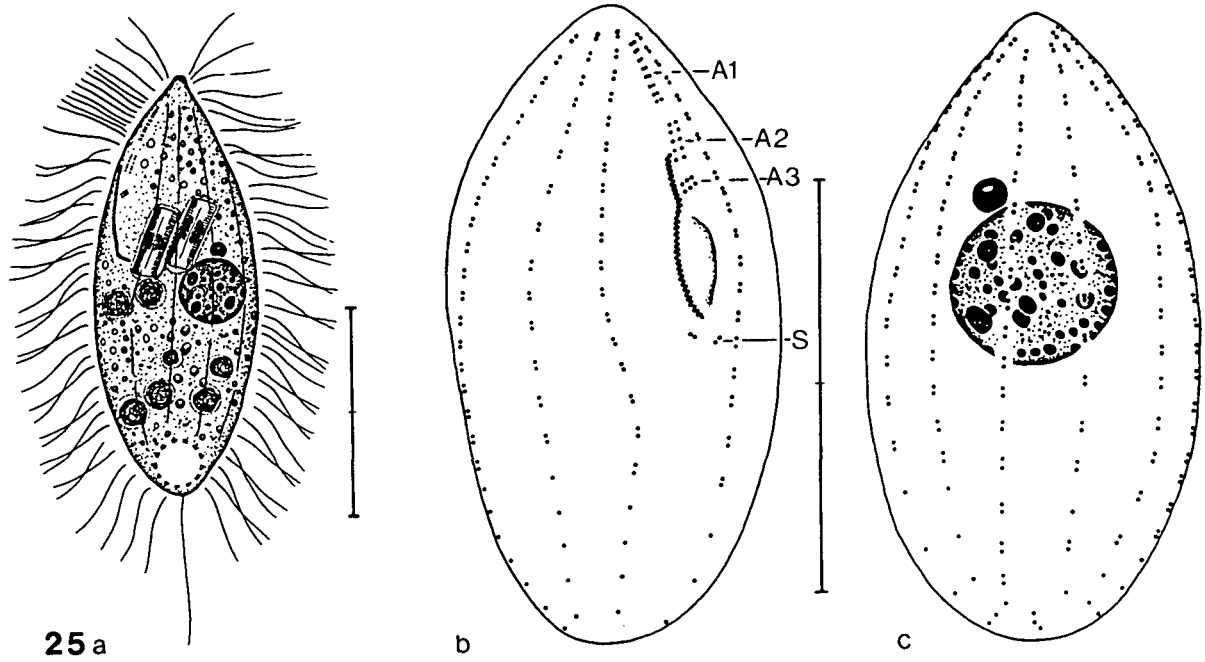
Uronema acutum BUDDENBROCK, 1920

Morphology and infraciliature (Figs. 25a-c, Table 15): In vivo 30-45 x 13-20 µm. Shape spindle-like, anteriorly tapering, posteriorly rounded, ventral and dorsal margin convex (Fig. 25a). Cross section circular. Frontal plate small. Usually 1, very rarely 2 smaller macronuclei, spherical to ellipsoid, usually anterior of mid-body, with ribbon-like nucleoli. 1 micronucleus, globular, adjacent to anterior portion of macronucleus, generally not impregnated with protargol. Contractile vacuole terminally, pulsation, however, not observed. Cytoplasm contains small greenishly shining globules, numerous food vacuoles with pennate diatoms (8-11 µm long) and few with bright green contents. Movement moderately fast to fast, rotating about long axis of body.

Somatic kineties extending over entire length of body, composed of dikinetids (both basal bodies ciliated) and monokinetids in about posterior 1/4 of body, about 22 basal bodies/row, cilia ca. 8 µm long (Figs. 25b, c). Single caudal cilium on posterior

pole, 13-17 µm long. Polar basal body complex on rear pole, composed of 2-3 argentophilic granules. Extrusomes along somatic kineties, exploded rod-like, about 9 µm long.

Oral apparatus in anterior half of cell. 3 adoral membranelles, cilia about 10 µm long; membranelle 1 commences almost at frontal pole, consists of apparently paired basal bodies; membranelle 2 shorter, composed of 2 basal body rows; membranelle 3 very short, oblique, very likely 2-rowed (Fig. 25b). Paroral membrane on right of shallow buccal cavity, gently curved, composed of zigzag row of basal bodies, cilia about 5 µm long. Scutica consists of about 2 apparently paired basal bodies (Fig. 25b).



Figs. 25a-c: *Uronema acutum* from life (a) and after protargol impregnation (b, c). a: Left ventrolateral view. b, c: Right ventrolateral and dorsolateral view of same specimen. Scale bar divisions = 10 µm. A1-A3, adoral membranelles 1-3; S, scutica.

Occurrence and ecology: Frequently found in pancake and multiyear sea ice of the Weddell Sea, between latitude 68° 38'-71° 00' S and longitude 06° 04'-12° 00' W. Up to 6 105 active ind./l melted ice (biomass 0.024 mg/l; x = 2 619 active ind./l, biomass 0.01 mg/l, n = 6) were found comprising up to 30.8% (x = 15.8%) of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -4.1 to -2.0°C, salinity 44.0-70.5‰, PO_4 0.6-1.4 µmol/l, NO_2 0.2-0.6 µmol/l, NO_3

24.8-34.2 µmol/l, NH_4 7.2-10.2 µmol/l, Si 25.6-57.0 µmol/l; chlorophyll *a* 11.1-80.1 µg/l melted ice. In raw cultures also at +1°C and 15.6-20.5‰ salinity; do not burst at higher, i.e. room, temperature. Biomass of 10^6 individuals: 4 mg.

Generic position and comparison with related species: The structure of the adoral membranelles is important for the generic assignment of scuticociliates (THOMPSON 1964, 1967; THOMPSON & MOEWUS 1964). The adoral membranelles in the species described here are like those in *Parauronema* (THOMPSON 1967). This genus differs from *Uronema* only in an additional basal body row of adoral membranelle 1, i.e. double- vs. single-rowed. This difference does not warrant a separation at generic level because *U. marinum*, type of *Uronema*, sometimes also has a paired basal body in adoral membranelle 1, i.e. a very short 2nd row (Fig. 28a; AGAMALIEV 1974). We thus follow FOISSNER (1971) who synonymized *Parauronema* with *Uronema*. Consequently, *Parauronema antarcticum* is also transferred to *Uronema*: *U. antarcticum* (THOMPSON, 1972) nov. comb.

The shape, oral infraciliature, e.g. short adoral membranelle 1 composed also mostly of 1 row of basal bodies, and stomatogenesis of *Metanophrys durchoni* PUYTORAC et al., 1974a, type of the genus, are very similar to that of some species of *Uronema*. *Metanophrys durchoni* differs slightly from *Uronema* in having 2 contractile vacuole pores which are situated within 2nd and 3rd somatic kinety and the silverline surrounding the posterior pole forms a closed circle (vs. open); the endocommensal mode of life very likely justifies the separation at generic level (PUYTORAC et al. 1974a). Adoral membranelle 1 and 2 of *M. elongata* (BIGGAR & WENRICH, 1932) GROLIÈRE et al., 1978 are distinctly different from those of *Uronema* (GROLIÈRE et al. 1980).

Uronema acutum as described in the literature is of similar size as the specimens found here, has an equal number of somatic kineties (viz. 9-14), a slightly tapering anterior pole and a double-rowed adoral membranelle 1 (BORROR 1963, 1965; DRAGESCO & DRAGESCO-KERNÉIS 1986). The specimens found by BUDDENBROCK (1920) are slightly larger, i.e. 50-70 µm. Shape, body size (27-33 µm), number of somatic kineties (9-13) and composition of adoral membranelles (e.g. membranelle 1 double-rowed) of *U. virginianum* (THOMPSON, 1967) FOISSNER, 1971 are very similar to *U. acutum* (BORROR 1963, 1965; DRAGESCO & DRAGESCO-KERNÉIS 1986; THOMPSON 1967; WILBERT & KAHAN 1981). *Uronema virginianum* is thus

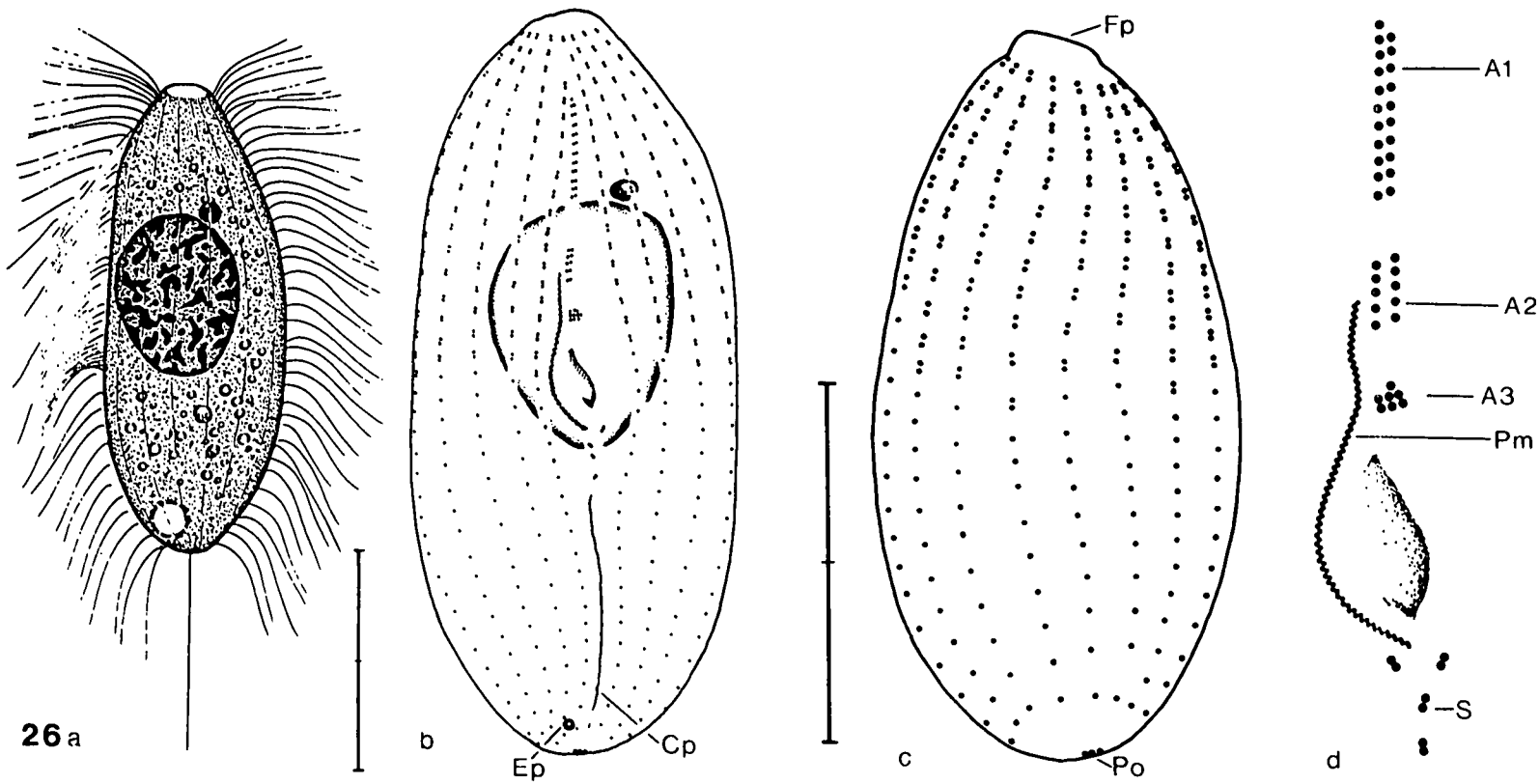
considered to be a junior synonym of *U. acutum*. Likewise, *U. marinum* DUJARDIN, 1841 as pictured by DRAGESCO & DRAGESCO-KERNÉIS (1986; plate 90, Fig. H) seems to be *U. acutum*.

Uronema acutum and *U. antarcticum* are rather similar in the structure of the adoral membranelles. The latter species differs in more somatic rows (16-22 vs. 9-11), the larger frontal plate and the composition of the scutica, i.e. Y-shaped vs. 2 basal body pairs (Figs. 25, 26a-c, Table 15; THOMPSON 1972; THOMPSON & CROOM 1978). *Uronema* sp. and *Parauronema* sp. found in Antarctic sea ice and sea water, respectively, might also be *U. acutum* (FENCHEL & LEE 1972; THOMPSON & CROOM 1978).

***Uronema antarcticum* (THOMPSON, 1972) nov. comb.**

Morphology and infraciliature (Figs. 26a-d, Table 15): In vivo 45-60 x 20-30 µm. Barrel-shaped to slightly sac-like, ventral margin almost straight to slightly concave, ventral surface gently indented in buccal area, dorsally convex, widest behind mid-body; anteriorly with distinct frontal plate, 2.5-5 µm across; posteriorly rounded (Fig. 26a). Laterally very slightly flattened. Single macronucleus ellipsoid to spherical, about in mid-body, contains ribbon-like and globular nucleoli. 1 micronucleus, globular, anteriorly adjacent to macronucleus. Contractile vacuole slightly subterminally near ventral margin; excretory pore close to terminal end of kinety 2 right of oral area. Cytopyge posterior of scutica. Cytoplasm colourless, hyaline; sometimes with numerous refractile particles, specimens thus appearing rather dark. Apparently feeds on bacteria. Movement fast, rests for rather long periods, e.g. when feeding.

Somatic kineties longitudinal, extending over entire length of body, kinety right of oral area slightly shortened anteriorly; composed of dikinetids (usually 6-11) in anterior half of cell and monokinetids posteriorly, about 26-41 basal bodies/row, each kinetosome with cilium (9-11 µm long). Single caudal cilium fine, on posterior pole, 17-26 µm long; kinetosome of this and 2 argentophilic granules (parasomal sacs) form polar basal body complex (Figs. 26b, c). In silver nitrate slides, silverlines mainly along somatic kineties. Extrusomes not observed in living individuals, extruded rod-like in protargol slides, about 14 µm long.



Figs. 26a-d: *Uronema antarcticum* from life (a) and after protargol impregnation (b-d). a: Left lateral view. b, c: Ventral and dorsal view. d: Detail of oral ciliature. Scale bar divisions = 10 µm. A1-A3, adoral membranelles 1-3; Cp, cytopyge (after silver nitrate impregnation); Ep, excretory pore of contractile vacuole (from silver nitrate impregnation); Fp, frontal plate; Pm, paroral membrane; Po, polar basal body complex; S, scutica.

Oral apparatus tetrahymenal, in anterior body half. 3 adoral membranelles: membranelle 1 long, composed of obliquely arranged paired basal bodies, 1-2 monokinetids at anterior end; membranelle 2 usually consists of 2 basal body rows, very rarely apparently with a 3rd row posteriorly; membranelle 3 small, irregularly 2- to 3-rowed, base often cluster-like (Figs. 26b, d). Paroral membrane on right of shallow buccal cavity, composed of zigzag row of basal bodies, posteriorly curved, cilia about 7 µm long. Scutica consists of apparently paired basal bodies, usually Y-shaped, non-ciliated (Fig. 26d).

Occurrence and ecology: Found only in multiyear land-fast sea ice of the Atka Bay, Weddell Sea, latitude 70° 31' S and longitude 07° 59' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates, e.g. *Uronema paramarinum* nov. spec. Environmental parameters in brine: temperature <-1.6°C, PO_4 5 µmol/l, NO_2 0.2 µmol/l, NH_4 18 µmol/l. In raw cultures also at +1°C. Biomass of 10^6 individuals: 14 mg.

Comparison with related species: This species was originally described from marine habitats of the South Shetland Islands, Antarctica, and included in *Parauronema* (see above; THOMPSON 1972; THOMPSON & CROOM 1978). The population found in the Weddell Sea is rather similar to the original and a subsequent description in terms of adoral membranelles, especially membranelle 1, and number of somatic kineties (16-22 vs. 17-19; THOMPSON 1972; THOMPSON & CROOM 1978). The specimens found by us are, however, slightly larger (36-55 µm vs. 25-45 µm) and apparently possess only 1 contractile vacuole pore (vs. 2-3; THOMPSON 1972; THOMPSON & CROOM 1978).

***Uronema paramarinum* nov. spec.**

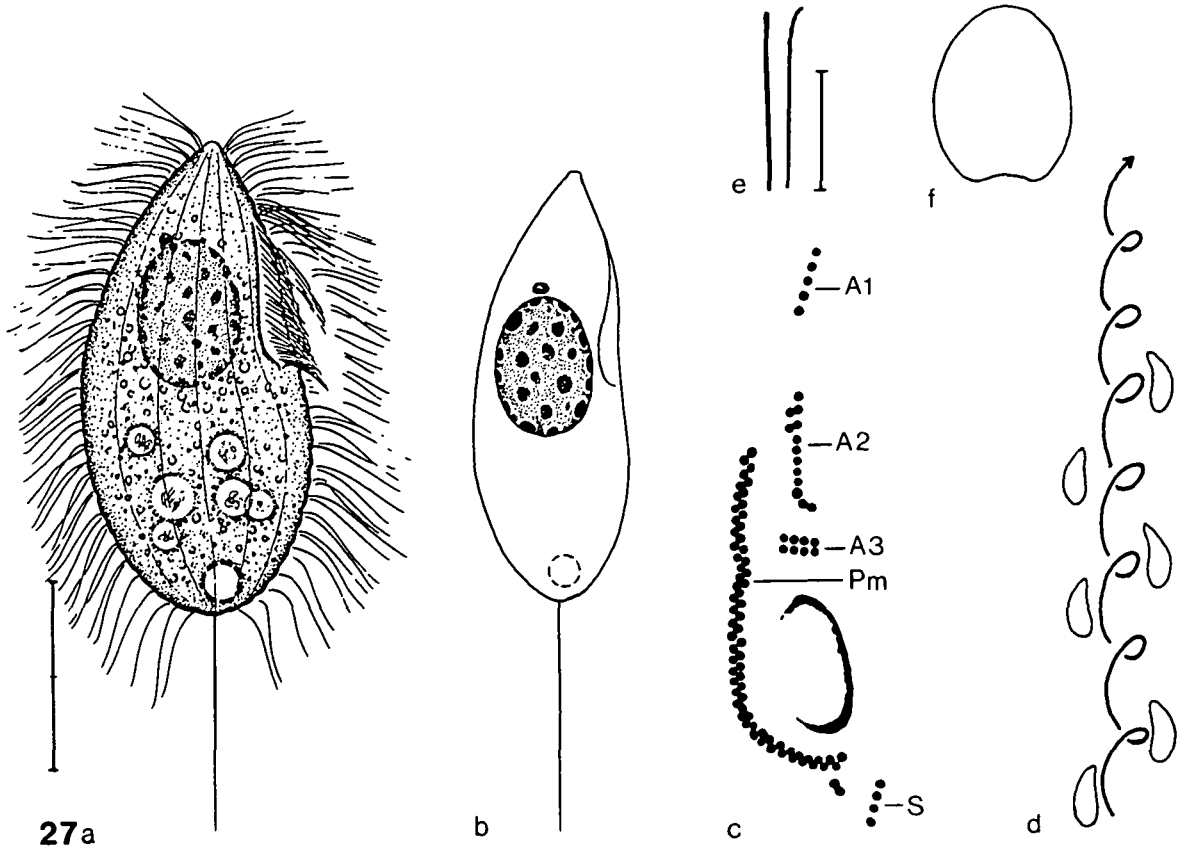
Diagnosis: In vivo 40-55 x 17-30 µm. Body drop-shaped. Anteriorly pointed, frontal plate very small. 13-15 somatic kineties. 3 adoral membranelles; membranelle 1 and 2 single-rowed, membranelle 2 anteriorly with few paired basal bodies. 1 macronucleus. Free-living.

Type location: Sea ice of Weddell Sea, Antarctica, 70° 31' S, 07° 59' W (core number AN 103099).

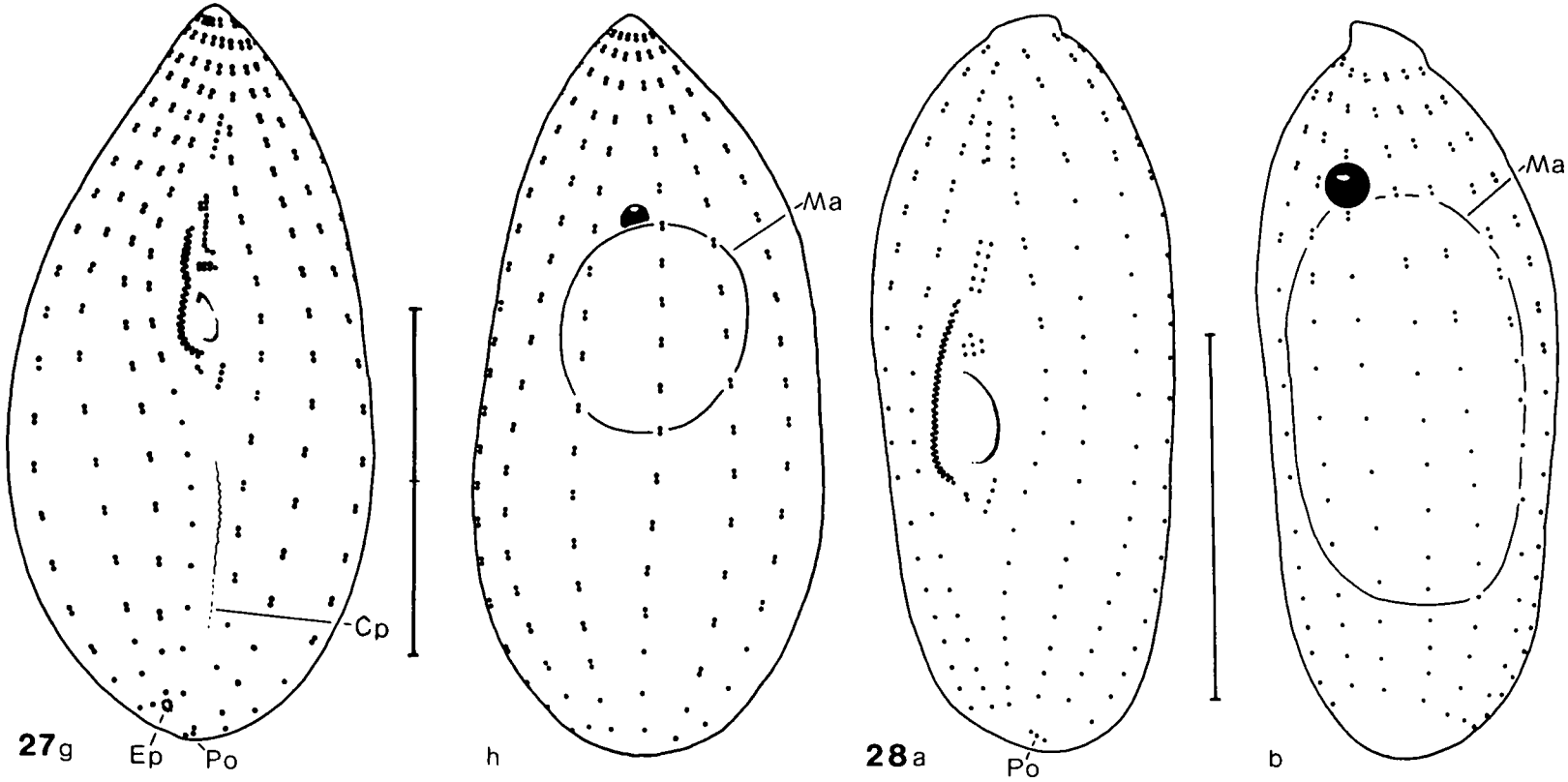
Type specimens: 1 holotype as a slide of protargol impregnated cells has been deposited.

Derivatio nominis: „para-", next to; „marinus", living in the sea; Lat.; referring to similarity with *U. marinum*.

Description (Figs. 27a-h, Table 15): Shape slim drop-like to pear-shaped, depending on nutritional state, ventral margin indistinctly indented in area of buccal cavity, dorsal convex; oral area slightly concave; anteriorly tapering, bluntly pointed, non-ciliated frontal area very small; posteriorly broadly rounded (Figs. 27a, b). Laterally slightly compressed (Fig. 27f). Pellicle notched. Macronucleus spherical to ellipsoid, in anterior half of body, with roundish nucleoli (up to 2.5 µm across).



Figs. 27a-f: *Uronema paramarinum* from life (a, b, d, f) and after protargol impregnation (c, e). a: Right lateral view. b: Right lateral view of slim specimen. c: Detail of oral ciliature. d: Swimming path; arrow indicates direction. e: Extruded extrusomes. f: Cross section in area of buccal cavity. Scale bar divisions = 10 µm. A1-A3, adoral membranelles 1-3; Pm, paroral membrane; S, scutica.



Figs. 27g, h: *Uronema paramarinum* after protargol impregnation; ventral and dorsal view.

Figs. 28a, b: *Uronema marinum* after protargol impregnation; ventral and dorsal view of same specimen. Individuals found in the pelagial of the Atlantic Ocean distinctly north of the Antarctic Convergence (about 51° S). Scale bar divisions = 10 µm. Cp, cytopyge (after silver nitrate impregnation); Ep, excretory pore of contractile vacuole (from silver nitrate impregnation); Ma, outline of macronucleus; Po, polar basal body complex.

Micronucleus globular, near anterior end of macronucleus. Contractile vacuole terminally, excretory pore at posterior end of 2nd kinety right of oral apparatus (Fig. 27g). Silverline of cytopyge irregular, longitudinal, posterior of scutica. Cytoplasm colourless, hyaline, with some pale greenish globules. Food vacuole with indefinable contents; in cultures fed with shrimp muscle. Movement not fast, distinctly spiralling when swimming (Fig. 27d).

Somatic kineties meridional, slightly sigmoidal on right lateral side, extending over entire length of body, composed of dikinetids in anterior portion (both kinetosomes ciliated) and usually monokinetids in posterior 1/3-1/4, rarely 2/5, of body, about 20-27 basal bodies/row, cilia 9-13 µm long; kinety right of oral apparatus usually with 7-9 single basal bodies posteriorly (Figs. 27g, h). Single caudal cilium on posterior pole, rather stiff, 21-29 µm long. Polar basal body complex on antapical pole, usually formed by 3 argentophilic granules, i.e. basal body of caudal cilium and 2 parasomal sacs (CORLISS 1979). Silverlines mainly along somatic kineties (not illustrated). Extruded extrusomes rod-like, distally sometimes slightly bent, 14-17 µm long, not observed in vivo (Fig. 27e).

Oral apparatus tetrahymenal, in anterior half of cell. 3 adoral membranelles, cilia about 7-8 µm long; membranelle 1 short distance from apex, consists of 1 row of basal bodies; membranelle 2 single-rowed, anteriorly always with 1-3 obliquely arranged paired basal bodies (i.e. very short 2nd row), posteriorly slightly curved, about 11 kinetosomes long; membranelle 3 short, often 2-, rarely 3-rowed, transversely oriented (Figs. 27c, g, Table 15). Paroral membrane on right of shallow buccal cavity, posteriorly curved, composed of zigzag row of basal bodies, cilia about 4 µm long. Scutica Y-shaped, consists of row of 4-5 and, right of these, 1 pair of basal bodies (Figs. 27c, g).

Occurrence and ecology: Regularly found in multiyear and multiyear land-fast (Atka Bay) sea ice, less frequently in pancake ice and once in the pelagial of the Weddell Sea, between latitude 69° 46'-71° 16' S and longitude 06° 18'-12° 02' W. Up to 11 611 active ind./l melted ice (biomass 0.08 mg/l) were found comprising up to 20.4% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates, e.g. *Uronema antarcticum*. Reaches high numbers in slightly older raw cultures. Environmental parameters in brine (1 measurement): temperature -2.3°C, salinity 41.5‰, PO_4 1.1 µmol/l, NO_2 0.2 µmol/l, NO_3 20.2 µmol/l, NH_4 17.5 µmol/l, Si 27.9 µmol/l; chlorophyll *a* 30.1 µg/l melted

ice. In raw cultures also at +1°C and 21.3‰ salinity; do not burst at higher, i.e. room, temperature. Biomass of 10^6 individuals: 7 mg.

Comparison with related species: The somatic kinety number in *U. paramarinum* is similar to that of *U. marinum* (Figs. 28a, b; AGAMALIEV 1974; BORROR 1963; COPPELLOTTI 1990; DRAGESCO & DRAGESCO-KERNÉIS 1986; JANKOWSKI 1964; KAHL 1931; PUYTORAC et al. 1974a; THOMPSON 1964, 1972). The latter species differs, however, in the barrel-shaped body, the larger frontal plate and the composition of the adoral membranelle 2 (2-3 equally long basal body rows vs. 1 long and 1 very short).

Uronema paramarinum differs from *U. acutum* in slightly more somatic kineties (13-15 vs. 9-14), composition of adoral membranelle 1 (single- vs. double-rowed) and composition of scutica (4-8 basal bodies of which 1 is paired vs. 2 paired kinetosomes; Figs. 25b, 27c; BORROR 1963, 1965; DRAGESCO & DRAGESCO-KERNÉIS 1986; THOMPSON 1967; WILBERT & KAHAN 1981). The frontally pointed species of *Miamiensis* differ in an anteriorly elongated paroral membrane and in wider adoral membranelles 1 and 2 (SMALL & LYNN 1985; THOMPSON & MOEWUS 1964).

Pleuronema glaciale CORLISS & SNYDER, 1986

A few specimens of this species were found in the brown layer of multiyear sea ice of the Weddell Sea, 70° 21' S, 08° 53' W (core number AN 103107b). It was, however, not observed in vivo. The infraciliature is identical to that in the drawing by CORLISS & SNYDER (1986). Only morphometric data are thus given (Table 17). Biomass of 10^6 individuals (from fixed specimens): 190 mg.

Pleuronema puytoraci GROLIÈRE & DETCHEVA, 1974

Morphology and infraciliature (Figs. 29a-e, Table 16): In vivo about 90-170 x 40-60 µm. Outline elongate oval to elliptical, widest at or behind mid-body, anteriorly and posteriorly broadly rounded, ventral and dorsal margin almost straight to slightly convex (Figs. 29a, c). Cross section circular to laterally slightly compressed. Macronucleus with globular and ribbon-like nucleoli. Micronucleus not impregnated with protargol. Contractile vacuole in posterior 1/3 at

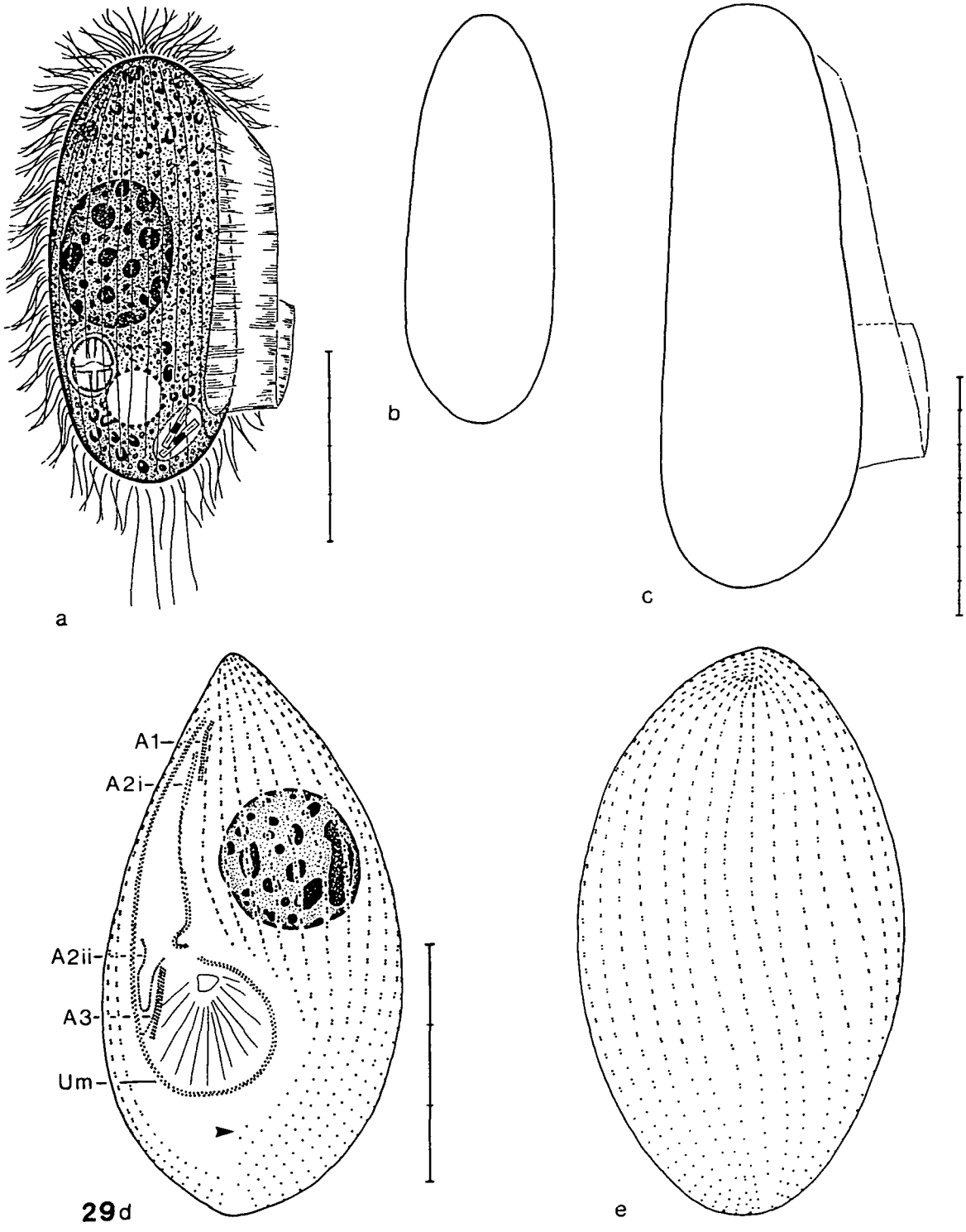
level of cytostome. Cytoplasm colourless, contains greasily shining globules and food vacuoles with dinoflagellates and, rarely, pennate diatoms. Movement moderately fast, sometimes zigzag, rotates about main body axis, rests for short periods.

Somatic kineties extending over entire length of cell, terminate in pre- and postoral suture; in anterior 2/3 of body composed mainly of paired basal bodies, single kinetosomes posteriorly, cilia about 17-20 µm long (Figs. 29d, e). Few caudal cilia, 23-34 µm long. Leftmost preoral kinety sometimes continued posterior of cytostome with few basal bodies (postoral row; Fig. 29d). Extruded extrusomes filamentous in protargol slides, about 16 µm long; resting states not distinct.

Table 16. Morphometric characteristics of *Pleuronema puytoraci* (upper line, n = 5) and *P. glaciale* (lower line, n = 4); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	87.4	74.0	30.4	13.58	34.7	70	141
	134.5	135.0	8.2	4.11	6.1	124	144
Body, width	41.0	38.0	5.4	2.41	13.1	37	50
	60.0	57.5	8.4	4.18	13.9	53	72
Macronucleus, length	22.3	23.0	3.0	1.49	13.4	18	25
	36.0	35.0	3.6	2.08	10.0	33	40
Macronucleus, width	18.5	19.0	4.2	2.10	22.7	13	23
	27.7	25.0	4.6	2.67	16.7	25	33
Undulating membrane, length	70.4	61.0	30.0	13.42	42.6	47	123
	102.0	109.5	15.3	7.67	15.0	79	110
Adoral membranelle 1, length	12.1	10.3	2.3	1.16	19.2	10	15
	43.7	42.0	2.9	1.67	6.6	42	47
Adoral membranelle 2i, length	52.5	38.0	25.8	12.89	49.1	37	91
	75.0	77.0	4.4	2.52	5.8	70	78
Adoral membranelle 2ii, length	10.3	10.5	1.0	0.48	9.3	9	11
	16.5	16.5	0.7	0.50	4.3	16	17
Adoral membranelle 3, length	13.6	13.0	3.1	1.40	23.0	11	19
	33.0	33.0	0.0	0.00	0.0	33	33
Somatic kineties, number[1]	27.6	26.0	3.8	1.69	13.7	25	34
	58.0	58.0	0.0	0.00	0.0	58	58
Preoral kineties, number	3.6	4.0	0.9	0.40	24.8	2	4
	–[2]	–	–	–	–	–	–

[1] Including preoral kineties.
[2] Not recognizable.



Figs. 29a-e: *Pleuronema puytoraci* from life (a-c) and after protargol impregnation (d, e). a, c: Right lateral view. b: Dorsal view. d, e: Ventral and dorsal view. Arrowhead marks postoral row. Scale bar divisions = 10 µm. A1-A3, adoral membranelles 1-3; Um, undulating membrane.

Adoral membranelles of „coronatum" type: membranelle 1 short, about 23% of length of membranelle 2i, anteriorly with some disordered basal bodies; adoral membranelle 2 bipartite, membranelle 2i posteriorly hook-like, anteriorly and posteriorly distinctly 2-rowed, middle portion apparently single-rowed (due to obliquely arranged basal body pairs?); membranelle 2ii U-shaped; membranelle 3 inverted Y-shaped, composed of 3 basal body rows (Fig. 29d, Table 16). Undulating membrane conspicuous, about 81% of body length, cilia 27-40 µm long.

Occurrence and ecology: Rarely found at 1 site in deeper layers of multiyear sea ice of the Weddell Sea, 70° 21' S, 08° 53' W. 1 526 active ind./l melted ice were found (biomass 0.2 mg/l), comprising 7.7% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -3.4 to -3.0°C, salinity 51.8-58.8‰; in melted ice: PO_4 0.3-2.8 µmol/l, NO_2 0.1 µmol/l, NO_3 0.6-6.1 µmol/l, NH_4 1.1-3.5 µmol/l, Si 2.1-14.8 µmol/l, chlorophyll *a* 27.3-80.1 µg/l. In raw cultures also at +1°C. Biomass of 10^6 individuals: 125 mg.

Comparison with related species: This population is very similar to that of *P. puytoraci* found in the mesopsammon of the Black Sea in size (70-120 µm) and number of somatic (28-29), preoral (3) and postoral (0-1) kineties (GROLIÈRE & DETCHEVA 1974). It differs from *P. coronatum* KENT, 1881 and other rather similar species in the larger size and fewer somatic kineties (AGAMALIEV 1968; BORROR 1963, 1972b; DRAGESCO 1960, 1968; DRAGESCO & DRAGESCO-KERNÉIS 1986). The most similar of these, *P. smalli* DRAGESCO, 1968, is shorter (42-70 vs. 70-141 µm; BORROR 1972b; DRAGESCO 1968). As size is apparently the only difference between *P. smalli* and *P. puytoraci*, these might be conspecific. *Pleuronema marinum* DUJARDIN, 1841 has more somatic kineties and lacks the hook-like bend of the M2i (AGAMALIEV 1983; BORROR 1963; DRAGESCO 1960, 1968).

Pleuronema puytoraci differs from *P. glaciale* by having fewer somatic (28 vs. 52) and preoral kineties (4 vs. 6), and the considerably shorter adoral membranelle 1 (CORLISS & SNYDER 1986). *Pleuronema arcticum* AGATHA et al., 1993 from Arctic sea ice is about twice as large as *P. puytoraci*, has distinctly more somatic kineties and lacks postoral rows. *Pleuronema arcticum* is rather similar to *P. glaciale* but has only 3-4 preoral rows (vs. 6) and a distinctly shorter adoral membranelle 1.

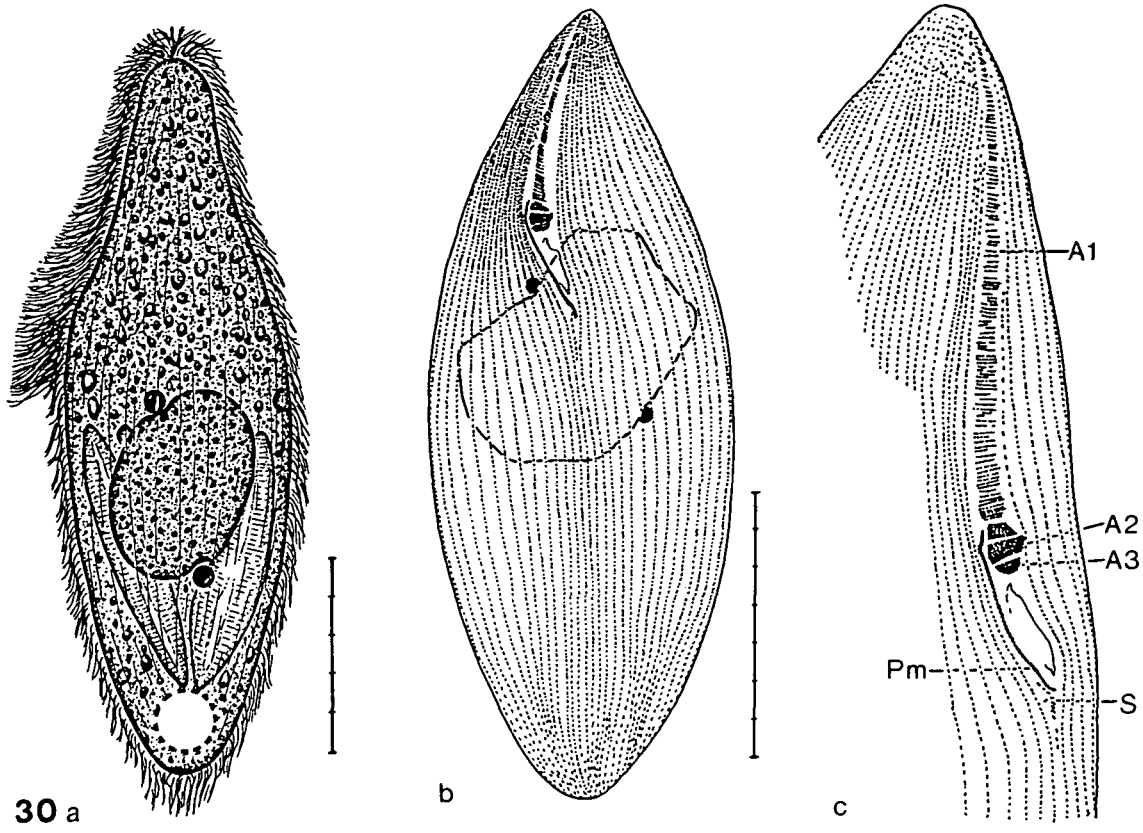
Pleuronema sp. found in Antarctic tidal pools is similar to *P. puytoraci* in size and oral infraciliature but differs by having considerably more somatic kineties, viz. 53-62 (THOMPSON 1972). *Pleuronema* sp. is distinguished from *P. glaciale* only in the shorter adoral membranelle 1 (CORLISS & SNYDER 1986).

***Porpostoma grassei* (CORLISS & SNYDER, 1986) nov. comb.**

Morphology and infraciliature (Figs. 30a-c, Table 17): In vivo 170-185 x 55-85 µm. Outline slightly variable, slender bottle-shaped to fusiform, depending on nutritional state; anteriorly and posteriorly rounded to somewhat tapering; dorsal margin sigmoidal to convex (Fig. 30a). Laterally compressed, well fed specimens roundish. Macronucleus in or, usually, below mid-body, often transversally situated, with granular nucleoli. 2 micronuclei, in shallow indentation of macronucleus. 1 contractile vacuole terminally. Specimens often dark red (due to digested food?), cytoplasm with red (digested diatoms?) and green inclusions, 5-8 µm across, and greasily shining globules usually rendering cells dark at low magnification. Feeds on large pennate diatoms. Movement slow to moderately fast, gliding back and forth on substrate.

Somatic kineties meridional, composed of ciliated basal bodies, usually closely associated with non-ciliated granule (extrusome?), also specimens without this granule, cilia ca. 12 µm long (Fig. 30b). Left- and rightmost somatic kineties terminate at adoral membranelle 1 (Fig. 30c). Extrusomes about 4 µm long (mucocysts), usually not stained with protargol; impregnated, however, in original slides of *Cohnilembus grassei* (types not yet deposited; CORLISS & SNYDER 1986).

Adoral membranelle 1 (oral polykinetid 1; CORLISS & SNYDER 1986) extends to apex, composed of many transverse ciliary rows which gradually lengthen posteriad (2.5-6.5 µm long); membranelle 2 about 7-10 µm wide, often not distinctly separate from membranelles 1 and 3; membranelle 3 about 6.5-8 µm wide; cilia distally 12-13 µm long, proximally about 23 µm. Paroral membrane (oral dikinetid; CORLISS & SNYDER 1986) oblique to main body axis, on right of oral cavity. Scutica posterior of paroral membrane, slightly irregularly arranged (Fig. 30c).



Figs. 30a-c: *Porpostoma grassei* from life (a) and after protargol impregnation (b, c). a: Left lateral view. b: Ventral view. c: Detail of oral area. Scale bar divisions = 10 µm. A1-A3, adoral membranelles 1-3; Pm, paroral membrane; S, scutica.

Table 17. Morphometric characteristics of *Porpostoma grassei* (n = 9); measurements in µm.

Character	$\bar{x}$	**M**	**SD**	**SE**	**CV**	**Min**	**Max**
Body, length	196.1	184.5	79.8	28.20	40.7	95	316
Body, width	84.4	85.0	31.9	10.62	37.7	43	133
Macronucleus, length	60.9	64.0	18.3	6.10	30.1	33	94
Macronucleus, width	48.1	52.0	15.0	5.00	31.2	26	64
Oral apparatus, length	77.0	68.0	20.0	8.93	25.9	56	105
Adoral membranelles 1–3, length	56.2	53.5	21.4	8.72	38.0	31	82
Paroral membrane, length	39.0	40.0	5.3	2.37	13.6	32	46
Somatic kineties, number	69.5	72.0	10.9	3.45	15.7	48	80
Membranelle 1, number of rows	50.0	41.5	22.5	9.18	45.0	26	79

Occurrence and ecology: Not frequently encountered in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 69° 07'-71° 00' S and longitude 07° 19'-12° 08' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature <-2.9°C, salinity >51.8‰. In raw cultures also at a salinity of 15.6‰ and +1°C. Biomass of 10^6 individuals: 260 mg.

Comparison with original description and related species: This population corresponds very well with the original description, i.e. *Cohnilembus grassei*; it differs slightly in the presence of the scutica which was very likely overlooked by CORLISS & SNYDER (1986).

The structure of the oral apparatus does not suggest inclusion in *Cohnilembus* KAHL, 1933, e.g. adoral membranelle 1 not single-rowed, membranelle-like somatic kinety adjacent to membranelle 1 lacking (BORROR 1963; DIDIER & DETCHEVA 1974; EVANS & THOMPSON 1964; SMALL 1967; THOMPSON 1968). Instead, the composition of the adoral membranelles is very similar to that of *Porpostoma notatum* MOEBIUS, 1888, type of the genus (CZAPIK & JORDAN 1977; MUGARD 1949). *Cohnilembus grassei* is thus transferred to *Porpostoma*: *P. grassei* (CORLISS & SNYDER, 1986) nov. comb. *Porpostoma notatum* differs from *P. grassei* mainly in the band-like macronucleus, the higher number of micronuclei and the absence of a pigment fleck (CZAPIK & JORDAN 1977; KAHL 1931; MUGARD 1949).

Order Heterotrichida STEIN, 1859a

Condylostoma granulosum BULLINGTON, 1940

Improved diagnosis: In vivo about 2140-590 x 65-200 µm. Shape elongate ellipsoidal. 28-65 somatic kineties. 123-210 adoral membranelles. 1-3 apical membranelles. 6-13 macronuclear nodules. Marine.

Neotype specimens: 1 neotype and a 2nd slide of protargol impregnated cells have been deposited.

Redescription (Figs. 31a-f, 67-69, Table 18): Shape usually rather stout, somewhat variable, 2-2.5x longer than wide, right margin convex, left straight to convex, posteriorly rounded, slightly pointed; body rarely slightly twisted, contractile

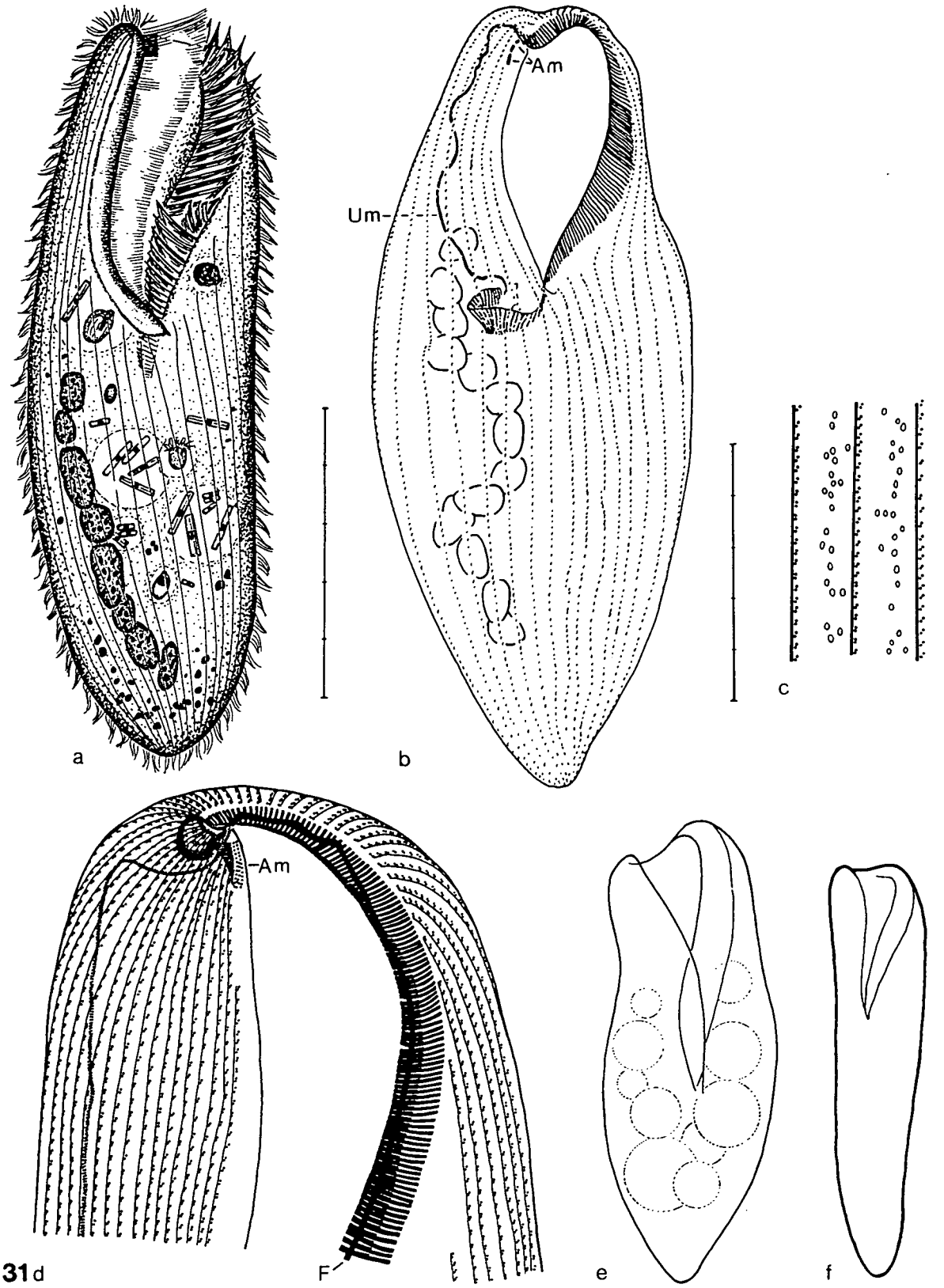
(Figs. 31a, e, f). Dorso-ventrally somewhat flattened to circular. Macronucleus on right, beaded, nodules globular to ellipsoid, with spherical and ribbon-like nucleoli. Micronucleus not impregnated with protargol. Contractile vacuole not observed. Cortical granules in 1-3 irregular interkinetal rows, colourless, ellipsoidal, ca. 1.5 µm long (Figs. 31c, 69). Cytoplasm colourless, occasionally rather vacuolated (Fig. 31e); usually with numerous food vacuoles containing mainly small pennate (7-42 µm long) and, less frequently, centric diatoms (7-30 µm across), ciliates (e.g. oligotrichs, *Myrionecta* sp., *Pleuronema* sp.), flagellates and undefined green contents, specimens thus quite dark at low magnification.

Somatic kineties composed of paired basal bodies, generally both ciliated, cilia 14-20 µm long. Few kineties of right ventral side terminating near oral cavity, cilia-free area right of oral rim 10-30 µm wide (Fig. 68); kineties on left ventral side extending anteriorly almost to adoral zone, posteriorly few rows shortened (Fig. 67). Longitudinal bundle of fibres associated with each kinety (Figs. 31c, d, 69). 1-3 apical membranelles (membranelles erratiques, TUFFRAU 1967; cirri), frontally on right of oral cavity, bases 8-20 µm long, composed of 2-5 longitudinal basal body rows, cilia 8-18 µm long (Figs. 31b, d, 67).

Table 18. Morphometric characteristics of *Condylostoma granulosum* (n = 21); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	543.3	540.0	165.4	36.10	30.5	286	837
Body, width	223.1	212.0	59.6	13.00	26.7	144	330
Macronuclear figure, length	281.4	280.5	102.1	23.06	36.7	57	455
Macronuclear nodule, length	47.7	39.0	19.8	3.61	41.5	17	85
Macronuclear nodule, width	25.9	26.0	6.2	1.13	23.9	15	36
Buccal overture, length	175.5	176.0	60.0	13.10	34.2	56	309
Apex to cytostome, distance	216.3	212.0	66.4	14.48	30.7	74	325
Macronuclear nodules, number	9.4	10.0	2.3	0.49	23.9	6	13
Somatic kineties, number	46.1	43.0	11.0	2.41	23.9	28	65
Adoral membranelles, number	152.8	140.0	33.4	11.14	21.9	123	210

Figs. 31a-f: *Condylostoma granulosum* from life (a, e, f) and after protargol impregnation (b-d). a, b: Ventral views. c: Detail of cortical granulation and fibres associated with somatic kineties. d: Detail of anterior region. e, f: Different shapes. a, scale bar divisions = 40 µm; b, scale bar divisions = 30 µm. Am, apical membranelles; F, fibres; Um, undulating membrane.



31

Oral cavity conspicuous, deep, transversely striated, buccal overture about 32% of body length. Adoral zone of membranelles about 40% of body length, proximally invaginated; bases in anterior portion consisting of 3 basal body rows each, i.e. 1 short (composed of 1 to several kinetosomes), 2 long; posteriorly 2 equally long rows per base; longest bases about 23 µm, cilia 30-45 µm long. Thick bundle of fibres originates from basal bodies of apical and adoral membranelles and anteriormost kinetids of undulating membrane and somatic kineties, extends leftwards underneath adoral zone (Fig. 31d). Undulating membrane long, in oral cavity on right, composed of 2 basal body rows, cilia 50-110 µm long; associated with bundle of fibres (Figs. 31b, d).

Occurrence and ecology: Not common in the endopagial of pancake, nilas and mainly multiyear sea ice of the Weddell Sea, between latitude 68° 38'-71° 00' S and longitude 06° 05'-11° 54' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine (1 measurement): temperature -2.6°C, salinity 59.1‰, PO_4 1.7 µmol/l, NO_2 0.1 µmol/l, NO_3 2.6 µmol/l, NH_4 3.5 µmol/l, Si 7.7 µmol/l; chlorophyll *a* 49.3 µg/l melted ice. In raw cultures also at a salinity of 16.4‰ and +1°C. Biomass of 10^6 individuals: 3.25 g.

Comparison with related species: The identification of *Condylostoma* spp. is difficult because body size and shape are usually highly variable and the infraciliature is often not known. This population is rather similar to *C. granulosum* found by BULLINGTON (1940) off the coast of Florida in shape, size range and proportions; on average, it is, however, almost twice as large as in the original description (effect of temperature?, cf. KIESSELBACH 1935). In addition, the Antarctic specimens have longer adoral cilia (30-45 µm vs. 18 µm) and the cortical granulation is less dense. BULLINGTON (1940) found a subterminal contractile vacuole which was not observed here.

Condylostoma arenarium SPIEGEL, 1926 is longer in relation to width, the oral cavity is shorter and less prominent, it has distinctly fewer adoral membranelles (60-100), usually fewer somatic kineties (26-34) and often more apical membranelles (3-7; AGAMALIEV 1972; BOCK 1952; BORROR 1963; DRAGESCO 1960; DRAGESCO & DRAGESCO-KERNÉIS 1986; HARTWIG 1973; KAHL 1932; SPIEGEL 1926). A second, slightly different form of *C. arenarium* has a comparable oral cavity but more macronuclear nodules (13-30), fewer adoral (60-70) and more apical membranelles

(4-6) and the somatic kineties are formed by cirri (BORROR 1972b; RICCI et al. 1982; VILLENEUVE-BRACHON 1940). The rather similarly shaped *C. curva* BURKOVSKY, 1970 is distinctly smaller, has fewer somatic kineties and more, viz. 5, cirri.

We do not follow JANKOWSKI (1978) who established the ill defined genus *Predurostyla* for *C. arenarium* (diagnosis: „with frontal cirri") because *Condylostoma patens* (MUELLER, 1786) DUJARDIN, 1841, type of the genus *Condylostoma*, also apparently has frontal cirri, i.e. apical membranelles (MAUPAS 1883; MORGAN 1925).

***Condylostoma* sp.**

Description (Figs. 32a-e): In vivo >1200 x 110 µm, about 1500 x 180 µm after protargol impregnation. Shape elongate worm-like, slim, right and left margins parallel in anterior body half, posteriorly tapering; very flexible (Fig. 32a). Dorso-ventrally flattened in anterior portion, circular posteriorly. Macronucleus beaded, about 708 µm long, posterior of adoral zone on right; consists of about 15 nodules, ellipsoidal, 13-33 x 9-10 µm, connected thread-like. Micronucleus not impregnated with protargol. Contractile vacuole not observed. Cortical granules in 2 irregular interkinetal rows, colourless, circular to ellipsoid, about 1 µm across (Fig. 32d). Cytoplasm with numerous lipid droplets, red inclusions (spherical to ellipsoid; digested food?) and larger dark bodies (ca. 60 µm across); feeds on small pennate diatoms (6-12 µm long) and flagellates; specimens appear reddish at low magnification. Movement slowly gliding on substrate, moving short distances back and forth.

About 39 somatic kineties, longitudinal, extending over entire length of body, few kineties terminating on left and right of oral cavity; composed of dikinetids and, rarely, apparently few monokinetids, all basal bodies with cilium (15-20 µm long; Figs. 32b, c). Each kinety associated with longitudinal bundle of fibres (Figs. 32d, e).

Oral cavity triangular, large, buccal overture about 15% of body length, distance apex to cytostome about 270 µm. Adoral zone of membranelles ca. 18% of cell length, proximally invaginated, composed of about 180 membranelles, bases consist of 3 basal body rows each, cilia about 18 µm long. Undulating membrane in oral cavity on right, long, composed of 2 kinetosome rows. Single apical membranelle, frontally on right of oral cavity, base about 16 µm long, double-rowed. Thick bundle of fibres originating from basal bodies of apical membranelle, anterior portions of undulating

membrane and right somatic kineties, and adoral membranelles; extending leftwards, underneath adoral zone (Fig. 32e).

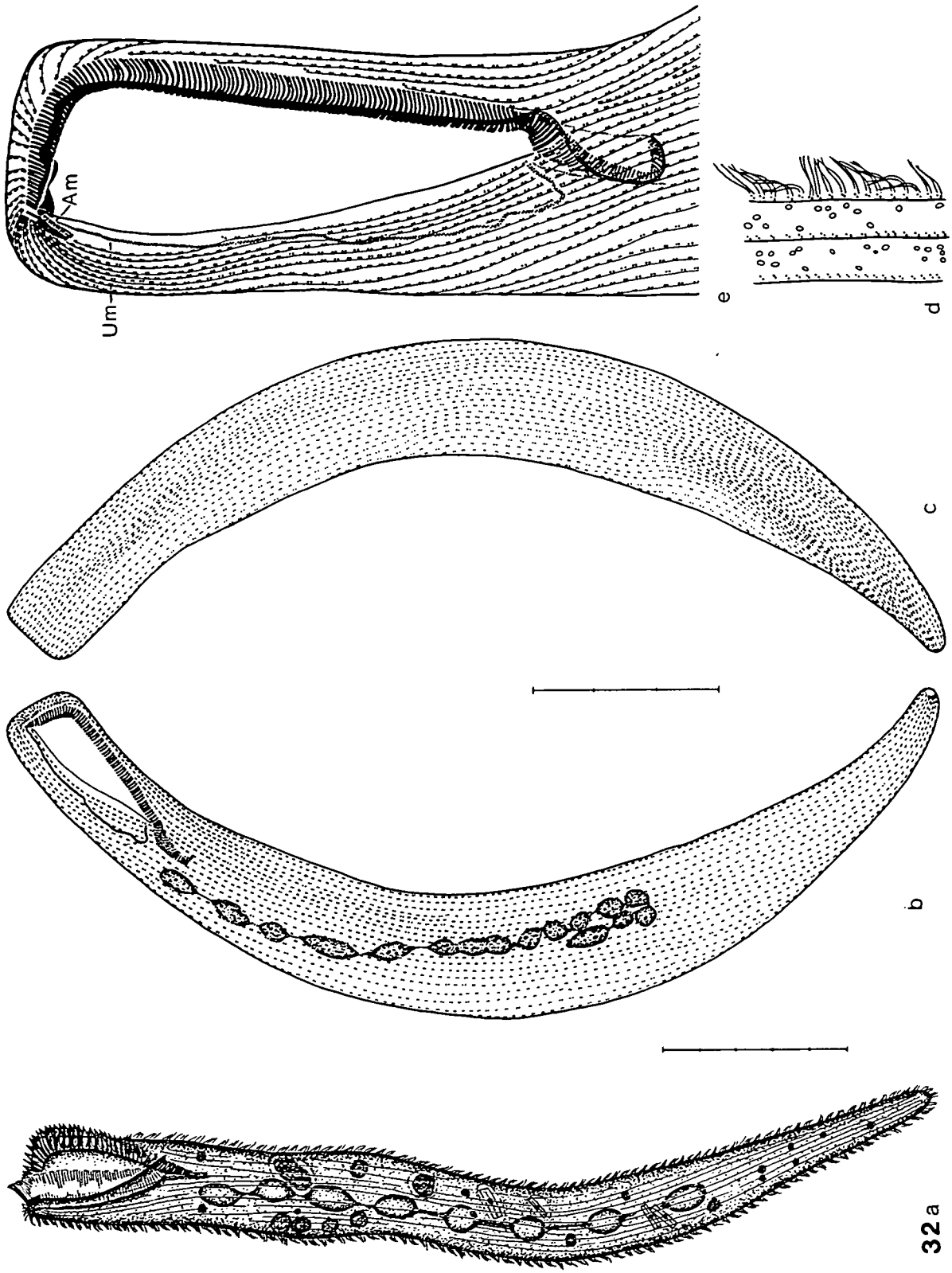
A slide with a protargol impregnated specimen has been deposited for reference.

Occurrence and ecology: Very rarely found in 1 location in multiyear sea ice of the Weddell Sea, latitude 70° 21' S and longitude 08° 53' W. Occurs in the brown layer together with organisms like diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine (1 measurement): temperature -2.6°C, salinity 59.1‰, PO_4 1.7 µmol/l, NO_2 0.1 µmol/l, NO_3 2.6 µmol/l, NH_4 3.5 µmol/l, Si 7.7 µmol/l; chlorophyll *a* 49.3 µg/l melted ice. In raw culture at +1°C. Biomass of 10^6 individuals: 8.11 g.

Comparison with related species: Only very few specimens of this species, which was the longest encountered in the endopagial during this study, were found. The shape of *C. remanei* SPIEGEL in KAHL, 1932 as pictured by DRAGESCO & DRAGESCO-KERNÉIS (1986) is rather similar to these specimens. *Condylostoma remanei* is, however, usually smaller (ca. 200-700 µm), it has a conspicuous tail, apparently fewer adoral membranelles (about 85), more apical cirri and the somatic kineties form a distinct spica ventrally (DRAGESCO 1960, 1963; FJELD 1955; KAHL 1928b, 1932; SPIEGEL 1926). *Condylostoma remanei* var. *oxyoura* is smaller (about 400 µm) and possesses fewer somatic rows (ca. 27-30; DRAGESCO 1960).

Only *C. reichi* WILBERT & KAHAN, 1981 has a similarly high number of adoral membranelles. This species is, however, posteriorly distinctly pointed, has a larger oral cavity (1/4 vs. 1/7 of body length), more somatic kineties (55-80 vs. about 39) and apical membranelles (about 11; DRAGESCO & DRAGESCO-KERNÉIS 1986; WILBERT & KAHAN 1981). *Condylostoma magnum* SPIEGEL, 1926 and *C. patulum* CLAPARÈDE & LACHMANN, 1858 differ from this Antarctic species mainly in having distinctly fewer adoral and more apical membranelles (about 6) as well as more somatic kineties (72-110 and 48-80, respectively); the former species also has a comparatively larger oral cavity, the latter is usually shorter and has a smaller buccal overture (BOHATIER 1978; BULLINGTON 1940; CLAPARÈDE & LACHMANN 1858; DRAGESCO 1963; DRAGESCO & DRAGESCO-KERNÉIS 1986; KAHL 1932, 1933; SPIEGEL 1926; TUFFRAU 1967; WILBERT & KAHAN 1981).

Figs. 32a-e: *Condylostoma* sp. from life (a) and after protargol impregnation (b-e). a: Ventral view. b, c: Ventral and dorsal view of same specimen. d: Detail of cortical granulation and fibres associated with somatic kineties. e: Detail of oral area. a, scale bar divisions = 50 µm; b, c, scale bar divisions = 100 µm. Am, apical membranelle; Um, undulating membrane.



Order Strombidiida JANKOWSKI, 1980

Strombidium antarcticum (BUSCH, 1930) KAHL, 1932

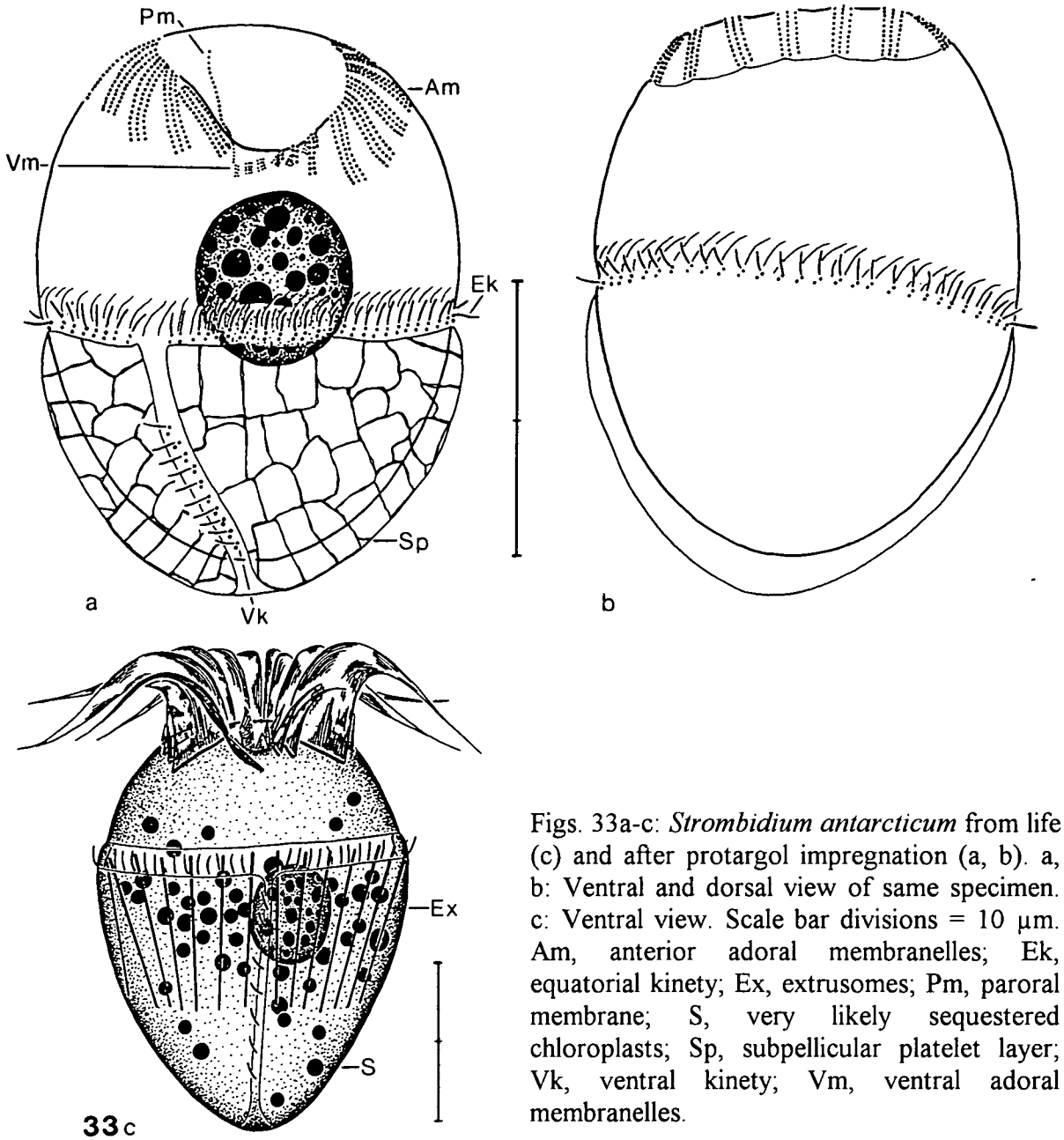
Improved diagnosis: In vivo about 35-55 x 20-40 µm. Shape obovoid to almost spherical, no anterior protrusion. 1 equatorial, 1 ventral kinety. 14-17 anterior, 6-7 ventral adoral membranelles which invaginate on anterior surface; diameter of adoral zone large. 1 supraequatorial girdle of extrusomes. Extrusomes long. Marine.

Neotype specimens: 1 slide of protargol impregnated cells has been deposited.

Redescription (Figs. 33a-c, Table 19): Shape longer than wide, anteriorly broadly rounded to transversely truncate, posteriorly usually narrowed, rarely broadly rounded, widest slightly anterior of mid-body (Fig. 33c). Cross section circular. Subpellicular platelets polygonal, transparent, in posterior 2/3 of cell (Figs. 33a-c). Pellicle rather delicate, specimens burst easily. Single macronucleus globular to slightly ellipsoid (16 x 13 µm in vivo), contains roundish nucleoli (up to 3 µm across), in mid-body, left of median. 1 micronucleus, spherical, ca. 2 µm across, usually not impregnated with protargol. Contractile vacuole not found. Cytoplasm tightly packed with bright green globules (about 3 µm in diam., probably sequestered chloroplasts) and rarely food vacuoles containing diatoms, rendering specimens almost black at low magnification. Movement usually rather slow, sometimes resting briefly and rotating about main body axis.

Girdle distinct, anterior of mid-body, continuous on ventral side, about 2.5 µm wide, immediately anterior of subpellicular platelet layer; extrusomes insert in this structure (Figs. 33b, c). Extrusomes numerous, evenly spaced around periphery, slightly inclined to cell surface, evidently firmly anchored because extrusion not observed; gently cone-shaped, posteriorly tapering, about 20 µm long, distinct in vivo, not impregnated with protargol (Fig. 33c).

Equatorial and ventral kinety composed of dikinetids, only 1 basal body each with short cilium (ca. 2 µm long; Figs. 33a, b). Equatorial kinety at edge of subpellicular platelet layer, circular or with very small gap ventrally, rarely continuous (preparation artifact?). Ventral kinety in shallow groove, usually right of median (preparation artifact?), extending from posterior region anteriad, generally terminating distinctly below equatorial kinety.



Figs. 33a-c: *Strombidium antarcticum* from life (c) and after protargol impregnation (a, b). a, b: Ventral and dorsal view of same specimen. c: Ventral view. Scale bar divisions = 10 µm. Am, anterior adoral membranelles; Ek, equatorial kinety; Ex, extrusomes; Pm, paroral membrane; S, very likely sequestered chloroplasts; Sp, subpellicular platelet layer; Vk, ventral kinety; Vm, ventral adoral membranelles.

Peristomial field usually large, surrounded by adoral zone of membranelles in closed spiral (Fig. 33b). Anterior adoral membranelles composed of 3 basal body rows each, longest bases about 10 µm, cilia 25-30 µm long; rightmost membranelle distinctly oblique, along cytoplasmic wall which separates oral cavity from ventral surface (Fig. 33b). Ventral adoral membranelles continuous with anterior membranelles, invaginate anteriorly on peristomial field; inconspicuous, bases gradually shortened,

3-rowed (2 equally long, 1 slightly shorter basal body row), innermost membranelle very likely 2-rowed (Fig. 33b). Oral cavity shallow, funnel-shaped, acentric on anterior area (defining ventral side), contains invaginated ventral adoral membranelles and single-rowed paroral membrane (about 9 µm long, extending to peristomial field); separated from ventral surface by cytoplasmic wall (Figs. 33b, c).

Occurrence and ecology: Widespread in the endopagial of newly formed and multiyear sea ice of the Weddell Sea, between latitude 69° 07'-70° 31' S and longitude 06° 18'-12° 08' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Found once also in the pelagial. Up to 4 430 active ind./l melted ice were found (biomass 0.09 mg/l), comprising up to 50% of the total ciliate community. Environmental parameters in brine: temperature -4.5 to -2.0°C, salinity 37.6-59.4‰, PO_4 1.5-6.0 µmol/l, NO_2 0.3-0.6 µmol/l, NO_3 15.5-45.8 µmol/l, NH_4 15.5-21.3 µmol/l, Si 23.4-40.4 µmol/l; chlorophyll *a* 15.5-120.2 µg/l melted ice. In raw cultures also at +1°C and a salinity of 17.6‰. Biomass of 10^6 individuals: 21 mg.

Comparison with related species: The population described here is similar in shape, size and number of adoral membranelles to *S. antarcticum* and is thus identified with this species (BUSCH 1930; HADA 1970). The girdle is, however, less prominent than pictured by BUSCH (1930) and HADA (1970). *Strombidium striatum* (MEUNIER, 1910) WULFF, 1919 is posteriorly almost pointed and distinctly larger (70-90 µm; WULFF 1919).

As concerns the invaginated ventral adoral membranelles, *S. antarcticum* is very similar to *S. kryale* PETZ, 1994 and *S. emergens* (LEEGAARD, 1915) KAHL, 1932. It differs from the latter in shape and distinctly smaller size (see below), and from the former in the prominent adoral zone, i.e. larger diameter (27 vs. 17 µm on average) and longer anterior membranelle bases (10 vs. 6 µm), more ventral membranelles (on average 7 vs. 5), the elongate body, longer extrusomes (20 vs. 8-13 µm), the higher number of dikinetids in the equatorial (69 vs. 33) and ventral kinety (11 vs. 6) and the supraequatorial location of the equatorial kinety (PETZ 1994).

Protargol impregnated specimens of *S. antarcticum* are sometimes similarly shaped to those of *S. dalum* LYNN et al., 1988 described by LYNN & GILRON (1993). The latter species is considerably smaller (12-21 µm), anterior and ventral adoral membranelles are distinctly separate and the ventral kinety is shorter (LYNN & GILRON 1993; LYNN et al. 1988). *Strombidium constrictum* (MEUNIER, 1910)

WULFF, 1919 differs from *S. antarcticum* in the more extensive subpellicular platelet layer, the considerably longer ventral adoral zone and the elongated macronucleus (ALEKPEROV & MAMAJEVA 1992; LEEGAARD 1915; WULFF 1919).

Table 19. Morphometric characteristics of *Strombidium crassulum* (upper line, n = 25), *S. glaciale* (middle line, n = 25) and *S. antarcticum* (lower line, n = 30); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	62.0	59.0	11.3	2.25	18.2	43.0	90
	38.4	38.0	3.3	0.65	8.5	30.0	44
	41.2	41.5	5.5	1.00	13.3	30.0	52
Body, width	53.7	53.0	7.8	1.56	14.6	35.0	74
	29.2	29.0	3.2	0.64	11.0	22.0	37
	35.1	34.0	4.8	0.87	13.5	26.0	43
Macronucleus, length	26.4	27.0	4.8	1.04	18.1	16.0	37
	12.4	12.0	1.6	0.34	13.3	9.0	16
	15.6	15.0	3.6	0.66	23.3	9.0	23
Macronucleus, width	21.5	22.0	4.0	0.87	18.5	13.0	28
	11.0	11.0	0.8	0.17	7.6	9.0	12
	12.6	12.0	2.9	0.53	23.1	8.5	17
Apex to cytostome, distance	34.0	34.0	5.5	1.22	16.0	25.0	50
	14.6	14.5	1.8	0.35	11.9	12.0	18
	9.6	9.0	1.7	0.50	17.3	8.0	12
Apex to equatorial kinety, distance	40.6	37.0	9.6	3.2	23.6	31.0	62
	24.9	23.5	3.8	0.85	15.3	19.0	33
	22.1	22.0	2.6	0.76	12.0	18.0	25
Adoral zone, diameter[1]	26.8	26.5	3.4	0.67	12.8	18.0	34
Anterior adoral membranelles, number	17.4	17.0	1.2	0.42	6.8	16.0	19
	18.2	18.0	1.7	0.57	9.4	16.0	22
	15.4	15.0	0.8	0.23	5.5	14.0	17
Ventral adoral membranelles, number	15.3	15.0	2.0	0.67	13.0	13.0	19
	8.2	8.0	0.5	0.10	6.2	8.0	10
	6.8	7.0	0.4	0.12	6.5	6.0	7
Dikinetids in equatorial kinety, number	–[2]	–	–	–	–	–	–
	–[2]	–	–	–	–	20.0	30
	69.4	68.0	10.7	3.8	15.5	56.0	86
Dikinetids in ventral kinety, number	11.2	11.0	1.6	0.36	13.8	9.0	15
	10.1	10.0	1.3	0.39	12.9	9.0	13
	11.2	11.0	2.1	0.43	19.0	6.0	15

[1] In *S. antarcticum*.
[2] Not determined or not enough data.

Strombidium crassulum (LEEGAARD, 1915) KAHL, 1932

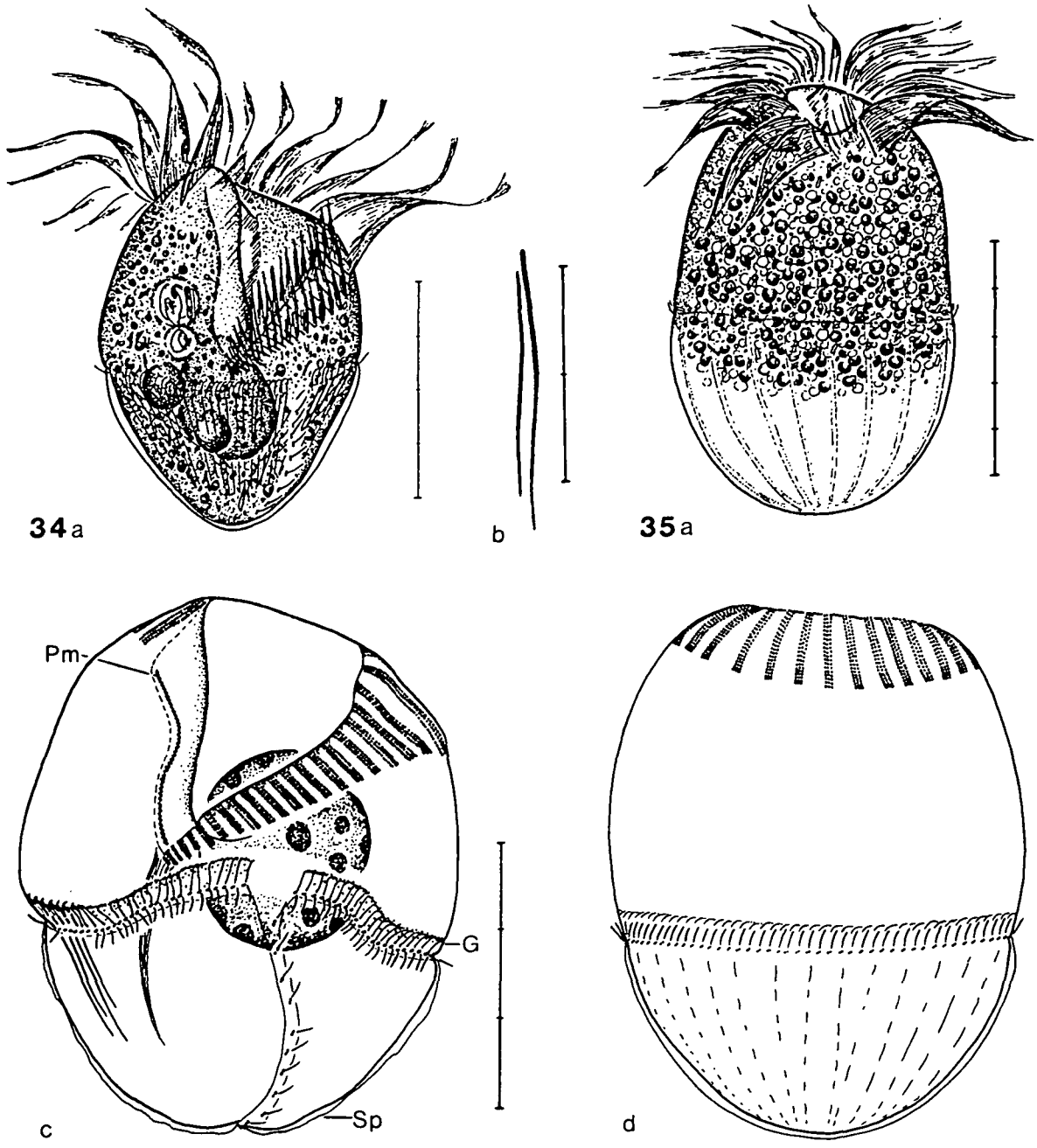
Improved diagnosis: In vivo about 50-70 x 30-40 µm. Shape obconic, protuberance on right. Oral cavity conspicuous. 1 discontinuous equatorial kinety with densely spaced cilia, 1 ventral kinety. 16-19 anterior and 13-19 ventral adoral membranelles, continuous. 1 equatorial extrusome girdle. Marine.

Neotype specimens: 1 slide of protargol impregnated cells has been deposited.

Redescription (Figs. 34a-d, Table 19): Shape broadly obconic to elliptical, widest anterior of mid-body, posterior half slightly tapering, anterior adoral membranelles on inconspicuous protrusion slanting ventrally and leftwards (Fig. 34a). Unmounted protargol stained specimens larger, 93-118 x 81-99 µm (n = 6). Cross section circular to dorso-ventrally slightly flattened. Subpellicular platelet layer in posterior 1/2-1/3 of cell, transparent, longitudinally furrowed. Macronucleus large, ellipsoid to spherical, in centre of mid-body, contains roundish nucleoli (up to 3 µm across). Micronucleus globular, ca. 2 µm across, in indentation of macronucleus, usually not impregnated with protargol. Contractile vacuole not observed. Cytoplasm colourless, contains numerous greasily shining globules and food vacuoles with small pennate diatoms (7-17 µm long) and very likely flagellates, frequently rendering cells almost black at low magnification. Movement moderately fast.

Equatorial girdle around periphery of cell, 2-3 µm wide, immediately anterior of subpellicular platelet layer; extrusomes insert in this structure (Figs. 34c, d). Girdle of extrusomes continuous on ventral side; extrusomes generally numerous, not grouped, sometimes inclined to cell surface, apparently firmly anchored because extrusion not observed; needle-shaped, posteriorly pointed, anteriorly slightly widened, about 17 µm long, refractile, thus recognizable in living specimens; in protargol slides lightly stained, ca. 12-24 µm long (Fig. 34b).

Equatorial and ventral kinety composed of dikinetids, only 1 basal body each with short cilium (ca. 2.5 µm long). Equatorial kinety at edge of subpellicular platelet layer, circular, small gap on ventral area left of adoral membranelles, once continuous (preparation artifact?), composed of approximately 115 densely spaced dikinetids (Figs. 34c, d). Ventral kinety in shallow groove, extending from posterior region almost to equatorial kinety, usually distinctly left of cytostome (artifact?; Fig. 34c).



Figs. 34a-d: *Strombidium crassulum* from life (a) and after protargol impregnation (b-d). a: Ventral view. b: Extrusomes. c, d: Ventral and dorsal view.

Fig. 35a: *Strombidium emergens* from life; ventral view. Scale bar divisions = 10 µm. G, girdle; Pm, paroral membrane; Sp, outline of subpellicular platelet layer.

Peristomial field conspicuous, spirally surrounded by adoral zone of membranelles (Fig. 34c). Anterior adoral membranelles each composed of 3 basal body rows, longest bases about 12 µm, cilia 30-35 µm long. Ventral adoral membranelles continuous with anterior membranelles, not distinctly different from these, invaginate on peristomial field in mid-body; bases composed of 3 basal body rows each, proximally 1-2 membranelles 2-rowed, longest bases ca. 18 µm, gradually shortened posteriad, longest cilia ca. 16 µm (Fig. 34c). Oral cavity acentric, single-rowed paroral membrane along right border, cilia 15-22 µm long. Pharyngeal fibres up to 36 µm long.

Occurrence and ecology: Rarely found in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 68° 38'-70° 21' S and longitude 06° 05'-08° 53' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -3°C, salinity 55‰; in melted ice: PO_4 1.5 µmol/l, NO_2 0.1 µmol/l, NO_3 4 µmol/l, NH_4 3 µmol/l, Si 11 µmol/l, chlorophyll *a* 65 µg/l. Biomass of 10^6 individuals: 25 mg.

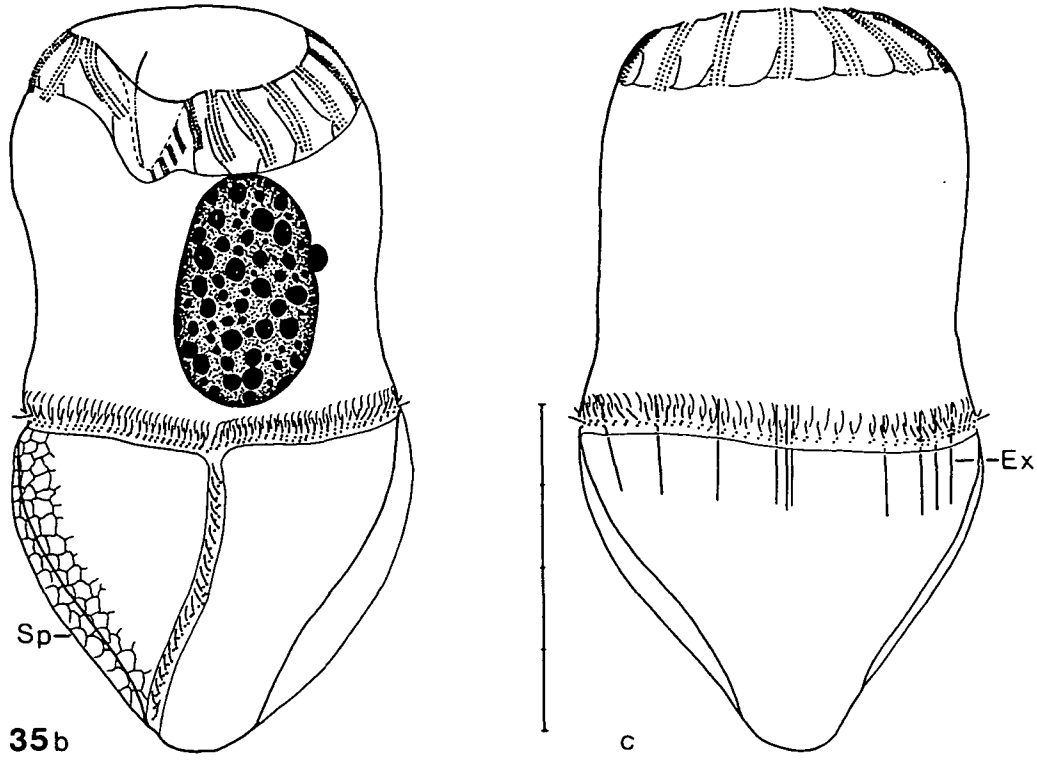
Comparison with related species: The short original description of *S. crassulum* matches this population very well; it differs only in the slightly smaller size (35-53 x 25-44 µm vs. 43-90 x 35-74 µm). The anterior and ventral adoral membranelles are always continuous in the Antarctic specimens. LEEGAARD (1915, Figs. 9b, c) pictured a continuous and a discontinuous adoral zone in 2 views of the same specimen. We thus define *S. crassulum* as having a continuous adoral zone.

The similarly shaped *S. capitatum* (LEEGAARD, 1915) KAHL, 1932 differs by having separate anterior and ventral adoral membranelles, an elongate macronucleus, a peristomial collar and the presence of symbiotic chloroplasts (KAHL 1932; LAVAL-PEUTO & RASSOULZADEGAN 1988; LEEGAARD 1915; MONTAGNES et al. 1988; STOECKER & SILVER 1990). *Strombidium lagenula* FAURÉ-FREMIET, 1924 has fewer anterior (about 10) and ventral membranelles (about 6), a prominent peristomial collar, a narrow oral cavity and a longer adoral zone. *Strombidium inclinatum* MONTAGNES et al., 1990 is smaller (30-42 x 18-30 µm) than *S. crassulum*, has an almost continuous adoral zone and distinctly fewer ventral membranelles (7-9 vs. 13-19; LYNN & GILRON 1993; MONTAGNES et al. 1990).

Strombidium emergens (LEEGAARD, 1915) KAHL, 1932

Improved diagnosis: In vivo about 95-110 x 60-65 µm. Outline elongate elliptical, no distinct anterior protrusion. 1 equatorial, 1 ventral kinety; composed of numerous dikinetids. 14-15 anterior, 4-5 ventral adoral membranelles which invaginate on anterior surface. 1 subequatorial girdle of extrusomes. Marine.

Neotype specimens: 1 slide of protargol impregnated specimens has been deposited.



Figs. 35b, c: *Strombidium emergens* after protargol impregnation; ventral and dorsal view of same specimen. Scale bar divisions = 10 µm. Ex, extrusomes; Sp, subpellicular platelet layer.

Redescription (Figs. 35a-c): Shape elongate, cylindrical in anterior portion, frontally slightly asymmetrical, posteriorly broadly rounded, widest below mid-body (Fig. 35a); in protargol slides 90 x 49-52 µm (n = 2). Cross section circular. Subpellicular platelet layer in posterior half of body, translucent, platelets inconspicuous, polygonal (ca. 1.5 µm across); longitudinal furrows, regularly spaced, in vivo usually easy to recognize. Macronucleus elongate-ellipsoidal, anterior of mid-

body in left half, 29-33 x 18-23 µm (n = 2); contains many spherical nucleoli (ca. 4 µm across). Micronucleus globular, in indentation of macronucleus, 3-3.5 µm across. Contractile vacuole not observed. Cytoplasm with many small crystals, numerous dark-green globules (up to 8 µm across) and bright green food vacuoles (up to 15 x 12 µm in diam.) containing dinoflagellates (e.g. *Peridinium* sp.), autotrophic flagellates and rarely diatoms; this renders cells almost black at low magnification; posteriorly however, specimens often transparent (artifact?). Movement moderately fast, to and fro, burrowing in detritus; rotates about main body axis when swimming.

Girdle slightly subequatorial, 3-4 µm wide, immediately anterior of subpellicular platelet layer; extrusomes inserting in this structure (Fig. 35c). Extrusome girdle continuous on ventral side; extrusomes rod-shaped, in protargol slides ca. 12 µm long (Fig. 35c). Equatorial and ventral kinety composed of dikinetids, only 1 basal body each with short cilium (2-4 µm long); equatorial row at edge of subpellicular platelet layer, continuous on ventral side, composed of approximately 120 cilia, densely spaced, distance to apex 49-52 µm; ventral kinety in shallow groove, extending from posterior area almost to equatorial kinety, consists of at least 20 cilia (Figs. 35b, c).

Peristomial field conspicuous, surrounded by adoral zone of membranelles in closed spiral (Fig. 35b). Anterior adoral membranelles each composed of 3 basal body rows, longest bases about 14 µm, cilia about 22 µm long; rightmost membranelle almost transversely arranged. Ventral adoral membranelles continuous with anterior membranelles, inconspicuous, bases distinctly shorter, 3-rowed, proximal (innermost) membranelle 2-rowed; invaginate anteriorly on peristomial field (Fig. 35b). Bases of adoral membranelles connected by system of fibres. Oral cavity acentric, on anterior area, separated from ventral surface by cytoplasmic wall, contains invaginated ventral adoral membranelles and single-rowed paroral membrane; distance from apex to cytostome about 20 µm (Fig. 35b).

Occurrence and ecology: Found in the endopagial of multiyear sea ice of the Weddell Sea, between latitude 69° 46'-70° 21' S and longitude 08° 53'-11° 00' W. Environmental parameters in brine: temperature about -2.6°C, salinity ca. 50‰. Biomass of 10^6 individuals: 190 mg.

Comparison with related species: The original description of *S. emergens* is strikingly similar to these specimens in body shape, subequatorial subpellicular platelet layer and arrangement of adoral zone, i.e. oral cavity not open

ventrally; the cell size is, however, considerably smaller, viz. 30-40 x 21-28 µm (LEEGAARD 1915). As size is the only difference, we identified the Antarctic individuals with *S. emergens*.

The population described by LYNN et al. (1988) as *S. sulcatum* and later determined as *S. emergens* by MONTAGNES et al. (1990), has a prominent oral cavity which is ventrally open, a shorter ventral kinety and a smaller macronucleus. It is thus not considered conspecific. As concerns body shape, oral cavity and adoral zone, these latter specimens are rather similar to *S. oblongum* LEEGAARD, 1915 (cf. LYNN et al. 1988). Contrary to MAEDA & CAREY (1985), *S. oblongum* LEEGAARD, 1915 is not considered synonymous with *S. ovale* (LEEGAARD, 1915) KAHL, 1932 because the subpellicular platelet layer is distinctly smaller in the former species as indicated by the subequatorial constriction of the body (LEEGAARD 1915). *Strombidium oblongum* LEEGAARD, 1915 differs clearly from *S. oblongum* (ENTZ, 1884) KAHL, 1932 by the discontinuous adoral zone. The latter is, however, not renamed because these species are considered not to be congeneric (see *Spirostrombidium*; art. 59c, ICZN 1985). *Strombidium oblongum* KELLICOTT, 1885 is different from these and was transferred to *Meseres* SCHEWIAKOFF, 1892 (PETZ & FOISSNER 1992).

Strombidium ventropinnum MARTIN & MONTAGNES, 1993 is also similarly shaped to *S. emergens* but differs in the ventrally open oral cavity, the distinctly smaller size (21-33 x 14-22 µm) and the short ventral kinety. This species is distinguished from *S. oblongum* only in having fewer ventral adoral membranelles (5-7 vs. 8-11; LYNN et al. 1988; MARTIN & MONTAGNES 1993).

***Strombidium glaciale* nov. spec.**

Diagnosis: In vivo about 35-45 x 30-33 µm. Obconic to elliptical, distinct protuberance on anterior right. 1 equatorial kinety, usually slightly spiralling, composed of rather widely spaced cilia. 1 ventral kinety. 16-22 anterior, 8-10 ventral adoral membranelles, anterior and ventral membranelles continuous. 1 equatorial extrusome girdle. Marine.

Type location: Multiyear sea ice of Weddell Sea, Antarctica, 70° 21' S, 08° 53' W (core number AN 103107b).

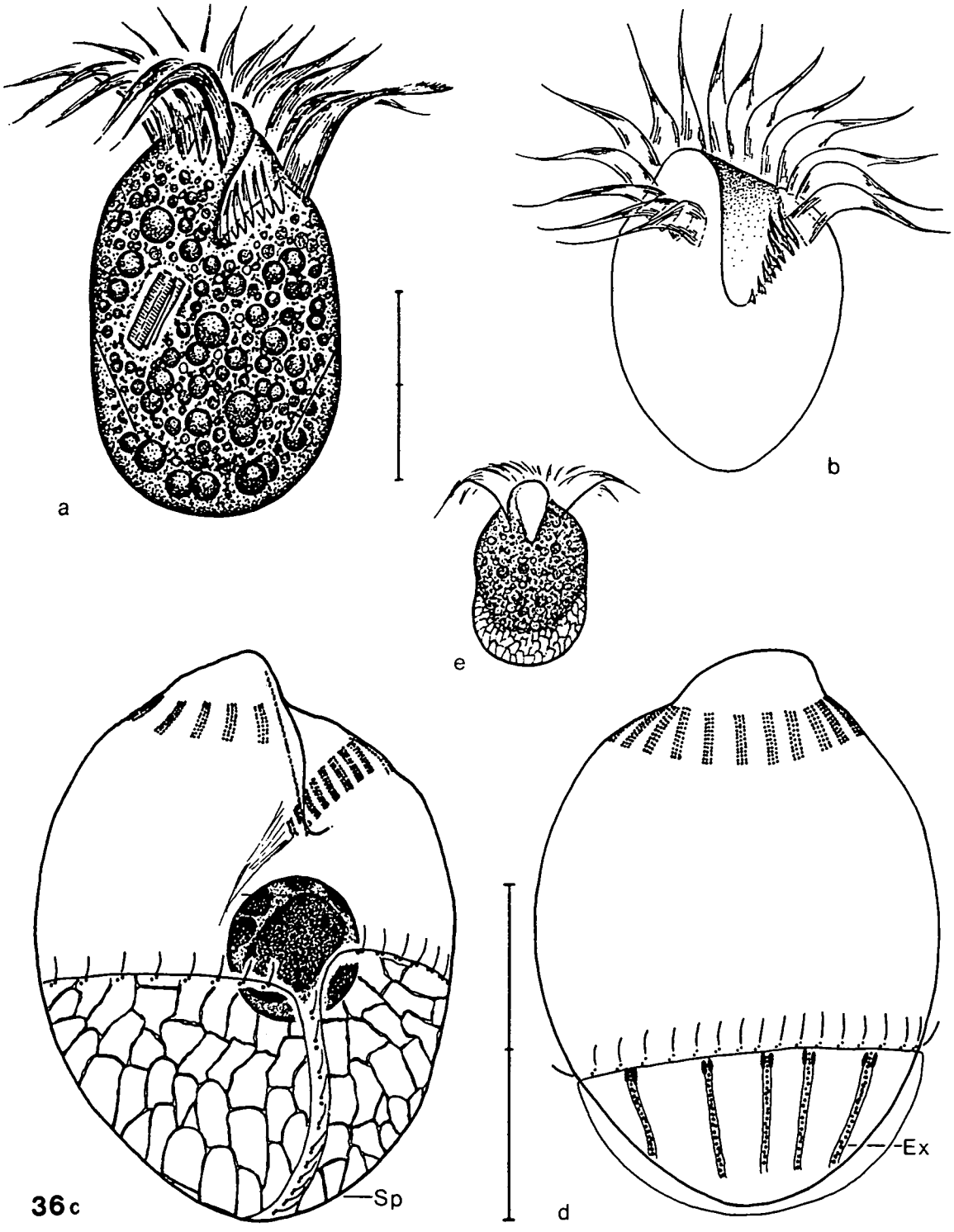
Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Derivatio nominis: „glacialis", Lat., icy.

Description (Figs. 36a-e, Table 19): Widest anterior of mid-body, posteriorly broadly rounded to slightly narrowed; oral area apparently slightly contractile; anterior adoral membranelles encircle protrusion slanting ventrally and leftwards (Figs. 36a, b). Some specimens long-elliptical (slightly damaged?), posterior portion very transparent, i.e. formed only by subpellicular platelet layer (Fig. 36e). Cross section circular. Subpellicular platelets irregularly polygonal, translucent, in posterior half of cell, platelet layer rarely with indistinct longitudinal furrows; remains as firm structure after cells burst (Fig. 36c). Pellicle fragile, specimens burst easily. Macronucleus almost spherical, in mid-body, with several small (2-2.5 µm across) and sometimes 1 large (ca. 6.5 µm across) nucleolus. Micronucleus ellipsoid, ca. 3 x 2 µm, in indentation of macronucleus, usually not impregnated with protargol. Contractile vacuole not observed. Cytoplasm tightly packed with green globules and lipid droplets (2-5 µm across), rendering cells dark green to almost black at low magnification. Food vacuoles contain small diatoms and rarely flagellates. Movement fast, hectically to and fro.

Equatorial girdle in mid-body, ca. 2 µm wide, immediately anterior of subpellicular platelet layer; extrusomes insert in this structure. Girdle of extrusomes inconspicuous in vivo; in protargol slides continuous on ventral side; extrusomes not grouped, widely spaced, slightly inclined to cell surface, 6-9 µm long, rod-shaped, thick, anteriorly with 2 small vesicle-like distentions (Fig. 36d).

Equatorial and ventral kinety composed of dikinetids, 1 basal body each with short cilium (1.5-2.5 µm long). Equatorial kinety at edge of subpellicular platelet layer, slightly discontinuous on ventral side, gently spiralling, right end shifted somewhat posteriad; rarely ventrally continuous, kinety circular (preparation artifact?); consists of 20-30 dikinetids (Figs. 36c, d). Ventral kinety in shallow groove, extends from posterior region almost to equatorial kinety (Fig. 36c).



Figs. 36a-e: *Strombidium glaciale* from life (a, b, e) and after protargol impregnation (c, d). a, b: Ventral views. c, d: Ventral and dorsal view of same specimen. e: Perhaps slightly damaged specimen. Scale bar divisions = 10 µm. Ex, extrusomes; Sp, subpellicular platelet layer.

Adoral zone spirally surrounds peristomial field (Figs. 36b, c). Anterior adoral membranelles each composed of 3 basal body rows, longest bases about 6 µm, cilia 20-25 µm long. Ventral adoral membranelles continuous with anterior membranelles, invaginated, gradually shortened posteriad, longest bases ca. 4 µm, comprise 3 ciliary rows each, proximally 1-2 membranelles 2-rowed, longest cilia 7 µm (Fig. 36c). Oral cavity acentric, contains single-rowed paroral membrane on right (cilia about 4 µm long). Pharyngeal fibres about 9 µm long.

Occurrence and ecology: Found only at 1 location in the endopagial of multiyear sea ice of the Weddell Sea, latitude 70° 21' S and longitude 08° 53' W. Occurs together with *S. crassulum*. Environmental parameters in brine: temperature about -3°C, salinity about 55‰; in melted ice: PO_4 ca. 1.5 µmol/l, NO_2 ca. 0.1 µmol/l, NO_3 ca. 4 µmol/l, NH_4 ca. 3 µmol/l, Si ca. 10 µmol/l, chlorophyll *a* ca. 60 µg/l. Biomass of 10^6 individuals: 19 mg.

Comparison with related species: This species is most similar to *S. sulcatum* CLAPARÈDE & LACHMANN, 1859 and *S. rehwaldi* PETZ & FOISSNER, 1992. *Strombidium glaciale* differs from the former in its higher number of anterior adoral membranelles (16-22 vs. about 12), the indistinct girdle, the slightly spiralling equatorial kinety (vs. circular) and the shorter ventral kinety, i.e. not extending to dorsal surface (BORROR 1963; FAURÉ-FREMIET 1924; FAURÉ-FREMIET & GANIER 1970; MONTAGNES et al. 1990). *Strombidium rehwaldi* is distinguished by having fewer anterior membranelles (10-14 vs. 16-22), an additional extrusome girdle and the freshwater habitat (PETZ & FOISSNER 1992).

Strombidium purpureum KAHL, 1932 and *S. tressum* LYNN et al., 1988 are also rather similar in shape. The former, however, contains endosymbiotic purple non-sulphur bacteria, the latter is smaller (21-29 µm), has fewer adoral membranelles (12-15), considerably longer adoral cilia and lacks a paroral membrane (FENCHEL & BERNARD 1993; KAHL 1932; LYNN et al. 1988). *Strombidium acutum* LEEGAARD, 1915 is of similar size, has well-impregnated extrusomes but a discontinuous adoral zone, a more extensive subpellicular platelet layer and lacks both paroral membrane and ventral kinety (MONTAGNES et al. 1988).

Genus *Spirostrombidium* JANKOWSKI, 1978

Improved diagnosis: Small to large strombidiids. Body slightly to distinctly elongate. Equatorial kinety long and spiralling, viz. transversely encircling almost completely ventral and dorsal side and extending in wide spiral almost to or across posterior pole. Ventral kinety parallel to posterior portion of equatorial kinety. Extrusome girdle along equatorial kinety.

Type species: *Strombidium sauerbreyae* KAHL, 1932. JANKOWSKI (1978) fixed as type *S. coronatum* SAUERBREY, 1928. This is, however, a homonym of *S. coronatum* (LEEGAARD, 1915) KAHL, 1932 and was already renamed by KAHL (1932).

Spirostrombidium pseudocinctum (WANG, 1934) nov. comb.

Remarks: This species was only found in protargol slides. Because only a very small drawing of this rare species was provided in the original description, we present figures from protargol slides and a morphometric characterization.

Morphology and infraciliature (Figs. 37a, b, Table 20): Outline usually elongate elliptical; prominent frontal protrusion in median, dorsally with longitudinal argentophilic structures (fibres?); posteriorly broadly rounded.

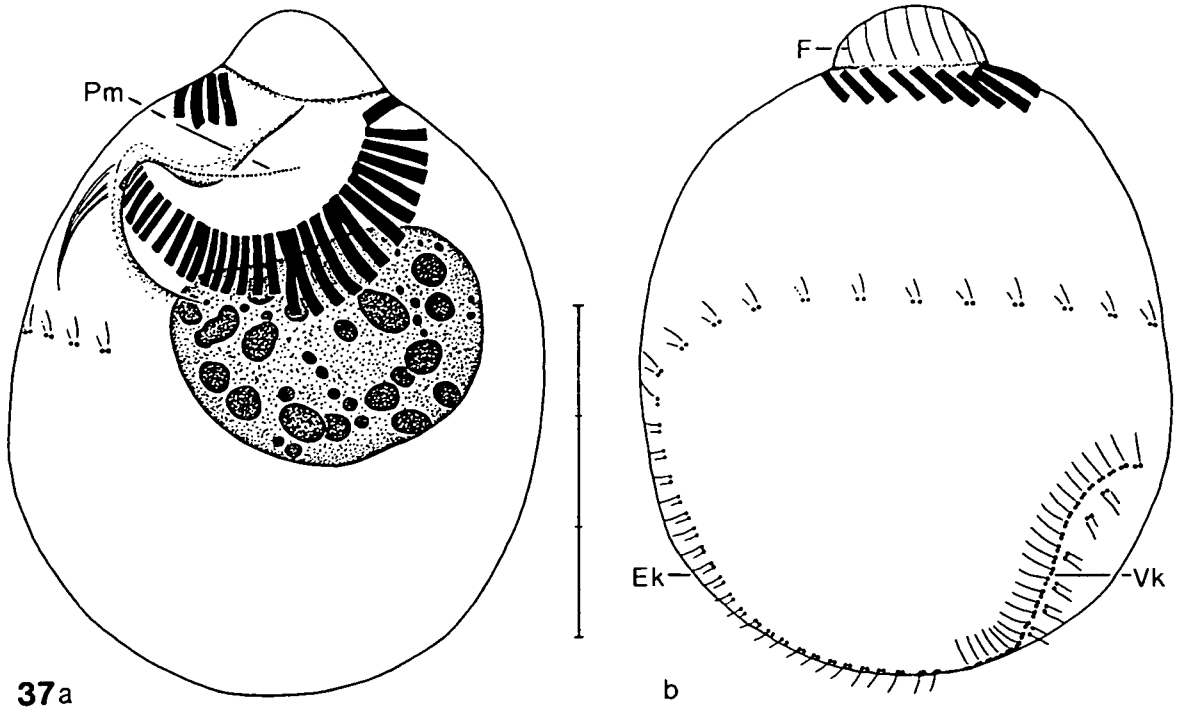
Dorso-ventrally slightly flattened. Subpellicular platelet layer not recognized in protargol slides. Single macronucleus, ellipsoid to spherical, situated ventrally, about in mid-body, left of adoral zone of membranelles, with circular nucleoli (1-5 µm across). Single micronucleus laterally adjacent to macronucleus, spherical, about 1.5 µm across, usually not impregnated with protargol. Food vacuoles contain flagellates.

Equatorial kinety extends from right ventral side transversely across dorsal side, curving posteriad along left margin, across posterior pole, terminates almost equatorially on right dorsolateral area; composed of widely spaced dikinetids, very likely 1 cilium each (about 2.5 µm long), 2nd basal body apparently with conspicuous argentophilic fibre (or short cilium?; usually overimpregnated). Ventral kinety on dorsal side, extends anteriad from posterior pole, parallel to equatorial kinety; consists of densely spaced dikinetids (Figs. 37a, b). Extrusomes not

impregnated, but some elongated argentophilic granules sometimes parallel to equatorial kinety.

Peristomial field rather small. Anterior adoral membranelles inconspicuous, encircling frontal protrusion; composed of 3 equally long basal body rows, longest bases about 8 µm, cilia 19-25 µm long. Ventral membranelles continuous with anterior membranelles, distinctly shorter, curve transversely across ventral side, zone extends almost to right lateral margin, invaginated; longest bases about 5 µm, gradually decreasing in length, comprising 3 basal body rows each, longest cilia about 7 µm. Oral cavity oblique, contains single-rowed paroral membrane on right; cytostome near right body margin. Pharyngeal fibres about 12 µm long.

A slide of protargol impregnated specimens has been deposited for reference.



Figs. 37a, b: *Spirostrombidium pseudocinctum* after protargol impregnation. Ventral and dorsal view of same specimen. Scale bar divisions = 10 µm. Ek, equatorial kinety; F, fibres; Pm, paroral membrane; Vk, ventral kinety.

Occurrence and ecology: Rarely found in the endopagial of pancake sea ice of the Weddell Sea, between latitude 69° 26'-70° 24' S and longitude 06° 18'-07° 19' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates

and ciliates. Environmental parameters in brine: temperature -2.1 to -1.3°C, salinity ca. 44‰, PO_4 ca. 1.6 µmol/l, NO_2 0.2 µmol/l, NH_4 ca. 17 µmol/l, Si ca. 25 µmol/l. In raw cultures also at +1°C. Biomass of 10^6 individuals (from fixed specimens): 44 mg.

Comparison with original description and related species: The species identification can only be provisional because live observations are not available, i.e. important features like extrusomes and subpellicular platelet layer were not seen. Nevertheless, the specimens correspond well to the superficial original description of *Strombidium pseudocinctum* in size and shape of oral cavity and adoral zone of membranelles (WANG 1934). In addition, the spiralling course of the extrusome girdle found by WANG (1934) and that of the equatorial kinety, which is missing in the original description but was observed by us, are very similar. In strombidiids, e.g. in *Spirostrombidium rhyticollare* nov. comb., the extrusomes are usually located along the equatorial kinety.

The course of the equatorial and ventral kinety of this species differs distinctly from that of most other *Strombidium* spp. whose equatorial kinety is considerably shorter, usually forms an almost closed circle in mid-body and lies in a right angle to the ventral kinety. These important differences deserve separation at generic level. *Strombidium pseudocinctum* is thus transferred to the insufficiently diagnosed „desk-genus" *Spirostrombidium* JANKOWSKI, 1978: *Spirostrombidium pseudocinctum* (WANG, 1934) nov. comb.

Strombidium elegans FLORENTIN, 1901 and *S. oblongum* (ENTZ, 1884) KAHL, 1932 have a very similar extrusome girdle (ENTZ 1884; FLORENTIN 1901; KAHL 1932) and are thus also included in *Spirostrombidium*: *Spirostrombidium elegans* (FLORENTIN, 1901) nov. comb., *S. oblongum* (ENTZ, 1884) nov. comb. The former species differs from *Spirostrombidium pseudocinctum* by having a conspicuous adoral zone of membranelles and 2 pad-like projections on either side of the body (preparation artifacts?) and the latter by its posteriorly pointed shape, the possession of 2 long thigmotactic adoral membranelles and the lack of equatorially arranged extrusomes (ENTZ 1884; FLORENTIN 1901; GOURRET & ROESER 1888; KAHL 1932).

Strombidium cinctum KAHL, 1932 has a distinctly longer extrusome girdle, fewer adoral membranelles (about 30 vs. 43 on average) and is distinctly elongate. Due to the course of its extrusome girdle, it may also be included in *Spirostrombidium*: *S. cinctum* (KAHL, 1932) nov. comb. Some other, poorly described species might also belong to *Spirostrombidium*.

Table 20. Morphometric characteristics of *Spirostrombidium rhyticollare* (upper line, n = 30) and *S. pseudocinctum* (lower line, n = 11); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	208.6	205.0	37.2	6.80	17.8	152	291
	61.2	60.0	10.3	3.09	16.8	47	82
Body, width	87.0	84.0	21.3	3.89	24.5	48	149
	41.6	39.0	5.9	1.77	14.1	35	50
Macronucleus, length	47.8	44.0	8.2	1.50	17.2	40	78
	19.9	17.0	6.2	2.07	31.2	14	31
Macronucleus, width	27.4	23.5	7.0	1.28	25.6	20	47
	15.5	16.0	3.2	0.98	20.8	12	21
Apex to cytostome, distance	69.0	70.5	11.6	2.12	16.8	39	93
	17.0	16.0	3.0	0.81	17.9	14	25
Buccal overture, length	49.3	50.0	7.9	1.44	16.0	31	62
	21.6	21.5	3.6	1.14	16.7	16	27
Anterior protrusion, length[1]	7.8	7.8	1.3	0.31	15.9	6	11
Extrusome, length[2]	9.3	9.0	1.6	0.28	16.7	7	13
Anterior membranelles, number	31.9	31.5	1.9	0.35	6.0	28	36
	26.7	26.5	1.0	0.30	3.6	26	29
Ventral membranelles, number	32.5	32.5	3.8	0.74	11.6	22	40
	16.2	16.0	1.0	0.30	6.1	14	17

[1] In *S. pseudocinctum*.
[2] In *S. rhyticollare*.

Spirostrombidium rhyticollare (CORLISS & SNYDER, 1986) nov. comb.

Improved diagnosis: In vivo about 150->200 x 55-130 µm. Shape elongate obconic. 1 spiral equatorial kinety, extending from anterior left margin to posterior pole; 1 ventral kinety parallel to posterior portion of equatorial kinety. About 18-36 anterior and 14-40 ventral adoral membranelles, anterior and ventral membranelles continuous. 1 extrusome girdle along equatorial kinety. Marine.

Morphology and infraciliature (Figs. 38a-f, 65, 66, Table 20): Shape elongate obconic, broadest slightly behind anterior adoral membranelles, pointed posteriorly (Fig. 38a). Macronucleus ellipsoid to drop-shaped, left of ventral adoral membranelles. Micronucleus about 7 x 5 µm, usually not impregnated with protargol. Contractile vacuole not observed; once however, hyaline vacuole seen left of peristome. Specimens very fragile, especially when tightly packed with 25-30 large pennate diatoms (60-100 µm long). Sometimes also feed on small pennate or

centric diatoms and dinoflagellates. Cytoplasm with many small, colourless globules (up to 10 µm across). Specimens sometimes brownish, probably due to digested diatoms. Movement not fast.

Extrusomes apparently delicate because not observed in vivo; in protargol slides ca. 12 x 1 µm, sometimes composed of 2-6 filaments (bundles of extrusomes?); usually densely spaced along equatorial kinety, i.e. in shallow groove near edge of subpellicular platelet layer, not grouped, sometimes slightly displaced (Figs. 38b, f, 65, 66). Subpellicular platelet layer transparent, difficult to recognize, encloses almost entire cell, discontinued in area of equatorial and ventral kineties, platelets 4-7 µm (Fig. 38e).

Equatorial and ventral kinety composed of dikinetids, only 1 basal body each with short cilium (ca. 5 µm long). Equatorial kinety spirals almost twice around cell; starting near left margin of cell, it follows an almost complete circle across ventral and dorsal side, then moves posteriad in wide spiral to end dorsally in longitudinal part (Figs. 38b, c, 65, 66). Ventral kinety in posterior half of cell, parallel to equatorial row.

Anterior adoral membranelles composed of 3 equally long basal body rows each, longest bases about 18 µm; base of rightmost membranelle sometimes slightly shortened (ca. 10 µm). Ventral adoral membranelles continuous with anterior membranelles, distinctly shorter, 3-rowed, invaginated (Figs. 38d, 66). Oral cavity acentric, with single-rowed paroral membrane along right border. Pharyngeal fibres up to 16 µm long.

A slide of protargol impregnated specimens has been deposited for reference.

Occurrence and ecology: Regularly found in the endopagial of pancake and multiyear sea ice of the Weddell Sea, between latitude 68° 44'-70° 22' S and longitude 06° 04'-12° 08' W. Often occurs in the distinctly brownish coloured, densely populated layer together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -3.4 to -1.6°C, salinity 28-59‰, PO_4 1.1-2.3 µmol/l, NO_2 0.2-0.6 µmol/l, NO_3 20.2-45.8 µmol/l, NH_4 2.5-18.7 µmol/l, Si 27.9-50.5 µmol/l; chlorophyll *a* 0.7-85.6 µg/l melted ice. In raw cultures also at a salinity of about 15‰ and +1°C. Biomass of 10^6 individuals: 165 mg.

Comparison with related species: The specimens found by us are fairly similar to the description of *Strombidium rhyticollare* (CORLISS & SNYDER 1986). At first glance, there are, however, some notable differences. According to the

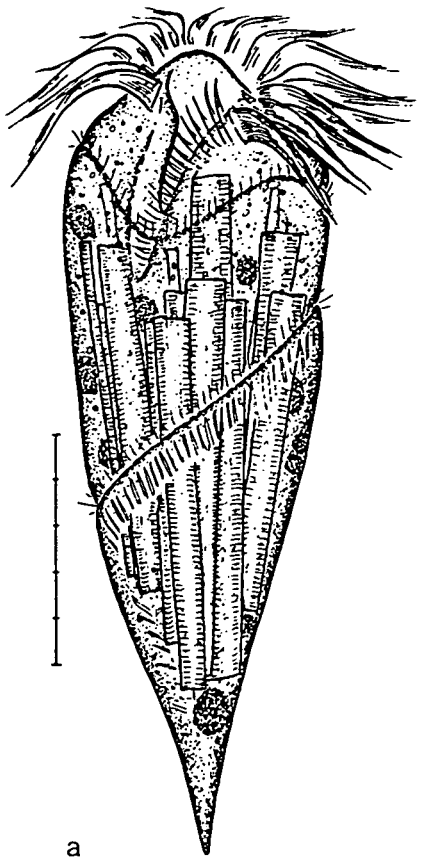
original description, this species has considerably fewer adoral membranelles than found by us (viz. 32 vs. 65 on average), a circular equatorial, a double-rowed ventral kinety and apparently lacks extrusomes; the fusiform shape, the shorter body size (ca. 50%) and smaller macronucleus might be fixation artifacts (CORLISS AND SNYDER 1986).

A reinvestigation of original slides (type slides not deposited yet) showed that *S. rhyticollare* is very similar in shape, has extrusomes as described above and the equatorial kinety (rather lightly stained) very likely extends to the posterior pole (indicated also by a distinct furrow in the subpellicular platelet layer). There are at least 35-45 adoral membranelles. However, numbers could not be exactly assessed. These observations strongly suggest that the population found by us is conspecific with *S. rhyticollare*.

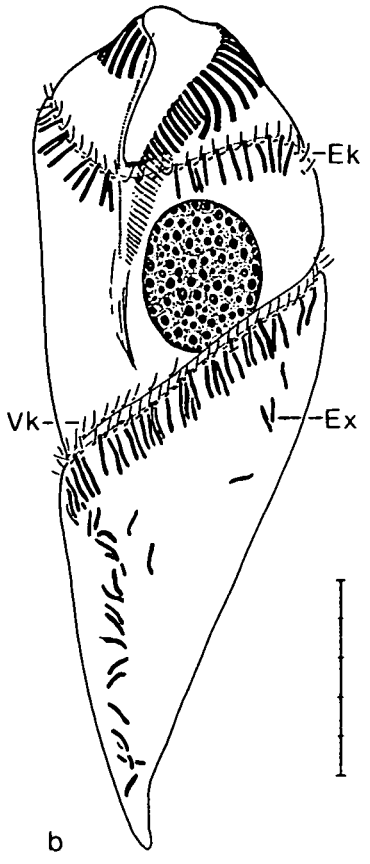
The somatic kinety arrangement of *S. siculum* MONTAGNES & TAYLOR, 1994 [syn. *S. acuminatum* (LEEGAARD, 1915) KAHL, 1932] is very similar to that of *S. rhyticollare*. The former differs, however, in a distinctly smaller size (80-138 vs. 152-291 µm) and macronucleus (17 x 6 µm vs. 48 x 27 µm), fewer anterior (20 vs. 32 on average) and ventral membranelles (on average 7 vs. 33), a shorter ventral kinety (8-10 vs. about 30 basal bodies) and extrusome shape (tear-shaped vs. rod-like; MONTAGNES & TAYLOR 1994).

According to the spiralling course of the equatorial kinety, *Strombidium rhyticollare* and *S. siculum* are transferred to *Spirostrombidium*: *Spirostrombidium rhyticollare* (CORLISS & SNYDER, 1986) nov. comb., *S. siculum* (MONTAGNES & TAYLOR 1994) nov. comb. In addition, MAEDA & CAREY (1985) listed 2 poorly described strombidiids, *Strombidium grande* LEVANDER, 1894 and *S. pulchrum* (LEEGAARD, 1915) KAHL, 1932, which are rather similar to *Spirostrombidium rhyticollare*, e.g. have a spiral band of extrusomes or a spiralling furrow in the subpellicular platelet layer, respectively. *Strombidium pulchrum* (1 specimen found, damaged?) and *S. grande* are thus considered synonyms of *Spirostrombidium rhyticollare*.

Figs. 38a-f: *Spirostrombidium rhyticollare* from life (a) and after protargol impregnation (b-f). a: Ventral view. b, c: Ventral and dorsal view of same specimen. d: Detail of adoral zone of membranelles. e: Outline of subpellicular platelet layer; platelets indicated. f: Extrusomes. Scale bar divisions = 10 µm. Am, anterior adoral membranelles; Ek, equatorial kinety; Ex, extrusomes; Pm, paroral membrane; Vk, ventral kinety; Vm, ventral adoral membranelles.



a



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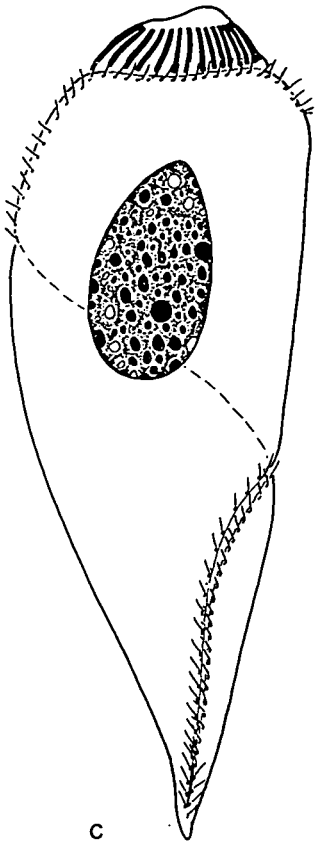

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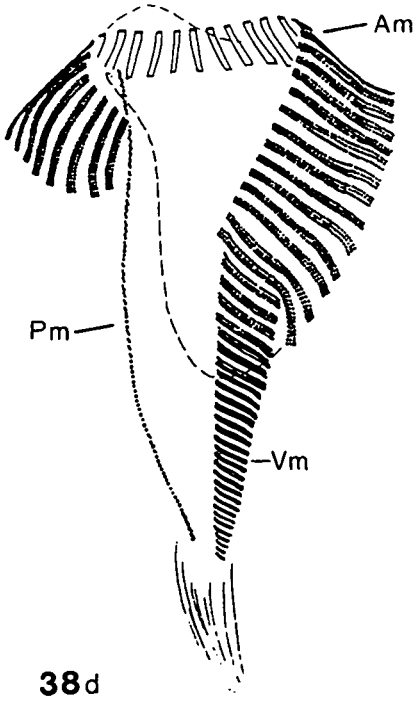
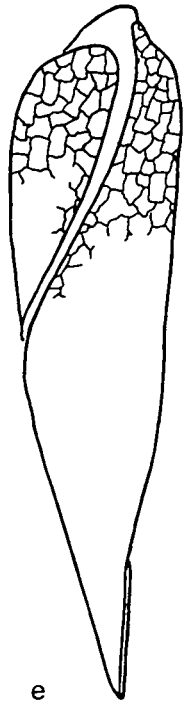


38 d



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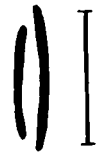


f

Strombidium grande described by CZAPIK (1976) is, however, rather small (about 50 µm), almost globular and the ends of the spiralling equatorial kinety rejoin on the ventral side. *Strombidium grande* sensu CZAPIK (1976) is thus very likely a separate species.

Strombidium elatum ALEKPEROV, 1985 is also elongate but has distinctly fewer adoral membranelles than *Spirostrombidium rhyticollare* and a markedly longer equatorial kinety, i.e. both ends extend to the antapical pole. *Strombidium elatum* may also be included in *Spirostrombidium*: *Spirostrombidium elatum* (ALEKPEROV, 1985) nov. comb.

Some other, often very poorly described species, e.g. *Strombidium typicum* (LANKESTER, 1874) BUETSCHLI, 1889 (evidently misidentification), *S. hadai* MAEDA & CAREY, 1985, *S. elongatum* (LEEGAARD, 1915) KAHL, 1932, are also very similarly shaped but distinctly smaller. Of these, *S. elongatum* and *S. hadai* were found in Antarctica (HADA 1970).

***Tontonia antarctica* nov. spec.**

Diagnosis: Body barrel-shaped, in vivo 55-80 x 50-75 µm. Tail long, contractile, ciliferous. 15-16 anterior, 22-25 ventral adoral membranelles. Equatorial kinety long, extending equatorially and across antapical pole to mid-body again, composed of paired basal bodies. No separate ventral kinety. 1 paroral membrane. 13-28 macronuclear nodules.

Type location: Pelagial of Weddell Sea, Antarctica, 69° 46' S, 09° 00' W (station 398).

Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated specimens have been deposited.

Derivatio nominis: „antarcticus", Lat., Antarctic.

Description (Figs. 39a-e, Table 21): Barrel-shaped, truncated in area of adoral zone, thus appears slightly angular, frontally straight (Fig. 39a). Transverse section circular. Tail (caudal appendix) conspicuous, highly contractile, slim when extended (up to 4x body length), broad when contracted; slightly mobile, obviously not used for locomotion; inserting on posterior left dorsolateral area, tapered where attached to body (Fig. 39b); easily detached when handled with pipette. Posterior 2/3 of body apparently with subpellicular platelets, ca. 2-4 µm across, very difficult to

recognize because highly transparent. Macronuclear nodules spherical to ellipsoid, scattered in body, contain globular nucleoli (1-4 µm across). Several micronuclei, perhaps as many as macronuclei, spherical, 2-3 µm in diam., usually not stained with protargol. Food vacuoles contain flagellates, very likely algae and, rarely, centric diatoms; specimens appear distinctly green in vivo. Movement very slow, swims with tail extended or laid against body (rolled up).

„Equatorial" kinety at anterior edge and in shallow groove of subpellicular platelet layer, long, coursing as in Figs. 39b, d, e, right portion on ventral, left portion on dorsal side; composed of dikinetids, with 1 cilium each (about 1.5 µm long); distance from apex to anterior portion of equatorial kinety 20-30 µm. No separate ventral row.

1 kinety apparently extending over entire length of tail, composed of densely spaced basal bodies (very likely dikinetids), with 1 cilium each (about 1.5 µm long) and up to 16 µm long fibre from 2nd granule (Figs. 39d, e). Extrusomes obviously overlooked in vivo; few lightly stained structures in protargol slides, posterior of adoral zone and around buccal overture, inclined to cell surface, rod-like, anteriorly thickened, about 13 µm long (Figs. 39a, c).

Adoral zone of membranelles prominent. Anterior adoral membranelles composed of 3 basal body rows each, bases 18-20 µm long, cilia about 50 µm long. Zone of ventral membranelles elliptical, separate from anterior membranelles, longest bases about 14 µm, 3-rowed, cilia 17-18 µm long. Paroral membrane in oral cavity on right, extends to centre of anterior surface, cilia about 10 µm long (Fig. 39d). Oral cavity conspicuous, acentric. Pharyngeal fibres about 10 µm long.

Occurrence and ecology: Quite rarely found in the pelagial (0-20 m depth) of the Weddell Sea, between latitude 68° 38'-70° 21' S and longitude 06° 05'-09° 00' W. Occurs together with diatoms and ciliates (e.g. often *Leegaardiella elbraechteri* nov. spec., *Pelagostrobilidium neptuni* nov. gen., nov. comb.). Environmental parameters in sea water: temperature -1.2 to -0.7°C, salinity 34.1-34.2‰. Biomass of 10^6 individuals (from fixed specimens): 105 mg.

Generic position and comparison with related species: *Tontonia antarctica* is most similar to *T. poopsia* MONTAGNES & LYNN, 1988 in size, number of adoral membranelles and macronuclei. However, *T. poopsia* differs by having more paroral membranes, viz. 2, a distinctly smaller tail, its equatorial kinety consists of monokinetids and is interrupted near the tail (vs. on the right lateral side; MONTAGNES & LYNN 1988). *Tontonia antarctica* is distinguished from

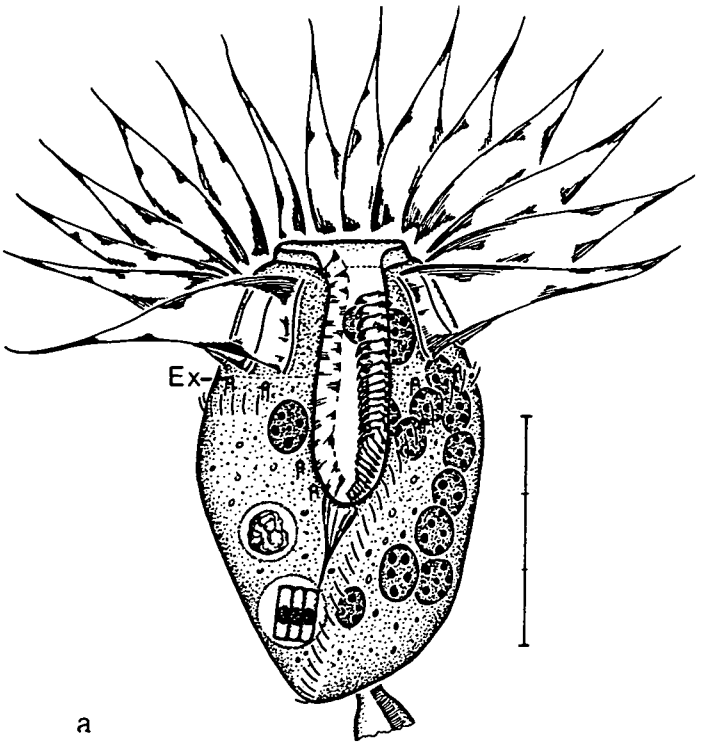
T. gracillima FAURÉ-FREMIET, 1924 in the larger size (60-80 vs. 30-50 µm), higher number of macronuclei (13-28 vs. 5-11), anterior (15-16 vs. 10-14) and ventral adoral membranelles (22-25 vs. 10-15), the dikinetidal composition of the equatorial kinety and the apparent lack of zoochlorellae (FAURÉ-FREMIET 1924; LAVAL-PEUTO & RASSOULZADEGAN 1988; LYNN et al. 1988); the population found by ALEKPEROV & MAMAJEVA (1992) is too superficially studied to allow a definitive identification.

JANKOWSKI (1978) erected the insufficiently defined genus *Paratontonia* for *T. gracillima* with the diagnosis: without cytoskeleton. However, *T. gracillima* possesses extrusomes and *Tontonia* is definded by having „trichites" and a subpellicular platelet layer (FAURÉ-FREMIET 1914, 1924; LYNN et al. 1988). We thus do not follow JANKOWSKI (1978). ALEKPEROV & MAMAJEVA (1992), on the other hand, suggested including *T. gracillima* and most other tontoniids in *Strombidium*. We do not follow this either because, in our opinion, the lack of a separate ventral kinety and the possession of a tail do warrant a separation at generic level.

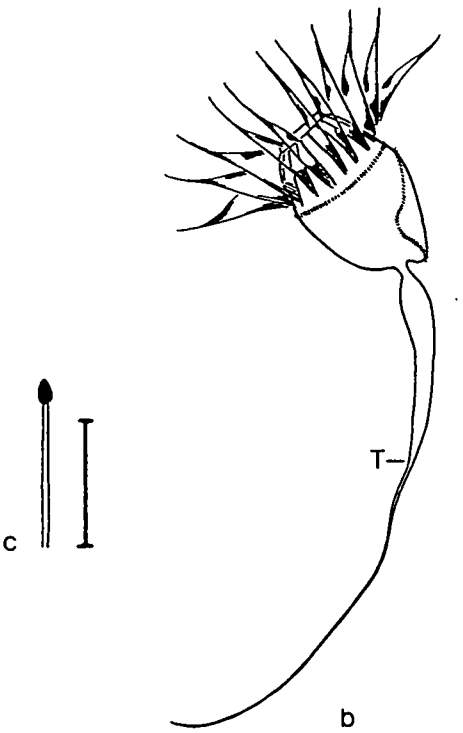
Table 21. Morphometric characteristics of *Tontonia antarctica* (n = 9); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	66.6	67.0	7.5	2.51	11.3	57	78
Body, width	59.2	57.0	8.8	2.92	14.8	49	73
Macronuclear nodule, length	7.4	7.5	2.1	0.46	28.8	4	14
Macronuclear nodule, width	5.6	5.3	1.2	0.25	21.5	4	8
Buccal overture, length	52.3	52.0	5.8	1.73	11.0	43	62
Paroral membrane, length	48.2	48.0	5.0	2.02	10.3	43	56
Peristomial collar, length	4.5	4.5	0.5	0.13	10.7	4	5
Tail, length	82.3	78.0	22.0	8.97	26.7	53	118
Tail, width	32.5	28.0	12.2	4.98	37.5	22	51
Macronuclear nodules, number	21.8	22.5	3.9	1.14	18.1	13	28
Anterior membranelles, number	15.3	15.0	0.5	0.16	3.0	15	16
Ventral membranelles, number	23.6	24.0	1.0	0.29	4.2	22	25

Figs. 39a-e: *Tontonia antarctica* from life (a, b) and after protargol impregnation (c-e). a: Ventral view of anterior portion. b: Dorsal view. c: Extrusome. d, e: Ventral and dorsal view of same specimen. Scale bar divisions = 10 µm. C, peristomial collar; Ek, equatorial kinety; Ex, extrusomes; F, fibres; Pm, paroral membrane; T, tail.



a



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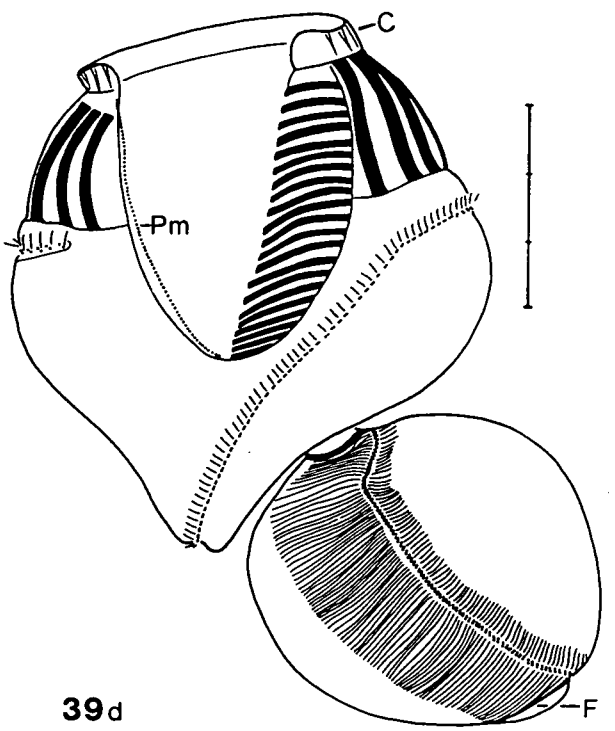
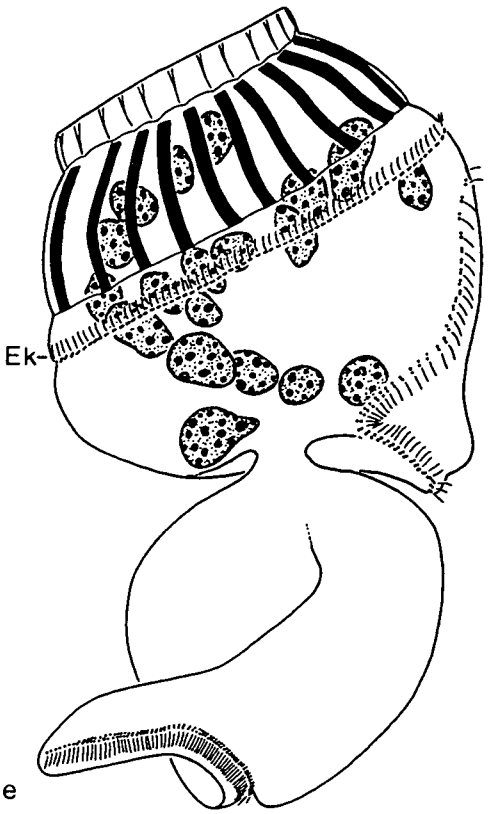


39d



e

Order Oligotrichida BUETSCHLI, 1887

Leegaardiella elbraechteri nov. spec.

Diagnosis: In vivo 50-65 x 40-55 µm. Body cornucopia-shaped, with hyaline „lorica". 4 longitudinal somatic kineties, short, ciliated, radiating almost from posterior pole, composed of dikinetids. 19-21 external, 4-5 distinct internal membranelles; rightmost internal membranelle enlarged. 2 macronuclei. Marine.

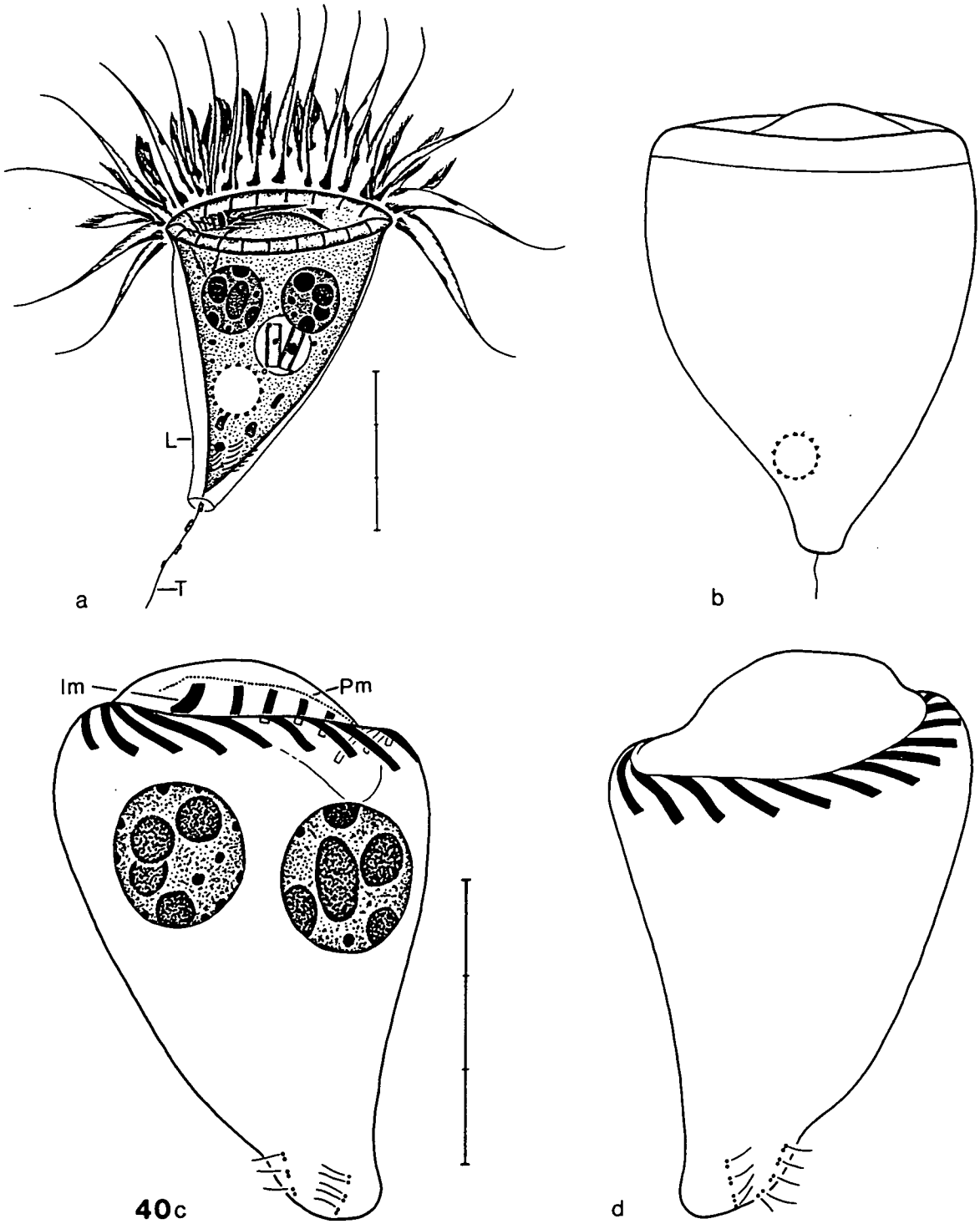
Type location: Pelagial of Weddell Sea, Antarctica, 69° 46' S, 09° 00' W (station 398).

Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Dedication: We dedicate this new species to Dr. Malte ELBRÄCHTER, Biologische Anstalt Helgoland, Sylt, Germany, as a small token of appreciation for his support and friendship.

Description (Figs. 40a-d, Table 22): Shape cornucopia-like, ventral side concave, dorsal convex, widest in area of adoral zone of membranelles, posteriorly tapering (Fig. 40a). Dividers usually turbinate to obconic, sometimes slightly asymmetrical (Fig. 40b). Cross section circular. Body in delicate „lorica", hyaline, caudal portion projecting through opening; only found in vivo, not observed in protargol slides (Fig. 40a). Macronuclei ellipsoid to globular, in anterior half of body, contain spherical and elongated nucleoli. 2 spherical micronuclei, each adjacent to macronucleus, usually not impregnated with protargol. Contractile vacuole in posterior 1/3 of body, pulsation, however, not observed. Cytoplasm colourless, hyaline, sometimes with small green crystal-like inclusions; food vacuoles contain pennate (8-16 µm long) and, rarely, centric (about 15 µm across) diatoms and flagellates.

Movement slow to moderately fast, rarely very rapid, rotating about main body axis, often swimming backwards; convulsively moving short distances back and forth. If undisturbed, secretes mucous thread (very short to quite long) at caudal end and attaches to substrate, remains on same spot still rotating; thread visible if particles adhere to it. Disturbed individuals immediately detach from thread and dart away.



Figs. 40a-d: *Leegaardiella elbraechteri* from life (a, b) and after protargol impregnation (c, d). a: Left lateral view. Arrowhead marks cirrus-like rightmost internal membranelle. b: Outline of divider. c, d: Ventral and dorsal view of same specimen. Scale bar divisions = 10 µm. Im, enlarged internal adoral membranelle; L, lorica; Pm, paroral membrane; T, mucous thread.

Somatic kineties longitudinal, radiate cross-like almost from posterior pole, very short, composed of few dikinetids, often (always?) both basal bodies with 1 cilium each (4-5 µm long; Figs. 40c, d).

Zone of adoral membranelles distinctly spiralling, situated on anteriorly slightly projecting rim. External membranelles (external polykinetids) each composed of 3 basal body rows, longest bases about 13 µm; usually 3 membranelles slightly elongated, extending into oral cavity. Cilia of distal portion of external membranelles distinctly longer (40-50 µm, finger-like) than proximally (about 25 µm long); living specimens thus helicopter-like in top view. Internal adoral membranelles (internal polykinetids) on right of oral cavity, very likely 2-rowed, longest bases about 10 µm; base of membranelle 4 (rightmost) distinctly enlarged, about 5-7 x 3-4 µm, cilia apparently agglutinated, i.e. forming very conspicuous cirrus-like structure in protargol slides, 14-26 µm long (Figs. 40a, c). Paroral membrane single-rowed, extends across anterior surface and into oral cavity, cilia 3-6 µm long. Centre of anterior surface (peristomial bottom) often domed in protargol slides (6-8 µm), less conspicuously vaulted in vivo. Oral cavity rather shallow, acentric on anterior surface, defines ventral side. Pharyngeal fibres about 26 µm long.

Many, usually early dividers occurred in plankton samples; complete divisional sequence, however, not found. Morphogenesis enantiotropic (FAURÉ-FREMIET 1953; CORLISS 1979; PETZ & FOISSNER 1993), i.e. oral anlage develops intracellularly on left-lateral side and main body axes of proter and opisthe are 180° inverted in middle divisional stages (not illustrated).

Table 22. Morphometric characteristics of *Leegaardiella elbraechteri* (upper line, n = 31), *Rimostrombidium glacicolum* (middle line, n = 31) and *Pelagostrobilidium neptuni* (lower line, n = 21); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	48.8	48.0	3.2	0.58	6.6	42.0	55.0
	29.8	29.0	4.6	0.82	15.3	21.0	40.0
	56.4	56.0	9.0	4.01	15.9	47.0	71.0
Body, width	38.7	39.0	3.7	0.66	9.5	33.0	45.0
	25.1	23.0	4.0	0.72	16.0	20.0	35.0
	52.3	52.5	6.9	1.47	13.2	26.0	62.0
Macronuclear figure, length	15.3[1]	15.0	3.3	0.59	21.6	10.0	21.0
	20.3	20.0	3.6	0.66	17.6	16.0	30.0
	42.6	43.0	5.7	1.25	13.5	23.0	53.0

Table 22 continued.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Macronucleus, width	11.8	12.0	2.0	0.37	17.2	9.0	16.0
	9.8	9.0	2.5	0.44	25.1	5.0	17.0
	9.3	9.0	1.9	0.41	20.2	5.0	14.0
Micronuclei, length	–[2]	–	–	–	–	–	–
	–[2]	–	–	–	–	–	–
	3.2	3.0	0.7	0.15	22.7	2.0	4.0
Micronuclei, width	–[2]	–	–	–	–	–	–
	–[2]	–	–	–	–	–	–
	2.1	2.0	0.2	0.04	9.9	2.0	2.5
Paroral membrane, length	19.2	19.0	3.3	1.10	17.2	16.0	26.0
	6.7	6.5	1.3	0.58	19.5	5.0	8.0
	24.4[3]	24.0	3.6	0.86	14.6	16.0	30.0
Adoral zone of membranelles, diameter	15.4	15.0	1.4	0.25	9.1	13.0	19.0
	equal to body width						
	equal to body width						
Apex to cytostome, distance	10.4	11.0	2.5	0.94	24.1	6.0	13.0
	3.5	4.0	0.6	0.12	17.6	2.5	4.0
	–[4]	–	–	–	–	–	–
Anterior end of somatic kineties to posterior pole, distance	5.0	5.0	0.9	0.19	18.3	3.0	6.5
	8.6	8.0	2.3	0.41	26.4	5.0	14.0
	–[4]	–	–	–	–	–	–
External membranelles, number	19.8	20.0	0.8	0.14	3.9	19.0	21.0
	18.6	19.0	0.8	0.15	4.4	17.0	20.0
	36.9	37.0	1.0	0.20	2.7	36.0	40.0
Internal membranelles, number	4.4	4.0	0.5	0.13	11.5	4.0	5.0
	0.0	0.0	0.0	0.00	0.0	0.0	0.0
	1.1	1.0	0.3	0.09	27.6	1.0	2.0
Somatic kineties, number	4.0	4.0	0.0	0.00	0.0	4.0	4.0
	5.0	5.0	0.0	0.00	0.0	5.0	5.0
	5.0	5.0	0.0	0.00	0.0	5.0	5.0
Dikinetids in somatic kineties, number	4.4	4.0	1.2	0.22	27.4	2.0	7.0
	4.7	5.0	0.8	0.15	15.9	3.0	6.0
	–[4]	–	–	–	–	–	–
Macronuclei, number	2.0	2.0	0.0	0.00	0.0	2.0	2.0
	1.0	1.0	0.0	0.00	0.0	1.0	1.0
	1.0	1.0	0.0	0.00	0.0	1.0	1.0
Micronuclei, number	–[2]	–	–	–	–	–	–
	–[2]	–	–	–	–	–	–
	2.0	2.0	0.0	0.00	0.0	2.0	2.0

[1] Macronuclei.
[2] Not impregnated.
[3] Figure.
[4] Not determined.

Occurrence and ecology: Frequently found in the plankton (0-20 m depth) between ice floes of the Weddell Sea, between latitude 68° 38'-70° 21' S and longitude 06° 05'-12° 14' W. Occurs together with diatoms, flagellates, foraminiferans (*Neogloboquadrina pachyderma*) and ciliates (e.g. tintinnids). Ingested by *Peridinium* sp. Environmental parameters in sea water: temperature -1.2 to -0.6°C, salinity 34.1-34.2‰. In raw cultures also at +1°C. Do not burst at higher, e.g. room, temperature. Biomass of 10^6 individuals: 32 mg.

Generic position and comparison with related species: The genus *Leegaardiella* is characterized by external adoral membranelles composed of an outer and an inner portion, internal membranelles and somatic kineties consisting of dikinetids and lacking a cytoplasmic flap (LYNN & MONTAGNES 1988). Additionally, the figures given by LYNN & MONTAGNES (1988) suggest that the internal membranelles are well developed. This corresponds with the species described here, which we thus include in this genus.

Leegaardiella was diagnosed from fixed material only (LYNN & MONTAGNES 1988). We thus do not place too much emphasis on the possession of the delicate lorica because it was found exclusively in vivo. Other strobilidiids, viz. strombidinopsids, have a hyaline lorica which is very easily lost (KAHL 1932; MAEDA 1986). Strombidinopsids are, however, distinguished by many and long somatic kineties (FAURÉ-FREMIET 1924; KENT 1881; LYNN et al. 1991).

Leegaardiella elbraechteri differs from *L. sol* LYNN & MONTAGNES, 1988 and *L. ovalis* LYNN & MONTAGNES, 1988 mainly in body shape, length and arrangement of the somatic kineties, in the enlarged rightmost internal adoral membranelle and, perhaps, in the hyaline lorica (LYNN & MONTAGNES 1988).

Genus *Pelagostrobilidium* nov. gen.

Diagnosis: Subspherical Strobilidiidae, small to medium sized, with longitudinal and transversely arched somatic kineties which do not form a spiral at posterior pole.

Type species: *Strobilidium neptuni* MONTAGNES & TAYLOR, 1994

Derivatio nominis: „to pelagos", Greek, the ocean, high sea; *Strobilidium*; neuter gender.

Pelagostrobilidium neptuni **(MONTAGNES & TAYLOR, 1994) nov. comb.**

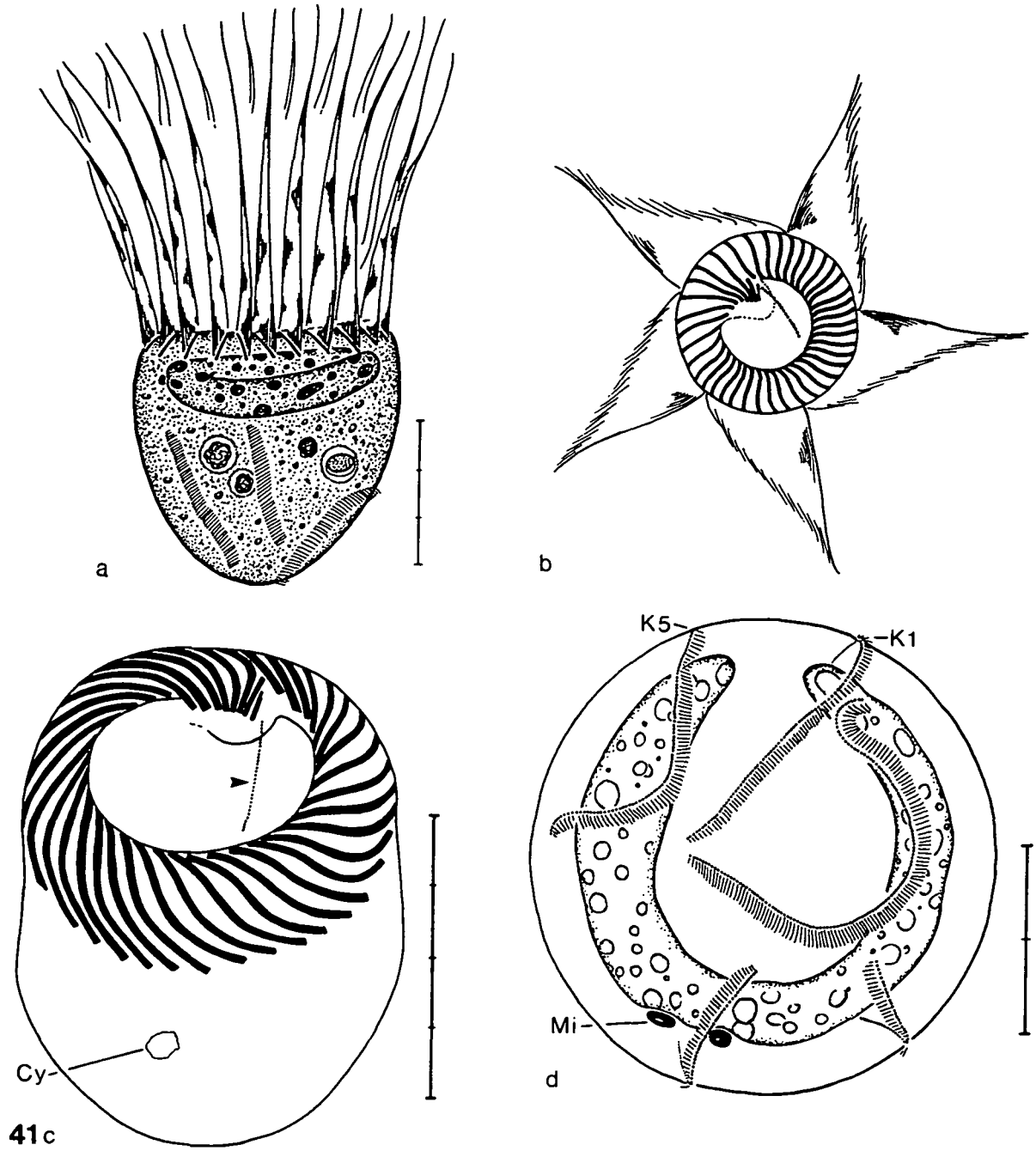
Morphology and infraciliature (Figs. 41a-d, Table 22): In vivo 35-60 µm across, bowl-shaped, posteriorly broadly rounded (Fig. 41a). Transverse section circular. Very fragile, usually burst when handled with pipette. Macronucleus with spherical (1-3 µm across), elliptical (about 4 x 1.5 µm) and ribbon-like nucleoli. Always 2 micronuclei, close together, in small indentations of macronucleus, lenticular to spherical (Fig. 41d). Contractile vacuole not observed. Cytopyge apparently dorsal. Cytoplasm reddish-brown, with red and green inclusions; food vacuoles contain centric, small and large pennate (6-61 µm long) diatoms and very likely algae; this renders cells distinctly dark. Movement very fast over long distances, sometimes jumping; adoral membranelles motionless when resting, raised upwards; sometimes remains stationary and rotates about main body axis, thus appearing helicopter-like in top view (Fig. 41b).

5 somatic kineties, as described by MONTAGNES & TAYLOR (1994), basal bodies densely spaced, cilia 2-4 µm long (Fig. 41d). Adoral zone of membranelles conspicuous, forms closed spiral. External membranelles frayed, composed of 3 basal body rows each, bases 13-23 µm long, cilia 50-60 µm long; 6-14 ($\bar{x}$ = 9.9, n = 13) membranelles gradually elongated, extending into oral cavity. Usually single internal membranelle 3-rowed; rarely 2nd membranelle, double-rowed. Paroral membrane single-rowed, in oral cavity on right, extends across frontal area, cilia about 13 µm long (Figs. 41b, c). Oral cavity funnel-shaped, acentric on anterior surface; distance from apex to cytostome about 12 µm.

Some dividers occurred in field material: division enantiotropic, oral anlage differentiates within cell, macronucleus with 2 replication bands (not illustrated).

2 slides of protargol impregnated specimens have been deposited for reference.

Occurrence and ecology: Found in moderate numbers in the pelagial (0-50 m depth) of the Weddell Sea, between latitude 68° 00'-70° 21' S and longitude 04° 10'-12° 14' W. Occurs together with diatoms, radiolarians and ciliates (often *Leegaardiella elbraechteri*, *Tontonia antarctica*). Environmental parameters in sea water: temperature -1.2 to -0.7°C, salinity 33.7-34.2‰. Biomass of 10^6 individuals (from fixed specimens): 70 mg.



Figs. 41a-d: *Pelagostrobilidium neptuni* from life (a, b) and after protargol impregnation (c, d). a: Right lateral view. b: Top view of living specimen. c, d: Side and aboral view. Arrowhead marks paroral membrane. Scale bar divisions = 10 µm. Cy, cytopyge; K1, K5, somatic kineties 1, 5; Mi, micronucleus.

Comparison with related genera and species: The original population very recently described by MONTAGNES & TAYLOR (1994) differs only in having argentophilic granules of unknown nature on the cell surface (artifact?).

The arrangement and composition of the somatic kineties is an important genus character in strobilidiids (LYNN & MONTAGNES 1988; PETZ & FOISSNER 1992). Based on this, *S. neptuni* cannot be included in either of the 4 strobilidiid genera *Strobilidium*, *Rimostrombidium*, *Leegaardiella* and *Lohmanniella*. Thus, a separate genus, *Pelagostrobilidium*, is hereby established for *S. neptuni* with which it is combined: *P. neptuni* (MONTAGNES & TAYLOR, 1994) nov. comb. The oral and somatic infraciliature of this species is also very similar to that of *Strobilidium spirale* (JONSSON 1987; LYNN & MONTAGNES 1988), which is thus transferred to *Pelagostrobilidium*: *P. spirale* (LEEGAARD, 1915) nov. comb. This species differs from *P. neptuni* in having only 1 micronucleus (vs. 2) and kinety 5 describes apparently a partial circle whereas this is not pronounced in *P. neptuni* (LYNN & MONTAGNES 1988; MONTAGNES & TAYLOR 1994; Fig. 41d). ALEKPEROV & MAMAJEVA (1992) found also only 1 micronucleus in very superficially studied individuals of *S. spirale*. These differ from the population studied by LYNN & MONTAGNES (1988) in the oval macronucleus (vs. C-shaped) indicating that they are not conspecific; data on somatic kineties are not given.

***Rimostrombidium glacicolum* nov. spec.**

Diagnosis: In vivo 30-45 x 20-30 µm. Body turbinate. 5 longitudinal somatic kineties on posterior portion, ciliated. 17-20 external, no internal adoral membranelles. Macronucleus reniform. Marine.

Type location: Multiyear sea ice of Weddell Sea, Antarctica, 70° 21' S, 08° 53' W (core number AN 103107b).

Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Derivatio nominis: „glacies", the ice; „colere", to inhabit; Lat.

Description (Figs. 42a-c, Table 22): Shape turbinate to obconic, posteriorly tapering (Fig. 42c). Depending on nutritional state, sometimes gentle ridges (cytoplasmic flap?) along somatic kineties. Cross section circular. Single macronucleus reniform to slightly C-shaped, about in mid-body, with opening in pharyngeal region, contains numerous spherical nucleoli, 0.5-3 µm across. 1 micronucleus, spherical to ellipsoid, in gentle indentation of macronucleus, usually

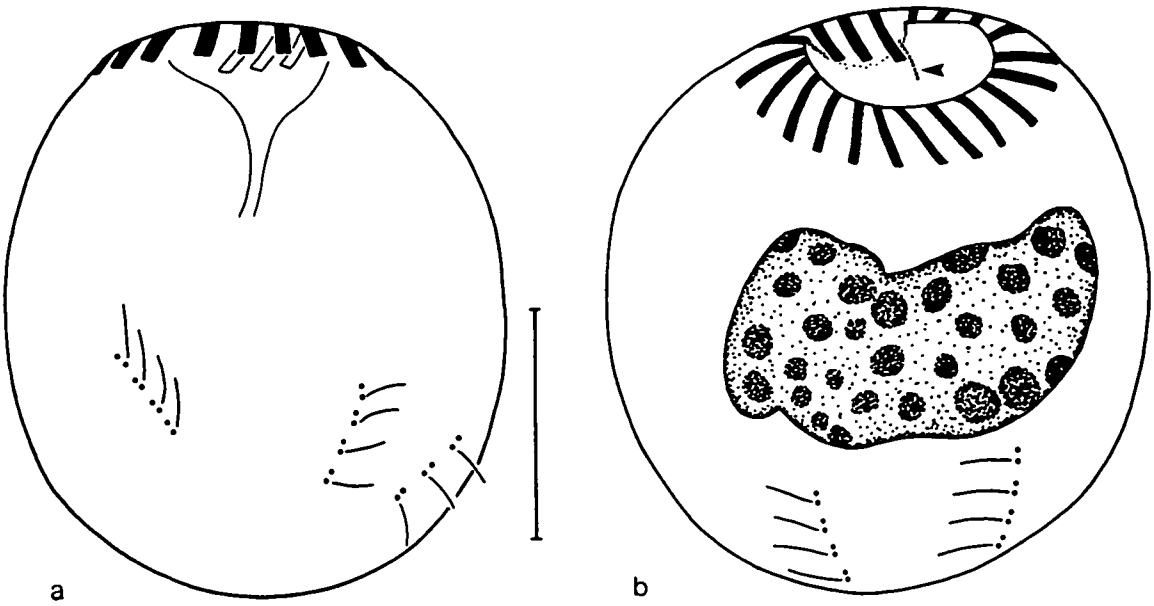
not stained with protargol. Contractile vacuole not observed. Food vacuoles containing pennate (6-16 µm long) and rarely centric diatoms, flagellates and indeterminate green contents; specimens dark at low, green at high magnification. Movement moderately rapid, sometimes jerking back and forth.

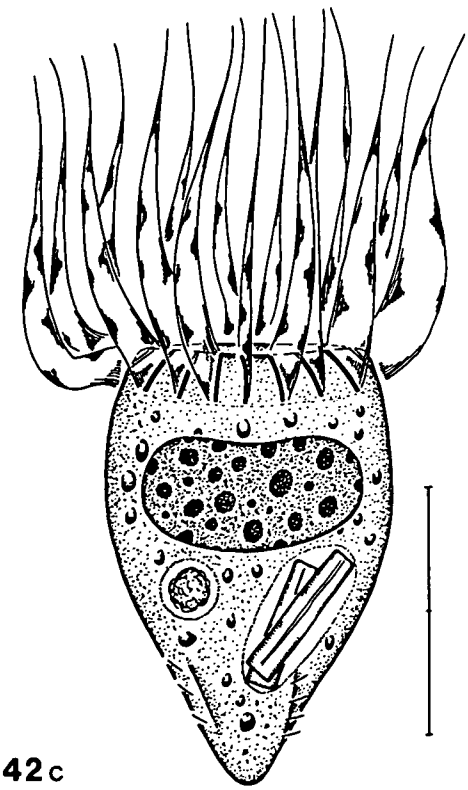
Somatic kineties in posterior 1/3 of body, short, longitudinal, radiating from near posterior pole; apparently composed of few dikinetids with 1 cilium each, i.e. non-ciliated granule anteriorly and ciliated basal body posteriorly; cilium usually about 1.5, sometimes 3-8 µm long (Figs. 42a, b).

Adoral zone of membranelles forms closed spiral (Fig. 42b). External membranelles 3-rowed, longest bases about 5 µm, cilia conspicuous (20-40 µm long); usually 3 membranelles gradually elongated, extend into oral cavity. Base of rightmost external membranelle slightly shortened, about 2.5 µm long. Internal adoral membranelles not found (lacking?). Paroral membrane in oral cavity on right, extends to anterior surface, cilia about 4 µm long. Anterior surface small, contains acentric oral cavity. Pharyngeal fibres 7-14 µm long.

Occurrence and ecology: Regularly found in the endopagial of multiyear, pancake and newly formed (grease) sea ice and in the pelagial (0-20 m depth) of the Weddell Sea, between latitude 67° 47'-71° 16' S and longitude 06° 04'-12° 02' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -2.4 to -0.4°C, salinity 34.1-44.0‰, PO_4 1.1-1.4 µmol/l, NO_2 0.2-0.6 µmol/l, NO_3 20.2-32.8 µmol/l, NH_4 10.2-18.7 µmol/l, Si 27.9-50.5 µmol/l; in melted ice: chlorophyll *a* 28.9-30.1 µg/l; in sea water between ice floes (1 measurement): temperature -1.8°C, salinity 33.7‰, PO_4 1.8 µmol/l, NO_2 0.2 µmol/l, NO_3 25.5 µmol/l, NH_4 1.7 µmol/l, Si 56.3 µmol/l, chlorophyll *a* 0.1 µg/l. In raw cultures also at a salinity of 15.6‰ and +1°C. Burst at slightly higher than environmental temperatures. Biomass of 10^6 individuals: 6 mg.

Comparison with related genera and species: This strobilidiid species is included in *Rimostrombidium* JANKOWSKI, 1978 because the longitudinal somatic kineties end subterminally, i.e. do not form a spiral at the caudal pole, and are accompanied by a cytoplasmic flap (JANKOWSKI 1978; LYNN & MONTAGNES 1988; PETZ & FOISSNER 1992). A transmission electron microscopical investigation is, however, needed to assess whether the somatic rows of *R. glacicolum* consist of dikinetids. Most other rimostrombidiids apparently have





42c

Figs. 42a-c: *Rimostrombidium glacicolum* from life (c) and after protargol impregnation (a, b). a, b: Ventral and dorsal view of same specimen. Arrowhead marks paroral membrane. c: Dorsal view. Scale bar divisions = 10 µm.

somatic monokinetids (e.g. FOISSNER et al. 1988; LYNN & MONTAGNES 1988; MARTIN & MONTAGNES 1993; PETZ & FOISSNER 1992).

Rimostrombidium glacicolum differs from *Strombidinopsis* KENT, 1881 by its fewer and considerably shorter somatic kineties (LYNN et al. 1991). *Lohmanniella*

LEEGAARD, 1915 (single, very similar species *L. oviformis* LEEGAARD, 1915) is distinguished by non-ciliated somatic monokinetids and the lack of cytoplasmic flaps adjacent to somatic rows (LYNN & MONTAGNES 1988). In addition, *R. glacicolum* lacks separate internal adoral membranelles, as present in *L. oviformis*. *Leegaardiella* differs by having external adoral membranelles consisting of an inner and outer portion and in the lack of cytoplasmic flaps (LYNN & MONTAGNES 1988). Leegaardiellids additionally apparently have prominent internal adoral membranelles (see above).

Rimostrombidium multinucleatum (LYNN & MONTAGNES, 1988) PETZ & FOISSNER, 1992 is similarly shaped but possesses many macronuclear nodules and markedly longer somatic kineties (LYNN & MONTAGNES 1988). *Strobilidium undinum* MARTIN & MONTAGNES, 1993 and *S. veniliae* MONTAGNES & TAYLOR, 1994 have more (viz. 6 and 10 on average, respectively) and longer somatic rows, a higher number of external (21-24 and 22-23 vs. 17-20, respectively) and separate internal membranelles and a distinctly C-shaped macronucleus. According to the definition of *Rimostrombidium* (JANKOWSKI 1978; PETZ & FOISSNER 1992), *S. undinum* and *S. veniliae* are included in this genus: *R. undinum* (MARTIN & MONTAGNES, 1993) nov. comb., *R. veniliae* (MONTAGNES & TAYLOR, 1994) nov. comb.

Codonellopsis glacialis (LAACKMANN, 1907) KOFOID & CAMPBELL, 1929

Synonymy: *Codonella glacialis* LAACKMANN, 1907; *Leprotintinnus glacialis* (LAACKMANN, 1907) LAACKMANN, 1910; *Codonellopsis gaussi* (LAACKMANN, 1907) – BALECH (1958, 1973), partim; *Codonellopsis glacilis* (LAACKMANN, 1907) – HADA (1970), incorrect subsequent spelling.

Silver impregnations of *C. gaussi* are necessary to assess whether it is conspecific with *C. glacialis* as suggested by BALECH (1958). Synonymizing these is currently premature.

Improved diagnosis: Lorica in vivo generally 55-80 x 35-40 µm, tapering bullet-shaped, usually bipartite, anteriorly hyaline, posteriorly with mineral and biogenic particles. 24-28 somatic and 1 dorsolateral kinety. 17-18 external, 1 internal adoral membranelle. 4 macronuclei. Marine.

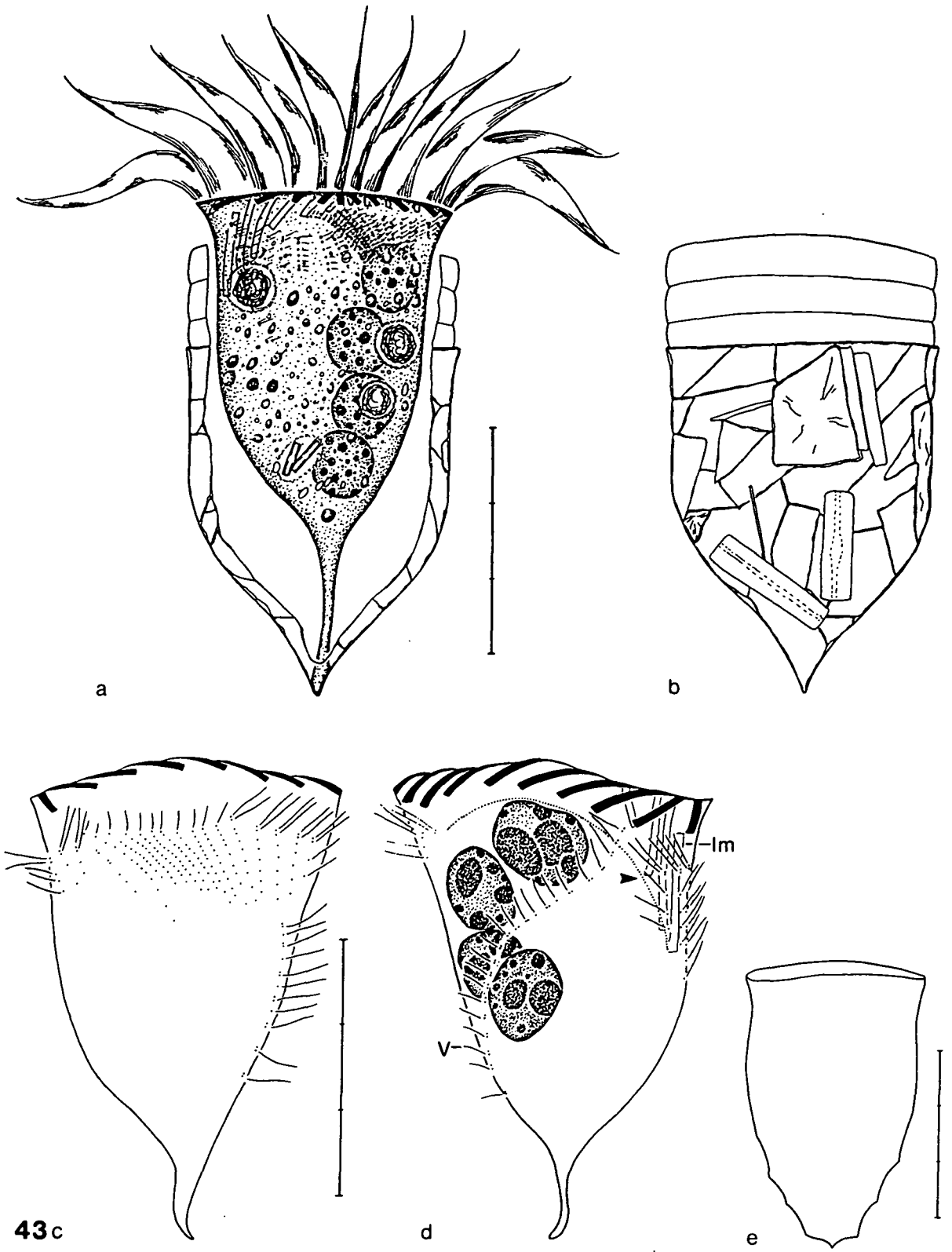
Neotype material: 1 neotype-slide and additional slides of protargol impregnated cells have been deposited.

Redescription (Figs. 43a-f, 63, Table 23): Lorica bipartite; collar cylindrical, hyaline, in vivo with usually 4-7 spiral rings (not visible in protargol slides), very rarely lacking, frontal margin smooth; bowl obconic, aborally usually pointed, covered with many irregular to rectangular mineral particles, some diatom frustules (also fragments) and parts of radiolarian skeletons (Figs. 43a, b; LAACKMANN 1907, 1910; BALECH 1973).

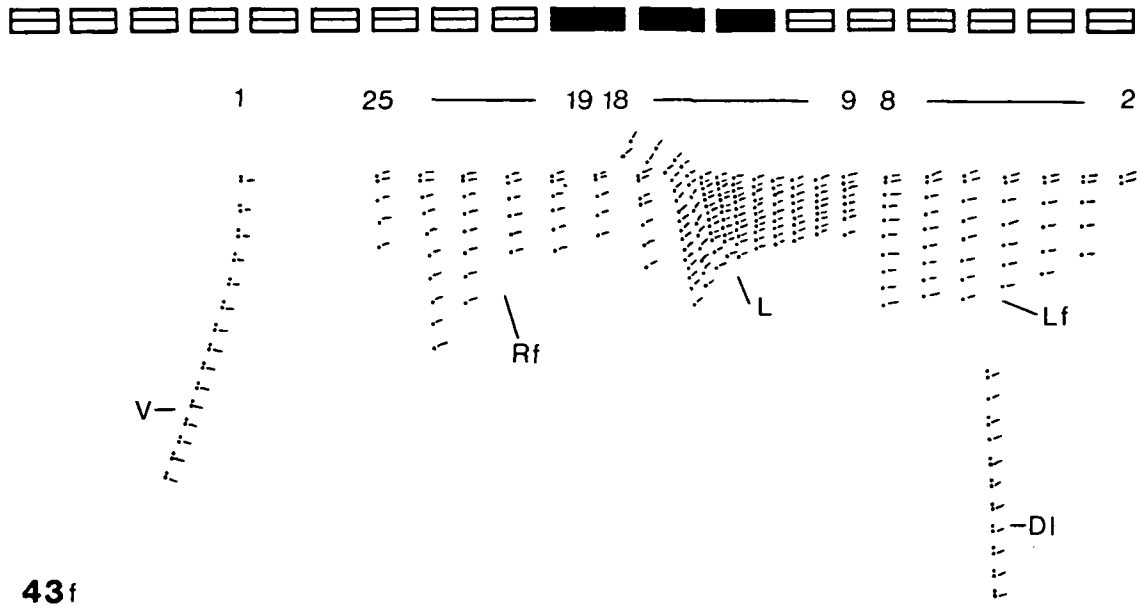
Stalk on posterior portion of body, contractile, attaches to inside of lorica (Fig. 43c). Specimens outside of lorica obconic. Macronuclei in dorsal half of body, ellipsoid to spherical, contain globular nucleoli (1-2.5 µm across), rarely 1 large central nucleolus (about 5 µm in diam.). Micronuclei not impregnated with protargol. Single, very likely contractile, vacuole in anterior half of body; pulsation not observed. Cytoplasm contains bright green inclusions and food vacuoles containing small pennate and centric diatoms and very likely flagellates. Movement not fast, swimming in straight line, sometimes backwards. Disturbed animals retract into posterior portion of lorica, adoral membranelles are tilted upwards and kept motionless.

Somatic kineties longitudinal, of differing length, most composed of monokinetids (Figs. 43c, d, f). Ventral kinety right of oral cavity, distinctly arched (preparation artifact?), consists of dikinetids, anterior basal body frequently with short cilium (about 4 µm), posterior with long cilium (about 9-17 µm); rarely only posterior basal body ciliated. Lateral field of kineties (rows 9-18) left of oral cavity, composed of closely spaced rows of monokinetids, 8-16 basal bodies/kinety, cilia 2-4 µm long; rows 17 and 18 distinctly elongated anteriad (Figs. 43c, f). Single dorsolateral kinety [ventrolateral in other tintinnids (cf. FOISSNER & WILBERT 1979; PETZ & FOISSNER 1993)] originates near left field of kineties, extends posteriad, composed of dikinetids, posterior basal body each with 1 cilium (3-7 µm long). Other kineties, i.e. numbers 2-8 (left field, WASIK & MIKOLAJCZYK 1994a) with 1-8 basal bodies/row (cilia 2.5-4 µm long) and numbers 19-25 (right field, WASIK & MIKOLAJCZYK 1994a) with 2-6 kinetosomes/row (cilia 2-5 µm long) each with ciliated dikinetid at anterior end; row 19 often anteriorly with 2 dikinetids (Fig. 43f). No ventral organelles.

Adoral zone of membranelles forming closed spiral; bases of membranelles composed of 3 (2 long, 1 slightly shorter) basal body rows each, cilia 25-40 µm long; 3 membranelles increasingly elongated, extending into oral cavity. Internal adoral membranelle in oral cavity on left, 3-rowed, base 14-18 µm long. Paroral membrane single-rowed, extends across anterior surface into oral cavity, about 30 µm long, cilia about 4 µm long (Fig. 43d). Anterior surface sloping towards acentric oral cavity. Pharyngeal fibres 16-18 µm long.



Figs. 43a-e: *Codonellopsis glacialis* from life (a, b) and after protargol impregnation (c-e). a: Left lateral view. b: Lorica. c, d: Left and right lateral view of same specimen; somatic cilia exemplified. Arrowhead points to paroral membrane. e: Ptychocyliform lorica. Scale bar divisions = 10 µm. Im, internal adoral membranelles; V, ventral kinety.



43f

Fig. 43f: *Codonellopsis glacialis* (protargol impregnation). Diagram of interphasic infraciliature (based on average number of kineties). Ciliation indicated; elongated adoral membranelles descending into oral cavity full, others open rectangles. Dl, dorsolateral kinety; L, lateral field of kineties; Lf, Rf, left and right field of kineties, respectively; V, ventral kinety.

Many often rather early dividers have been found in the field samples: division enantiotropic, oral anlage develops intracellularly, axes of proter and opisthe in early stages at an angle of 90°.

Occurrence and ecology: Often dominant in the pelagial (0-50 m depth), empty loricae also from 350-400 m depth; once found in grease ice. Encountered in the eastern Weddell Sea between latitude 68° 00'-71° 16' S and longitude 04° 10'-12° 14' W. Occurs in the pelagial together with diatoms, flagellates, radiolarians, foraminiferans (*Neogloboquadrina pachyderma*) and ciliates (oligotrichs). 500 active ind./l grease ice were found (biomass 0.01 mg/l), comprising 50% of the total ciliate community. *Codonellopsis glacialis* is ingested by *Peridinium* sp. Environmental parameters in sea water and grease ice: temperature -1.8 to 0.0°C, salinity 33.1-35.0‰, PO_4 1.8 µmol/l, NO_2 0.2 µmol/l, NO_3 26.8 µmol/l, NH_4 3.2 µmol/l, Si 56.3 µmol/l, chlorophyll *a* 0.4 µg/l. In raw cultures also at +1°C. Biomass of 10^6 individuals: 22 mg.

Comparison with related species: Size, shape and structure of the lorica correspond exactly to *C. glacialis* (LAACKMANN 1907, 1910). The infraciliature, which was not investigated before, is codonellid (cf. FOISSNER & WILBERT 1979; LAVAL-PEUTO & BROWNLEE 1986; PETZ & FOISSNER 1993). Like *Cymatocylis*, *Codonellopsis glacialis* differs from *Codonella* in the dikinetidal composition of the dorsolateral kinety (see below).

Two specimens of *C. glacialis* were found in the protargol slides with a structureless lorica, i.e. without agglutinated particles. One of these loricae was shaped like those of the genus *Ptychocylis* (Figs. 43e, 63; KOFOID & CAMPBELL 1929). A complete life cycle is, however, needed to assess the significance of this observation.

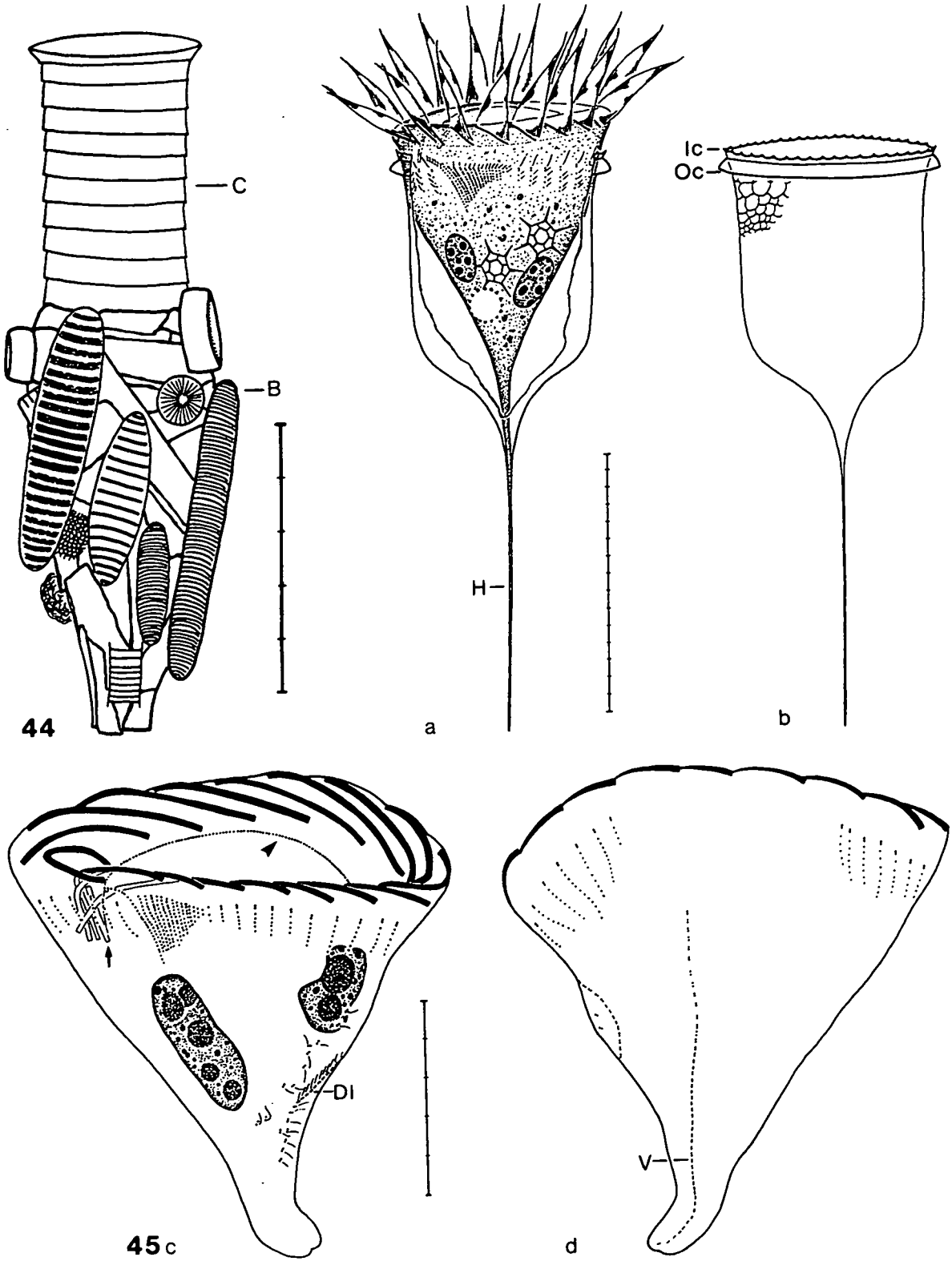
Table 23. Morphometric characteristics of *Codonellopsis glacialis* (upper line, n = 31), *Cymatocylis calyciformis* (middle line, n = 15) and *C. convallaria* (lower line, n = 14); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	46.7	43.0	8.4	1.51	17.9	32	65
	179.5	198.0	60.8	18.32	33.9	94	260
	86.9	84.5	16.0	4.63	18.5	68	118
Body, width	29.8	29.0	4.1	0.74	13.9	22	44
	96.3	95.0	8.5	2.00	8.8	85	114
	71.5	69.5	6.5	1.88	9.1	65	86
Lorica, length	52.0	52.0	3.5	0.63	6.7	42	58
	219.1	231.0	62.6	18.86	28.6	96	296
	92.1	93.0	6.0	1.34	6.5	74	101
Lorica, width	37.9	38.0	4.3	0.77	11.3	30	49
	129.3	130.0	13.3	3.43	10.3	98	150
	100.9	103.0	6.9	1.55	6.9	80	108
Aboral horn, length[1]	–	–	–	–	–	–	–
	124.6	136.5	53.8	14.37	43.2	20	216
	–	–	–	–	–	–	–
Macronuclear nodule, length	9.6	9.5	1.9	0.34	20.0	6	14
	27.2	26.0	5.4	1.43	19.7	21	39
	23.1	23.5	4.6	1.22	19.7	17	30
Macronuclear nodule, width	7.8	8.0	1.4	0.26	18.6	5	10
	15.7	15.5	3.0	0.77	19.0	11	22
	16.0	16.0	2.9	0.74	17.8	11	21
Inner collar, length[2]	11.2	12.0	3.5	0.62	31.0	0	17
	4.7	4.0	1.0	0.26	21.5	4	7
	3.5	3.8	0.7	0.15	19.2	2	5

Table 23 continued.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Apex to cytostome, distance	16.8	17.0	1.9	0.33	11.1	13	21
	26.6	25.5	7.7	2.74	29.1	18	42
	26.6	27.0	4.9	1.35	8.3	19	37
Macronuclei, number	4.0	4.0	0.2	0.03	4.5	3	4
	2.0	2.0	0.0	0.00	0.0	2	2
	2.0	2.0	0.0	0.00	0.0	2	2
External membranelles, number	17.8	18.0	0.4	0.11	2.3	17	18
	17.0	17.0	0.0	0.00	0.0	17	17
	18.0	18.0	0.0	0.00	0.0	18	18
Internal membranelles, number	1.0	1.0	0.0	0.00	0.0	1	1
	1.0	1.0	0.0	0.00	0.0	1	1
	1.0	1.0	0.0	0.00	0.0	1	1
Somatic kineties, number	25.7	26.0	1.1	0.37	4.4	24	28
	45.3	47.0	4.3	1.74	9.4	40	50
	37.0	37.0	0.9	0.29	2.3	36	38
Rows of lateral kinety field, number	9.7	10.0	1.1	0.21	11.1	7	11
	17.0	17.0	1.4	0.58	8.3	15	19
	15.3	15.0	1.0	0.27	6.8	14	17
Rows of left kinety field, number	7.3	7.0	1.2	0.28	16.2	5	10
	14.9	16.0	2.5	0.96	17.1	11	17
	11.9	12.0	0.6	0.18	4.8	11	13
Rows of right kinety field, number	7.3	7.0	1.4	0.39	18.7	6	11
	12.0	12.0	0.8	0.27	6.3	11	13
	8.9	9.0	0.5	0.13	5.8	8	10
Dikinetids of ventral kinety, number	14.6	15.5	3.6	0.80	24.5	9	20
	–[3]	–	–	–	–	–	–
	31.5	32.0	9.0	4.52	28.7	20	42
Dikinetids of dorsolateral kinety, number	11.3	12.0	2.0	0.39	17.7	7	15
	–[3]	–	–	–	–	–	–
	25.6	26.0	4.0	1.81	15.8	21	30

[1] Present only in *Cymatocylis calyciformis*.
[2] Collar in *Codonellopsis glacialis*.
[3] Not enough data.



Laackmanniella naviculaefera (LAACKMANN, 1907) KOFOID & CAMPBELL, 1929

Only very few living specimens of this species were found nor are protargol impregnations available. We include these observations because the lorica is rather distinct and some ecologic data were gathered.

Lorica morphology (Fig. 44): Lorica 121-125 x 40-45 µm, bipartite; collar 42-49 µm long, tubular, anteriorly slightly widened, hyaline, composed of 11 spiralling rings, apical opening about 33 µm across; bowl 76-78 µm long, slightly inflated, posterior portion narrowed, aborally open (about 12 µm in diam.), covered with mineral particles, adhering to these some pennate and centric diatoms (also fragments) and detritus (cf. LAACKMANN 1907, 1910; SASSI & MELO 1986; WASIK & MIKOLAJCZYK 1990).

Occurrence and ecology: Very rarely found in the pelagial (0-20 m depth) between ice floes in the Weddell Sea, between latitude 68° 38'-71° 00' S and longitude 06° 05'-12° 14' W. Occurs together with diatoms, radiolarians, foraminiferans and ciliates (oligotrichs). Environmental parameters in sea water: temperature -0.8 to -0.5°C, salinity 34.1-35.3‰.

Cymatocylis calyciformis (LAACKMANN, 1907) LAACKMANN, 1910

Synonymy: *Cyttarocylis calyciformis* LAACKMANN, 1907; *Cymatocylis brevicaudata* (LAACKMANN, 1910) KOFOID & CAMPBELL, 1929; *Cymatocylis cylindroides* (LAACKMANN, 1910) KOFOID & CAMPBELL, 1929.

Improved diagnosis: Lorica in vivo usually 310-350 (up to 440) x 115-135 µm, cup-shaped, without agglutinated particles. 40-50 somatic, 1 dorsolateral kinety. 17 external, 1 internal adoral membranelle. 2 macronuclei. Marine.

Fig. 44: Lorica of *Laackmanniella naviculaefera* from life.

Figs. 45a-d: *Cymatocylis calyciformis* from life (a, b) and after protargol impregnation (c, d). a: Left lateral view. b: Lorica. Reticulate structure indicated (usually only visible in vivo). c, d: Left and right lateral view of same specimen. Arrowhead marks paroral membrane, arrow points to internal adoral membranelle. Scale bar divisions = 10 µm. B, bowl; C, collar; Dl, dorsolateral kinety; H, aboral horn; Ic, inner collar; Oc, outer collar; V, ventral kinety.

Neotype material: 1 slide of protargol impregnated cells has been deposited.

Redescription (Figs. 45a-e, Table 23): Lorica cup-shaped, aboral horn (posterior prolongation) usually long, pointed, inner collar always serrated, outer collar bent backwards; at high magnification, wall in vivo with fine reticulate texture, mesh size up to 7 µm, decreasing posteriad, generally not visible in protargol slides; lorica, however, with numerous argentophilic dots, ca. 0.5 µm across (Figs. 45a, b; LAACKMANN 1907, 1910).

Body usually fills about half of lorica; stalk extends into aboral horn, contractile. Macronuclei generally in posterior half of body, ellipsoid, with few spherical nucleoli (1-8 µm across). Micronuclei not impregnated with protargol. Very likely single, contractile vacuole in posterior half of body; pulsation not observed. Cytoplasm contains greasily shining globules, few irregular reddish inclusions (digested prey?), globular inclusions (2-3 µm across in protargol slides) and food vacuoles with usually radiolarians (30-50 µm across), rarely ciliates, diatoms and unidentified green contents. Radiolarian skeletons often found outside of zooid in posterior portion of lorica. Movement swimming moderately fast, twitches back on obstacles; zooid contracts jerkily when slightly disturbed, remains in posterior portion of lorica for a while; may leave lorica.

Somatic kineties generally longitudinal, differing in length, composed mainly of monokinetids (Figs. 45c-e). Ventral kinety distinctly right of oral cavity, consists of about 54 dikinetids, posterior basal bodies each with single cilium (about 4 µm long). Lateral field of kineties (rows 17-33) immediately left of oral cavity, composed of closely spaced rows of monokinetids, 1-36 basal bodies/kinety, cilia about 1.5 µm long. Single dorsolateral kinety extends almost to left field of kineties, composed of about 32 dikinetids, only posterior basal body each with 1 cilium (ca. 8 µm long). Some scattered dikinetids left and right of dorsolateral kinety, only posterior basal body each with cilium (5-6 µm long). Other kineties, i.e. rows 2-16 (left field; 4-15 basal bodies/row) and 34-45 (right field; 6-9 basal bodies/row) each with ciliated dikinetid at anterior end, cilia 8-12 µm long; other cilia 2-8 µm long (Figs. 45c-e). No ventral organelles.

Adoral zone of membranelles forms closed spiral; bases very narrow, perhaps only composed of 2 basal body rows each, 36-44 µm long, cilia 45-52 µm long; 3 membranelles gradually elongated, extending into oral cavity, longest bases 46-52

µm. Single internal adoral membranelle composed of 2 basal body rows, base 20-24 µm long. Paroral membrane single-rowed, 65-75 µm long, extends across anterior surface into oral cavity, cilia about 10 µm long (Fig. 45c). Oral cavity acentric, anterior surface sometimes vaulted.

Numerous divisional stages in field material; morphogenesis enantiotropic, oral anlage develops within cell, adoral zone of proter and opisthe inverted 180° in some stages (not illustrated).

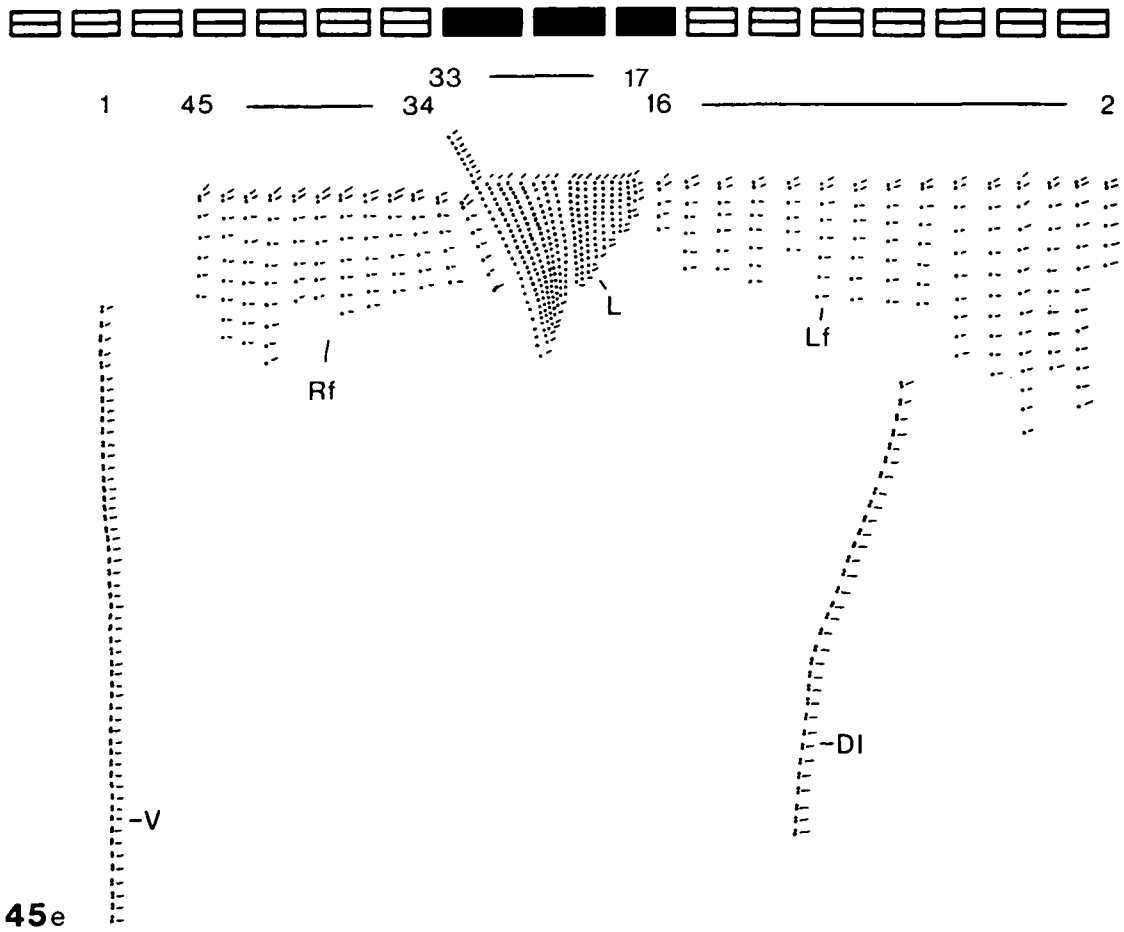


Fig. 45e: *Cymatocylis calyciformis* (protargol impregnation). Diagram of interphasic infraciliature (based on average number of kineties); ciliation exemplified. Dl, dorsolateral kinety; L, lateral field of kineties; Lf, Rf, left and right field of kineties, respectively; V, ventral kinety

Occurrence and ecology: Found once in moderate numbers in the pelagial (0-20 m depth) of the Weddell Sea, latitude 68° 38' S, longitude 06° 05' W.

Occurs together with diatoms, radiolarians and ciliates (oligotrichs). Environmental parameters in sea water: temperature -0.8°C, salinity 34.1‰. Biomass of 10^6 individuals: 318 mg.

Comparison with related species: The lorica shape matches that of *C. calyciformis* (LAACKMANN 1907; WILLIAMS et al. 1994). The length of the aboral horn is, however, highly variable (Table 23).

The infraciliature of *C. calyciformis* is codonellid. It differs from that of *C. convallaria* in the number of external adoral membranelles (17 vs. 18) and somatic kineties (40-50 vs. 36-38).

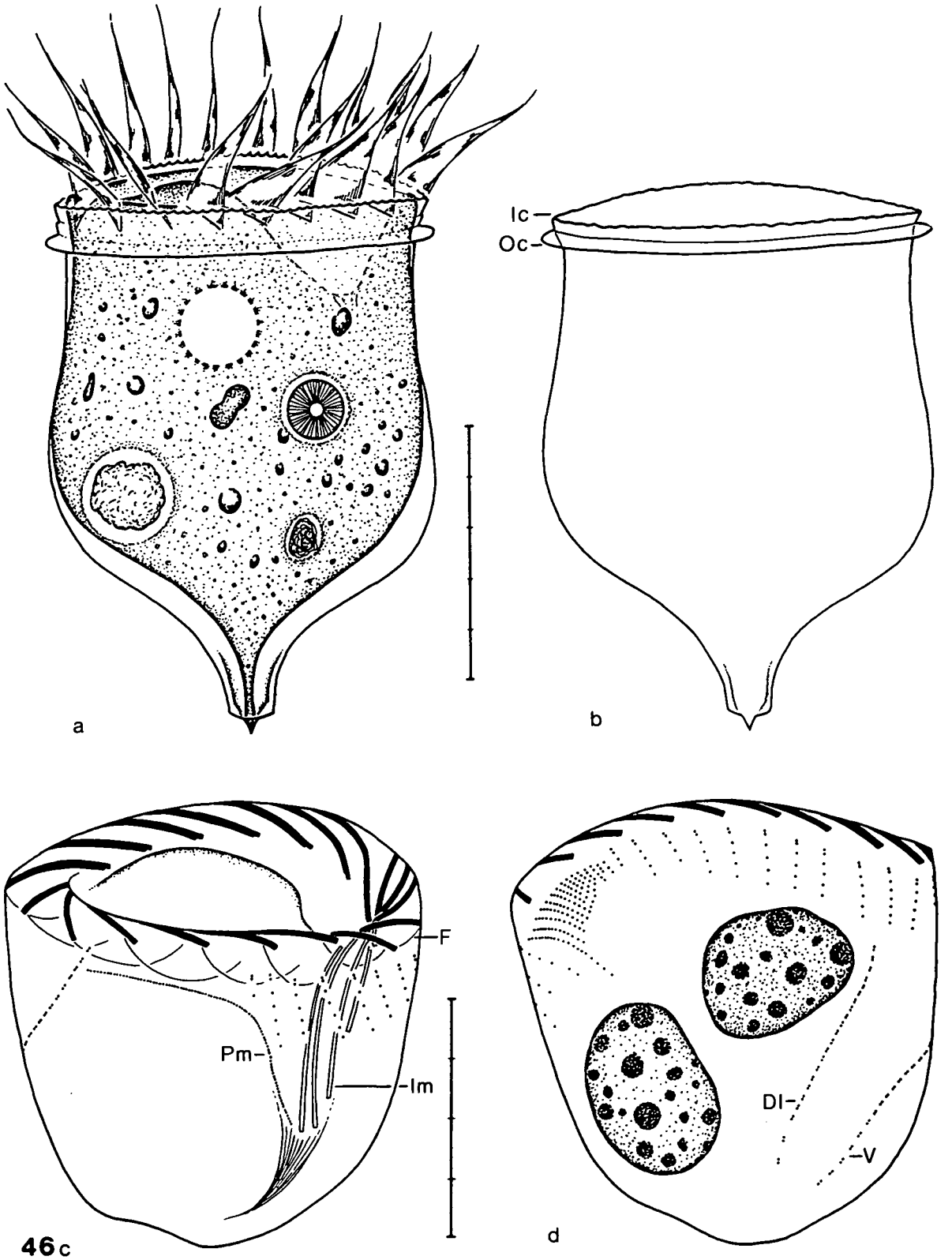
Cymatocylis convallaria LAACKMANN, 1910

Synonymy: *Cymatocylis affinis* LAACKMANN, 1910; *Cymatocylis affinis/convallaria* LAACKMANN, 1910 – BOLTOVSKOY & ALDER (1992), BOLTOVSKOY et al. (1990), WASIK & MIKOLAJCZYK (1994a,b); *Cymatocylis gaussi* (LAACKMANN, 1910) KOFOID & CAMPBELL, 1929; *Cymatocylis scyphus* (LAACKMANN, 1910) KOFOID & CAMPBELL, 1929; *Cymatocylis urnula* (LAACKMANN, 1910) KOFOID & CAMPBELL, 1929.

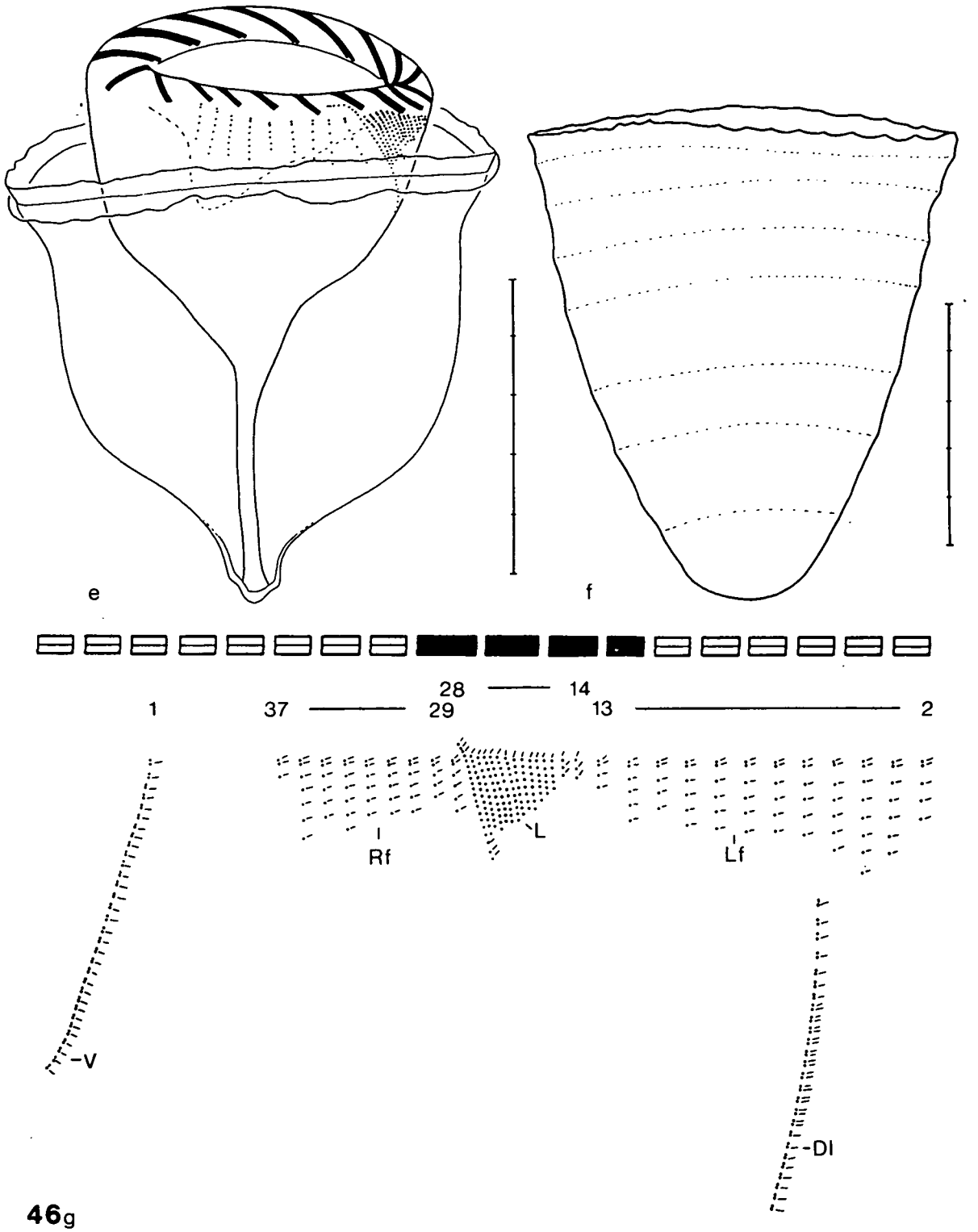
According to lorica morphology, some other tintinnids, e.g. *Cyttarocylis parva* LAACKMANN, 1907; *Cymatocylis parva* (LAACKMANN, 1907) LAACKMANN, 1910; *Amphorella antarctica* CLEVE, 1901; *Tintinnus antarcticus* (CLEVE, 1901) BRANDT, 1907; *Cyttarocylis antarctica* (CLEVE, 1901) LAACKMANN, 1910; *Cymatocylis antarctica* (CLEVE, 1901) KOFOID & CAMPBELL, 1929; *Cyttarocylis obscura* BRANDT, 1906; *Craterella obscura* (BRANDT, 1906) KOFOID & CAMPBELL, 1929; *Amphorella oxyura* JOERGENSEN, 1924; *Craterella oxyura* (JOERGENSEN, 1924) KOFOID & CAMPBELL, 1929, might also be synonymous with *Cymatocylis convallaria* (cf. JÖRGENSEN 1924).

BOLTOVSKOY & ALDER (1992) supposed a synonymy of the much larger *Cymatocylis drygalskii* (LAACKMANN, 1907) LAACKMANN, 1910 with *C. convallaria*. Based on a morphometric analysis of loricae, WILLIAMS et al. (1994) suggest that *C. convallaria* and *C. parva* are separate species. Protargol impregnations are thus urgently needed.

Improved diagnosis: Lorica in vivo about 80-140 x 85-120 µm, usually bell-shaped, without agglutinated particles. 36-38 somatic, 1 dorsolateral kinety. 18 external, 1 internal adoral membranelle. 2 macronuclei. Marine.



Figs. 46a-d: *Cymatocylis convallaria* from life (a, b) and after protargol impregnation (c, d). a: Right lateral view. b: Lorica. c, d: Right ventro- and left dorsolateral view of same specimen outside lorica. Scale bar divisions = 10 µm. F, fibres; Dl, dorsolateral kinety; Ic, inner collar; Im, internal adoral membranelles; Oc, outer collar; Pm, paroral membrane; V, ventral kinety.



46g

Fig. 46e-g: *Cymatocylis convallaria* (protargol impregnation). e: Right lateral view of specimen in lorica (early divider). f: Ptychocyliform lorica. g: Diagram of interphasic infraciliature (based on average number of kineties); ciliation indicated. Scale bar divisions = 10 µm. Dl, dorsolateral kinety; L, lateral field of kineties; Lf, Rf, left and right field of kineties, respectively; V, ventral kinety.

Neotype material: 1 neotype- and a 2nd slide of protargol impregnated specimens have been deposited.

Redescription (Figs. 46a-f, Table 23): Lorica aborally blunt to pointed; inner collar serrated, wavy or smooth, outer collar usually bent downwards in vivo (Figs. 46a, b, e; LAACKMANN 1910). Lorica with many tiny argentophilic dots in protargol slides (not illustrated).

Body sometimes fills entire lorica; posteriorly with stalk, attaches to inside of lorica, occasionally rather long, contractile; individuals outside of lorica hemispherical (Figs. 46c-e). Macronuclei ellipsoid, about in mid-body, contain circular nucleoli (1-3 µm across). Micronuclei not impregnated with protargol. Very likely 1 contractile vacuole, laterally in anterior body half, pulsation not observed. Cytoplasm contains numerous greasily shining globules, sometimes reddish inclusions (very likely digested food) and food vacuoles with mainly pennate (20-53 µm long) and, less frequently, centric diatoms and green contents (flagellates?). Do not swim fast; specimens sometimes attach to slide with adoral zone of membranelles, i.e. upside down; zooid leaves lorica when disturbed.

Somatic kineties usually longitudinal, of differing length, most composed of monokinetids (Figs. 46c, d, g). Ventral kinety right of oral cavity, always distinctly arched (preparation artifact?), consists of dikinetids, usually posterior basal body with single, long cilium (about 10 µm); once in anterior portion both basal bodies ciliated. Lateral field of kineties (rows 14-28) left of oral cavity, composed of monokinetids in closely spaced rows, 2-23 basal bodies/kinety, cilia ca. 2 µm long. Single dorsolateral kinety extending from posterior pole almost to left field of kineties; composed of dikinetids, rarely apparently also few monokinetids, in middle portion both basal bodies with cilium (ca. 2.5 µm long), anteriorly and posteriorly only posterior kinetosomes with 1 cilium each (4-5 µm long). Other kineties, i.e. rows 2-13 (left field; 3-7 basal bodies/row, cilia 8-10 µm long) and 29-37 (right field; 2-6 basal bodies/row, cilia 2-5 µm long) each with ciliated dikinetid at anterior end (Fig. 46g). No ventral organelles.

Adoral zone of membranelles forms closed spiral; bases of membranelles composed of 3 basal body rows, 16-29 µm long, cilia about 30 µm long; 3-5, usually 4, membranelles elongated, extending into oral cavity, longest bases 34-46 µm. Single internal adoral membranelle very likely composed of 3 basal body rows, base 25-35

µm long, cilia about 7 µm long. Paroral membrane single-rowed, on right in oral cavity (Fig. 46c). Oral cavity acentric, rather large. Pharyngeal fibres 30-40 µm long.

Many dividers occurred in field samples; division enantiotropic, anarchic field apparently originates on cell surface posterior to lateral kinety field; oral anlage subsequently invaginates and develops intracellularly (not illustrated). In early dividers, somatic kineties with more basal bodies than in interphasic specimens (Fig. 46e).

Occurrence and ecology: Frequently found in the pelagial (0-20 m depth) of the Weddell Sea between latitude 68° 32'-70° 20' S and longitude 06° 05'-12° 14' W. Occurs together with diatoms, radiolarians, foraminiferans and ciliates (oligotrichs). Environmental parameters in sea water: temperature -1.2 to -0.5°C, salinity 34.1-34.2‰. Biomass of 10^6 individuals: 176 mg.

Comparison with related species: The lorica corresponds well with that of *C. convallaria* and *C. affinis* (BOLTOVSKOY et al. 1990; LAACKMANN 1910; SASSI & MELO 1986; WASIK & MIKOLAJCZYK 1990, 1992, 1994a,b; WILLIAMS et al. 1994). These species differ only in the thickness of the outer collar of the lorica and the shape of the aboral end, i.e. pointed or not (LAACKMANN 1910). These characters are rather variable in our population (cf. BOLTOVSKOY et al. 1990; WASIK & MIKOLAJCZYK 1994a,b; WILLIAMS et al. 1994), whereas the infraciliature of these specimens is identical. We could not find other differences and thus consider these species synonymous as already proposed (BOLTOVSKOY et al. 1990). LAACKMANN (1910) described *C. convallaria* before *C. affinis*, thus the latter is the junior synonym (ICZN 1985). The use of the combination *C. affinis/convallaria* is not according to the ICZN (1985).

The loricae of *C. convallaria* found by SASSI & MELO (1986) are slightly larger than in this study, viz. 102-138 x 78-99 µm vs. 74-101 x 80-108 µm. The infraciliature of the present population is very similar to that found by WASIK & MIKOLAJCZYK (1994a). Dikinetid numbers of row 28, ventral and dorsolateral kinety are, however, considerably lower in our specimens (20-42 vs. 50-66). These higher numbers might be derived from dividing specimens because these do not correspond with the kinety diagram provided (WASIK & MIKOLAJCZYK 1994a: Fig. 2, Table 1). The rightmost row of the lateral kinety field is designated ventral kinety by WASIK & MIKOLAJCZYK (1994a). This row is, however, not homologous with the ventral kinety of other

tintinnids, e.g. *Codonella cratera* (FOISSNER & WILBERT 1979; PETZ & FOISSNER 1993).

The infraciliature of *C. convallaria* and *C. calyciformis* is rather similar to that of *Codonella* (cf. FOISSNER & WILBERT 1979; LAVAL-PEUTO & BROWNLEE 1986; PETZ & FOISSNER 1993). It differs mainly in the dikinetidal composition (vs. monokinetidal) and the slightly different location of the dorsolateral row (thus designated ventrolateral in *Codonella*).

A single specimen of *C. convallaria* was found in the slides with a goblet-shaped lorica, i.e. rather similar to that of *Ptychocylis drygalskii* BRANDT, 1896, *P. glacialis* MEUNIER, 1910, *P. media* MEUNIER, 1910 and *P. ventricosa* MEUNIER, 1910 (Fig. 46f). WILLIAMS et al. (1994) found, rarely, coxliellíform loricae in *Cymatocylis*.

Order Hypotrichida STEIN, 1859a

Holosticha foissneri nov. spec.

Diagnosis: In vivo about 130-170 x 40 µm, elongate. Contractile vacuole subequatorial. Left marginal row with usually 4 transversely arranged cirri at anterior end. 2 frontoterminal, 1 buccal and 9-17 transverse cirri. Midventral row extending to transverse cirri. 4 dorsal kineties. Adoral zone bipartite, consists of 26-36 membranelles. Usually 8 macronuclear nodules in right half of cell. Marine.

Type location: Sea ice of Weddell Sea, Antarctica, 69° 46' S, 11° 00' W (core number AN 103115a).

Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Dedication: We dedicate this new species to Professor Dr. Wilhelm FOISSNER, University of Salzburg, Austria, as a small token of appreciation for his support and friendship over many years.

Description (Figs. 47a-d, Table 24): Shape elongate to slightly fusiform, left and right body margin convex, anteriorly and posteriorly narrowly rounded (Fig. 47a). Dorso-ventrally slightly flattened 2:1 (Fig. 47d). Macronuclear nodules

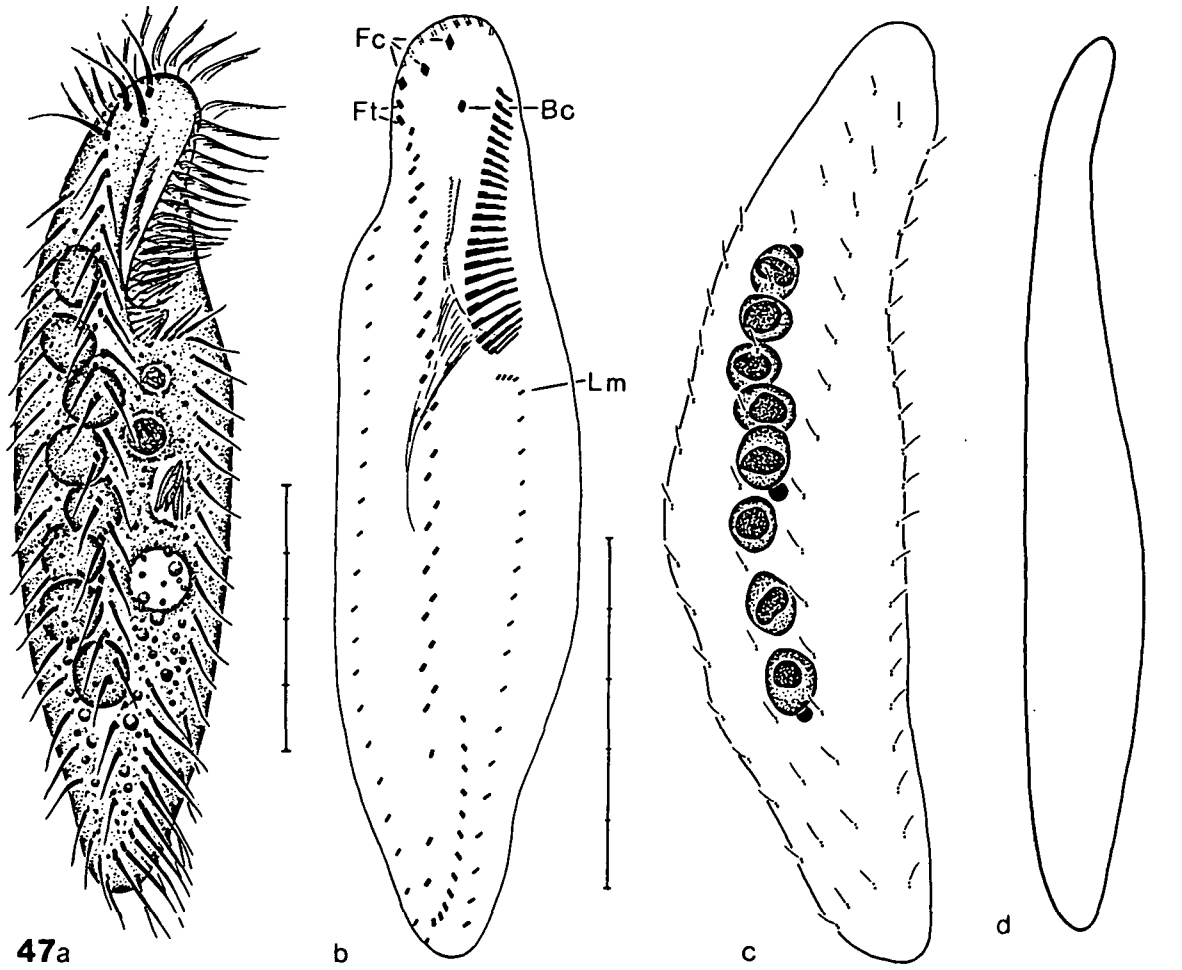
globular, in vivo about 10 µm across, lined up posterior of adoral zone on right side, usually with 1 large nucleolus each, 5-7 µm across. Rarely specimens with more than 8 (once; reorganizer or divider?) or fewer macronuclear nodules (apparently fused, i.e. 1 larger nodule with 2 large nucleoli or replication band). Micronuclei lenticular to globular, in indentation of macronuclear nodules; lightly stained with protargol. Contractile vacuole subequatorial, near median of cell, pulsation, however, not observed (Fig. 47a). Cytoplasm hyaline, contains many colourless globules 3-5 µm across. Food vacuoles ca. 13 µm in diam., contain small pennate diatoms and green debris (very likely flagellates). Movement slowly crawling on substrate, sometimes jerking back and forth; thigmotactic.

Marginal rows posteriorly almost confluent, cirri 16-18 µm long, bases composed of 2 basal body rows; left row with 3-4 transversely arranged cirri at anterior end (Fig. 47b). 3 frontal and single buccal cirrus slightly enlarged, buccal cirrus distinctly anterior of undulating membranes. Frontoterminal cirri between right end of adoral zone of membranelles and midventral row, bases 3-rowed (Fig. 47b). Midventral row composed of oblique pairs of cirri, posteriorly usually with 3 single cirri, extends to J-shaped row of transverse cirri. Dorsal kinety 1 (leftmost) slightly shortened anteriorly, others extending over whole length of body, cilia 2.5-3.5 µm long, widely spaced, 13-20 cilia per row; no caudal cirri (Fig. 47c).

Buccal field narrow. Adoral zone of membranelles about 35-39% of body length, bipartite by 3-7 µm wide gap in anterior third, 7-13 membranelles in anterior portion, 17-24 membranelles in posterior; size of membranelles increases proximally, largest bases about 8 µm long, cilia ca. 17 µm long. Undulating membranes short, almost parallel, equally long, double-rowed paroral crosses very likely single-rowed endoral membrane. Pharyngeal fibres about 30 µm long (Fig. 47b).

Occurrence and ecology: Frequently found in the endopagial of pancake and, more often, multiyear sea ice (brown layer) of the Weddell Sea, between latitude 69° 02'-71° 00' S and longitude 08° 02'-11° 80' W. Up to 4 000 active ind./l melted ice were found (biomass 0.3 mg/l), comprising up to 6% of the total ciliate community. Environmental parameters in brine: temperature -3.4 to -3.0°C, salinity 51.8-59.1‰; in melted ice: PO_4 2.8 µmol/l, NO_3 6.1 µmol/l, NH_4 3.5 µmol/l, Si 14.8 µmol/l, chlorophyll *a* 11.1-80.1 µg/l. In raw cultures also at a salinity of 15.6-21.3‰ and +1°C; does not burst at higher, e.g. room, temperature. Biomass of 10^6 individuals: 80 mg.

Comparison with related species: See *H. spindleri*.



Figs. 47a-d: *Holosticha foissneri* from life (a, d) and after protargol impregnation (b, c). a: Ventral view. b, c: Ventral and dorsal view. d: Lateral view. Scale bar divisions = 10 µm. Bc, buccal cirrus; Fc, frontal cirri; Ft, frontoterminal cirri; Lm, left marginal row.

Footnotes to Table 24.

[1] Anterior nodule of *H. pullaster*.

[2] Posterior nodule of *H. pullaster*.

[3] Anterior nodule of *N. parvulus*.

[4] Posterior nodule of *N. parvulus*.

[5] Not enough data.

[6] Not determined.

[7] n = 10.

[8] Pairs and single cirri, respectively.

Table 24. Morphometric characteristics of *Holosticha pullaster* (first line, n = 23), *H. foissneri* (second line, n = 23), *H. spindleri* (third line, n = 30) and *Notocephalus parvulus* (fourth line, n = 3); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	48.2	48.0	5.9	1.24	12.3	36.0	59
	134.1	130.0	22.5	4.69	16.8	93.0	174
	139.9	139.0	27.5	5.02	19.6	86.0	208
	151.0	153.0	16.1	9.29	10.7	134.0	166
Body, width	21.8	22.0	3.6	0.80	16.5	14.0	28
	40.4	39.0	8.7	1.95	21.6	29.0	55
	45.9	42.0	15.3	3.05	33.3	25.0	84
	58.0	58.0	15.6	11.00	26.8	47.0	69
Macronuclear nodule, length	11.3[1]	11.0	2.6	0.55	23.2	7.0	18
	10.1[2]	10.5	1.9	0.41	18.8	6.0	14
	10.7	11.0	3.3	0.62	31.0	6.5	20
	16.8	16.5	3.9	0.71	23.2	11.0	26
	25.7[3]	27.0	2.3	1.33	9.0	23.0	27
	26.7[4]	26.0	2.1	1.20	7.8	25.0	29
Macronuclear nodule, width	6.6[1]	6.0	1.4	0.29	20.8	5.0	11
	6.8[2]	6.5	1.4	0.30	21.2	5.0	12
	8.7	8.0	2.2	0.42	25.9	6.0	13
	12.3	12.0	2.5	0.46	20.5	8.0	17
	15.0[3]	14.0	2.7	1.53	17.6	13.0	18
	12.7[4]	13.0	2.5	1.45	19.9	10.0	15
Micronucleus, length	–[5]	–	–	–	–	2.0	2
	2.7	3.0	0.4	0.10	15.0	2.0	3
	2.4	2.5	0.3	0.06	14.0	2.0	3
	8.8	9.0	0.4	0.17	4.8	8.0	9
Micronucleus, width	–[5]	–	–	–	–	2.0	2
	2.4	2.3	0.5	0.11	18.9	2.0	3
	2.4	2.5	0.3	0.06	14.0	2.0	3
	5.3	5.0	1.2	0.48	21.9	4.0	7
Adoral zone of membranelles, length	18.4	17.5	2.4	0.52	13.3	14.0	25
	48.4	48.0	7.8	1.88	16.1	36.0	61
	51.9	54.0	9.4	2.21	18.1	30.0	64
	66.0	66.0	2.8	2.00	4.3	64.0	68
Adoral membranelle n–1, length	–[6]	–	–	–	–	–	–
	7.5	7.0	1.1	0.34	14.4	6.0	8
	9.5	10.0	1.3	0.32	13.2	8.0	12
	–[6]	–	–	–	–	–	–
Adoral membranelle n, length	–[6]	–	–	–	–	–	–
	6.8	7.0	0.8	0.25	11.6	6.0	8
	19.2	20.0	4.1	0.99	21.2	11.0	28
	–[6]	–	–	–	–	–	–

Table 24 continued.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Undulating membranes, length	6.5	6.5	0.8	0.20	11.7	5.0	8
	22.0	23.0	4.5	1.24	20.2	14.0	28
	21.8	22.0	5.6	1.31	25.6	11.0	35
	51.3	49.0	4.0	2.33	7.9	49.0	56
Macronuclear nodules, number	2.0	2.0	0.0	0.00	0.0	2.0	2
	7.5	8.0	1.1	0.22	15.2	5.0	11
	3.7	4.0	0.7	0.13	18.5	1.0	4
	2.0	2.0	0.0	0.00	0.0	2.0	2
Micronuclei, number	–[5]	–	–	–	–	2.0	2
	3.2[7]	3.0	1.0	0.33	32.3	2.0	6
	3.3	4.0	0.9	0.24	27.8	2.0	4
	2.0	2.0	0.0	0.00	0.0	2.0	2
Adoral membranelles, number	18.4	19.0	2.5	0.56	13.6	10.0	21
	32.1	32.0	2.9	0.63	9.0	26.0	36
	35.8	37.0	4.0	0.73	11.2	22.0	43
	56.5	56.5	2.1	1.50	3.8	55.0	58
Frontoterminal cirri, number	2.0	2.0	0.0	0.00	0.0	2.0	2
	2.1	2.0	0.3	0.08	13.4	2.0	3
	2.0	2.0	0.0	0.00	0.0	2.0	2
	0.0	0.0	0.0	0.00	0.0	0.0	0
Transverse cirri, number	6.7	6.5	0.8	0.22	11.7	6.0	8
	11.5	11.0	2.5	0.70	22.0	9.0	17
	10.8	11.0	1.7	0.32	16.0	7.0	14
	5.7	5.0	1.2	0.67	20.4	5.0	7
Left marginal cirri, number	9.5	9.0	1.1	0.27	11.2	9.0	12
	21.6	21.0	2.0	0.67	9.3	20.0	26
	22.2	22.0	2.1	0.41	9.4	19.0	26
	–[6]	–	–	–	–	–	–
Right marginal cirri, number	10.0	10.0	0.7	0.24	7.1	9.0	11
	23.4	23.0	2.0	0.71	8.5	21.0	27
	21.7	22.0	3.0	0.59	13.8	11.0	26
	–[6]	–	–	–	–	–	–
Midventral cirral pairs, number[8]	10.1	10.0	0.4	0.13	3.5	10.0	11
	17.7	17.0	1.3	0.38	7.4	16.0	20
	13.5	14.0	2.1	0.47	15.8	9.0	17
	6.7	6.0	2.1	1.20	31.2	5.0	9
Dorsal kineties, number	4.2	4.0	0.4	0.11	9.3	4.0	5
	4.0	4.0	0.0	0.00	0.0	4.0	4
	4.1	4.0	0.3	0.07	7.3	4.0	5
	3.0	3.0	0.0	0.00	0.0	3.0	3

***Holosticha spindleri* nov. spec.**

Diagnosis: In vivo about 100-115 x 45 µm, elongate. Contractile vacuole equatorial. Left marginal row with 4-8 transversely arranged cirri anteriorly. 2 frontoterminal, 1 buccal and 7-14 transverse cirri. Midventral row long. Usually 4 dorsal kineties. Adoral zone bipartite, consists of 22-43 membranelles, posteriormost membranelle distinctly elongate. 4 macronuclear nodules in right body half. Marine.

Type location: Sea ice of Weddell Sea, Antarctica, 70° 21' S, 08° 53' W (core number AN 103107b).

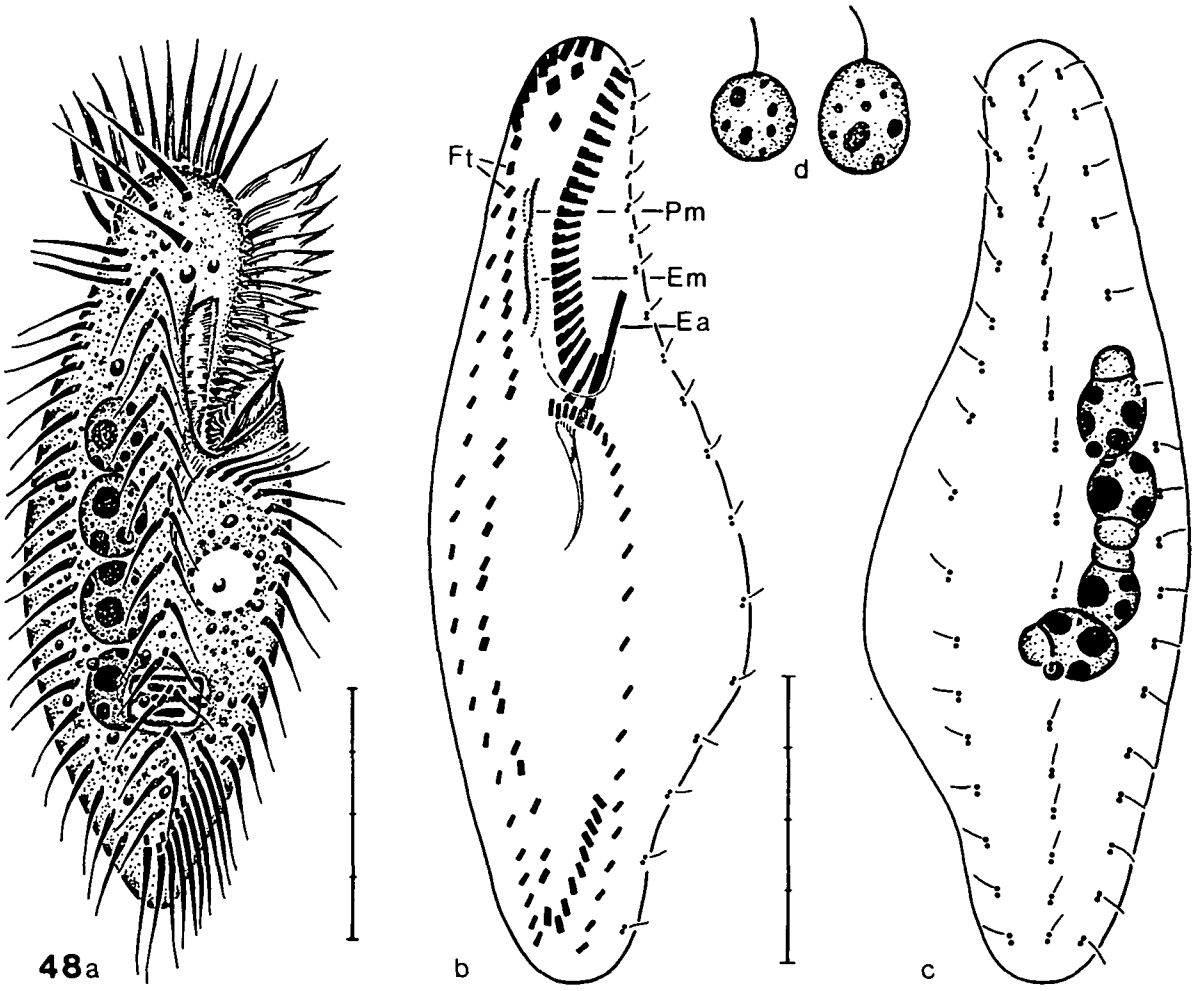
Type specimens: 1 holotype and 1 paratype as 2 slides of protargol impregnated cells have been deposited.

Dedication: We dedicate this new species to Professor Dr. Michael SPINDLER, University of Kiel, Germany, in recognition of his support of our Antarctic investigations.

Description (Figs. 48a-d, 59, 60, Table 24): Right and left body margin convex, anteriorly rounded, tapering posteriorly (Fig. 48a). Dorso-ventrally flattened about 1.5:1. Specimens rather fragile, i.e. burst easily. Macronuclear nodules closely spaced, arranged in a row along right side, slightly ellipsoid, with few large nucleoli (4-7 µm across). Usually 4 globular micronuclei, rarely lenticular, each attached to a macronuclear nodule. Contractile vacuole in or slightly behind mid-body, near left margin. Cytoplasm contains many slightly greenish shining globules (2-3 µm in diam.), small and larger pennate and centric diatoms and occasionally green flagellates. Movement crawling on substrate.

Marginal rows almost confluent posteriorly, bases consist of 2 rows of kinetids, cirri 13-20 µm long; anteriormost cirri of left row densely spaced, transversely arranged, immediately behind adoral zone of membranelles. 3 frontal and single buccal cirrus slightly enlarged, bases 4- to 5-rowed, cirri ca. 17 µm long. Buccal cirrus distinctly anterior of undulating membranes. Frontoterminal cirri between right end of adoral zone of membranelles and anterior terminus of midventral row, bases 2- to 3-rowed, cirri ca. 17 µm long. Midventral row composed of oblique pairs of cirri, generally a single cirrus before last pair, extending to J-shaped row of transverse cirri; bases 2- or 3-rowed, cirri ca. 13 µm long (Fig. 48b). Generally 4, very rarely 5, dorsal kineties extending over entire length of cell, about 16-20 cilia (2.5-6 µm long) per row; no

caudal cirri (Fig. 48c). In protargol stained specimens, often numerous small (2-3.5 µm across) globules with hair-like process (2-3 µm long) positioned along dorsal kineties, nature unknown (extrusomes, parasites?; Figs. 48d, 59).



Figs. 48a-d: *Holosticha spindleri* from life (a) and after protargol impregnation (b-d). a: Ventral view. b, c: Ventral and dorsal view of same specimen. d: Enigmatic structures along dorsal kineties. Scale bar divisions = 10 µm. Ea, elongate adoral membranelle; Em, endoral membrane; Ft, frontoterminal cirri; Pm, paroral membrane.

Buccal field narrow. Adoral zone of membranelles 31-35% of body length, bipartite by ca. 3 µm wide gap; 4-18, on average 14 membranelles in anterior portion, 17-26 membranelles in posterior (zone slightly C-shaped in protargol slides); shortest bases about 3 µm, proximally gradually lengthened, composed of 4 basal body rows, cilia 13-21 µm long (Fig. 59). Posteriormost adoral membranelle distinctly elongate, twice as long as adjacent membranelle (Figs. 48b, 60, Table 24). Undulating membranes

short, almost parallel, about equally long; 2-rowed paroral optically crosses single-rowed endoral membrane, cilia about 7 µm long. Pharyngeal fibres about 15-30 µm long.

Occurrence and ecology: As *H. foissneri*, but less frequently found between latitude 69° 26'-70° 21' S and longitude 07° 19'-11° 00' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates, e.g. *H. foissneri*. Environmental parameters in brine (1 measurement): temperature -3.4°C, salinity 59.1‰; in melted ice: chlorophyll *a* 49.3 µg/l. In raw cultures also at +1°C and a salinity of 21.3‰. Biomass of 10^6 individuals: 75 mg.

Comparison with related species: An oblique anterior portion in the left marginal row has been described in *H. foissneri*, *H. spindleri*, *H. kessleri* (WRZESNIOWSKI, 1877) WRZESNIOWSKI, 1877, *H. diademata* (REES, 1884) KAHL, 1932, *H. pullaster* (MUELLER, 1773) FOISSNER et al., 1991 and *Holosticha* sp. (FENCHEL & LEE 1972). *Holosticha* sp. and *H. pullaster* differ from *H. foissneri* and *H. spindleri* in size, number of macronuclear nodules (only 2) and/or shape of the adoral zone (FENCHEL & LEE 1972; FOISSNER et al. 1991; see below). The macronuclear position of *H. foissneri*, *H. spindleri* and *H. pullaster*, viz. in right body half, is rather unusual for holostichids.

The elongate posteriormost adoral membranelle is a unique character for *H. spindleri*. We could find no other holostichid in the literature having this peculiarity. *Holosticha extensa* KAHL, 1932 is distinguished from *H. foissneri* in the ruler-like shape, macronuclear position (on left vs. on right side), longer dorsal cilia and fewer transverse cirri (6-7); contractile vacuole position not given (KAHL 1932, 1933). *Holosticha mancoidea* HEMBERGER, 1985 occurs in freshwater, has fewer dorsal kineties (viz. 3) and a shorter midventral row and the contractile vacuole is located in the anterior body half.

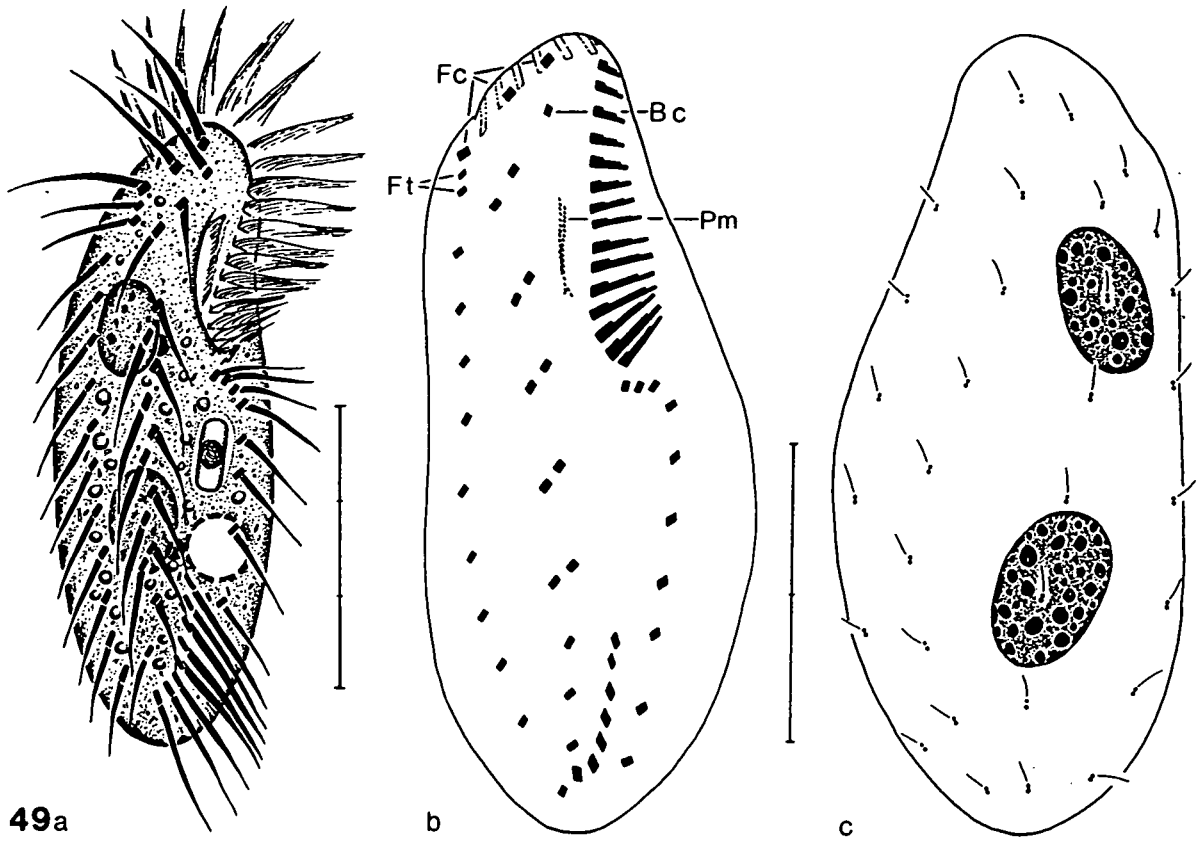
Holosticha pullaster (MUELLER, 1773) FOISSNER et al., 1991

Remarks: BORROR & WICKLOW (1983) assumed that morphologically identical populations of urostylines do not occur in fresh- and seawater. *Holosticha pullaster* is widespread in freshwater habitats but occurs also in salt water (for review see FOISSNER et al. 1991). A detailed description of a marine population of this species is thus presented here.

Morphology and infraciliature (Figs. 49a-c, Table 24): In vivo about 50-70 x 20-26 µm. Outline elliptical, anteriorly rounded, posteriorly sometimes tapering (Fig. 49a). Dorso-ventrally flattened about 1.5:1. Macronuclear nodules ellipsoid, about 10 x 5 µm, positioned in centre or in right body half, with several small globular nucleoli (up to 4 µm across). Micronuclei spherical, 2 µm in diam., each in indentation of a macronuclear nodule; usually not impregnated with protargol. Contractile vacuole near left border, behind mid-body, with inconspicuous collecting canals, pulsation interval about 15 minutes. Cytoplasm hyaline, contains small greasily shining globules and food vacuoles with pennate diatoms (6-12 µm long) and unidentified greenish contents. Movement slowly crawling on substrate, rests for long periods, sometimes jerking back and forth short distances; thigmotactic, i.e. not easily removable from solid surface with pipette.

Marginal rows not confluent posteriorly, cirri 8-12 µm long, left row with 3 transversely arranged cirri at anterior end, immediately behind proximal end of adoral zone (Fig. 49b). 3 slightly enlarged frontal cirri, single buccal cirrus distinctly before undulating membranes. Frontoterminal cirri between right end of adoral zone of membranelles and anterior end of right marginal row. Midventral row extends to transverse cirri, composed of oblique pairs of cirri, sometimes last 3-4 „pairs" with 1 cirrus only. Transverse cirri in J-shaped row, 10-17 µm long. Dorsal kinety 1 (leftmost) usually slightly shortened anteriorly, others extending over entire length of body, mid-dorsal rows composed of 9-11, others of 6-9 dikinetids, each with single cilium (2-3 µm long). No caudal cirri (Fig. 49c).

Adoral zone of membranelles about 38% of body length, bipartite, 3-8 (usually 6) membranelles on anterior dorsal side, 7-16 membranelles on ventral side, separated by 3-5 µm wide gap; bases 3-7 µm long, gradually lengthened posteriad, cilia 11-13 µm long. Undulating membranes short, about equally long, paroral membrane optically crosses endoral. Pharyngeal fibres 8-13 µm long (Fig. 49b).



Figs. 49a-c: *Holosticha pullaster* from life (a) and after protargol impregnation (b, c). a: Ventral view. b, c: Ventral and dorsal view of same specimen. Scale bar divisions = 10 µm. Bc, buccal cirrus; Fc, frontal cirri; Ft, frontoterminal cirri; Pm, paroral membrane.

Occurrence and ecology: Common in the endopagial, mainly in the brown layer, of multiyear and pancake sea ice of the Weddell Sea, between latitude 68° 38'-70° 21' S and longitude 06° 05'-11° 00' W. Up to 12 405 active ind./l melted ice were found (biomass 0.16 mg/l), comprising up to 41% of the total ciliate community; only multiyear sea ice: $\bar{x}$ = 5 819 ind./l (n = 5), sometimes dominant. Occurs together with a variety of other organisms, e.g. diatoms, flagellates and ciliates. Environmental parameters in brine: temperature -3.4 to -3.0°C, salinity 51.8-59.1‰, NO_3 7.2 µmol/l, Si 17.2 µmol/l; in melted ice: PO_4 2.8 µmol/l, NH_4 3.5 µmol/l, chlorophyll *a* 4.3-80.1 µg/l. In raw cultures also at a salinity of 21.3‰ and +1°C. Does not burst at higher, e.g. room, temperature. Biomass of 10^6 individuals: 13 mg.

Comparison with related species: The Antarctic specimens differ slightly from saltwater and limnetic populations of *H. pullaster* in being smaller (36-

59 µm vs. 50-90 µm) and having fewer adoral membranelles (10-21 vs. 20-28) and right marginal cirri (9-11 vs. 11-16; FOISSNER 1980; FOISSNER et al. 1991; FROMENTEL 1876; PÄTSCH 1974; TUCOLESCO 1962b; WANG & NIE 1932; WILBERT & KAHAN 1981). These apparently size-dependent characters are, however, overlapping. A separation of the Antarctic specimens at species level is thus not advisable.

Freshwater and marine populations of *H. pullaster* could not be separated morphologically. Physiologically, however, these seem to be different. In cultures, a population from the Antarctic endopagial could not be adapted to freshwater and a limnetic population could not be transferred to saltwater (ANDERMAHR & WILBERT unpubl.).

Holosticha pullaster is evidently often confused with *H. diademata*. In the latter species, the contractile vacuole is situated in mid-body (FOISSNER et al. 1991; KAHL 1932). Additionally, it is usually larger (i.e. 45-140 µm) and has more adoral membranelles (25-28; BORROR 1963; BORROR & WICKLOW 1983; HARTWIG 1973; KAHL 1932; WILBERT 1986). *Holosticha kessleri* is considerably longer (100-170 µm), has more transverse cirri (10-20) and the contractile vacuole is situated equatorially (BORROR & WICKLOW 1983; FOISSNER et al. 1991; KAHL 1932, 1933; WANG & NIE 1932; WRZESNIOWSKI 1877).

Holosticha sp. found by FENCHEL & LEE (1972) in sea ice of the Weddell Sea possesses 2 macronuclei and also a hook-shaped left marginal row. It is, however, not conspecific with *H. pullaster* because it is considerably longer (ca. 140 µm), has more adoral membranelles (about 40), marginal (ca. 18) and midventral cirri (11-17) and probably fewer transverse cirri, viz. 5; the contractile vacuole position is not known.

Genus *Notocephalus* nov. gen.

D i a g n o s i s : Body elongate, cephalized. Adoral zone extends far onto right side; proximal half spoon-shaped, with bases longest in posterior portion. 1 right and 1 left marginal row. Midventral and transverse cirri present. Without caudal cirri.

T y p e s p e c i e s : *Tachysoma parvulum* CORLISS & SNYDER, 1986

Derivation nominis: „ho notos", the south; „he kephale", the head; Greek. Masculine gender.

***Notocephalus parvulus* (CORLISS & SNYDER, 1986) nov. comb.**

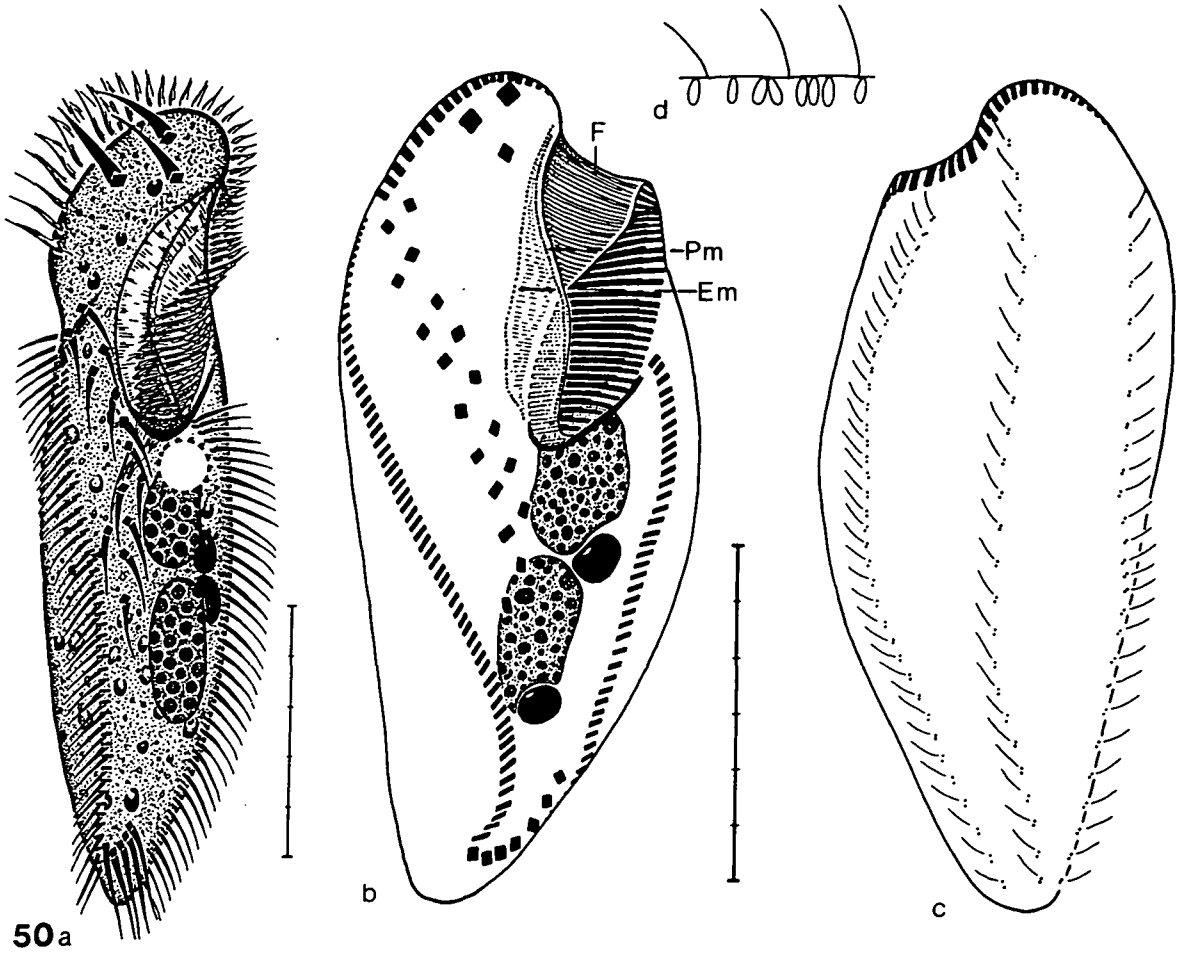
Improved diagnosis: In vivo about 155-160 x 40 µm. Body fusiform. Adoral zone composed of about 55-58 membranelles. Midventral row shortened, composed of 10-18 cirri. 3 frontal, usually 5 transverse cirri. 3 dorsal kineties. 2 macro-, 2 micronuclei. No buccal cirri. Marine.

Redescription (Figs. 50a-d, Table 24): Shape fusiform, posteriorly tapering; frontal portion enlarged head-like, oblique, anterior end rounded, cephalization not evident in slides (Fig. 50a). Dorso-ventrally slightly flattened, protargol stained specimens twisted. Macronuclear nodules in mid-body, contain spherical nucleoli (ca. 2 µm across). Micronuclei lenticular to ellipsoid, each adjacent to a macronucleus. Contractile vacuole not observed in vivo; in protargol slides probably posterior of adoral zone on left. Once in protargol slides, apparently few cortical granules in groups along dorsal kineties and near marginal rows; granules ellipsoid, 0.5 x 1 µm (Fig. 50d). Cytoplasm with many lipid droplets, 3-4 µm across, somewhat greenish, rendering cells moderately dark at low magnification; food vacuoles very likely contain flagellates. Movement slowly crawling on substrate.

Marginal rows not confluent posteriorly, right row extends very short distance to anterior dorsal side (preparation artifact?); cirri densely spaced, bases composed of 2 basal body rows each. 3 enlarged frontal cirri. Midventral cirri usually paired, arranged slightly irregularly, posteriorly 1-2 single cirri. Transverse cirri about 20 µm long. Dorsal kineties extend over entire length of body, cilia about 4 µm long (Fig. 50c). No buccal and caudal cirri, frontoterminal cirri not distinct (lacking?).

Buccal field large; refractile structure along posterior margin of adoral zone (bundle of fibres?), conspicuous in vivo, 23-27 µm long in protargol slides (Figs. 50a, b). Adoral zone of membranelles about 41% of body length, spoon-shaped, cilia about 10 µm long; distal portion on dorsal side, extends far onto right side, membranelles rather small, appear cirri-like in vivo, bases ca. 5 µm long; proximal portion ventrally, bases distinctly lengthened, longest bases about 24 µm. 2 undulating membranes, almost equally long; paroral on cytoplasmic lip, consists of single kinetosomes, cilia ca. 7 µm long; endoral membrane deep in oral cavity, very likely composed of single

file of kinetosomes, cilia about 20 µm long. Oral cavity deep, conspicuous cytoplasmic lip on right; numerous fibres extending transversely across bottom of oral cavity between undulating membranes and bases of adoral membranelles, intensively impregnated with protargol (Fig. 50b).



Figs. 50a-d: *Notocephalus parvulus* from life (a) and after protargol impregnation (b-d). a: Ventral view. b, c: Ventral and dorsal view of same specimen. d: Detail of cortical granulation (found only once). Scale bar divisions = 10 µm. Em, endoral membrane; F, fibres; Pm, paroral membrane.

Occurrence and ecology: Very rarely found in the endopagial of mainly multiyear sea ice of the Weddell Sea, between latitude 69° 02'-70° 21' S and longitude 08° 02'-08° 53' W. Occurs together with various other organisms, e.g. diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -3.4 to -2.4°C, salinity 59.5‰; in melted ice (1

measurement): PO_4 1.5 µmol/l, NO_2 0.1 µmol/l, NO_3 2.9 µmol/l, NH_4 2.7 µmol/l, Si 7.8 µmol/l, chlorophyll *a* 49.2 µg/l. Biomass of 10^6 individuals: 111 mg.

Comparison with original description: This very peculiar species was originally described as *Tachysoma parvulum* from preserved material only and has not been found since (CORLISS & SNYDER 1986). This description differs in a smaller size (60 µm, figure indicates 95 µm, vs. 134-166 µm), fewer dorsal rows (2 vs. 3), midventral cirri (8 vs. 10-18) and micronuclei (1 vs. 2; CORLISS & SNYDER 1986). A reinvestigation of an original slide of *T. parvulum* (1 specimen; types not deposited yet) showed, however, that body length is 140 µm and that 3 dorsal kineties and 10 midventral cirri are present; micronuclei were not discernible. These findings correspond exactly to the present specimens.

The composition of the midventral row does not suggest inclusion in *Tachysoma*. Instead, it shows a relationship with holostichids (BORROR 1972a). The very peculiar shape of the adoral zone and the cephalized frontal portion warrant the establishment of a separate genus, *Notocephalus*.

Holosticha discocephalus KAHL, 1932 is also cephalized but differs in shape of „head" and adoral zone, the larger body (180-280 vs. 134-166 µm), a longer midventral row, more transverse cirri (8-10 vs. 5-7), markedly longer dorsal cilia and the fragmented macronucleus. It is thus not included in *Notocephalus*. *Circinella arenicola* FOISSNER, 1994, which has an enlarged head like *N. parvulus*, is mainly distinguished by the filiform body, ventral ciliature, higher number of macronuclei and the soil habitat. Discocephaline hypotrichs are distinctly different in the attenuate anterior portion, reduced ventral ciliature, more and distinctly stronger transverse cirri, multiple macronuclei and the interstitial habitat (WICKLOW 1982).

Aspidisca antarctica CORLISS & SNYDER, 1986

Additional observations (Figs. 51a-c): In vivo 45-55 x 30-40 µm, in protargol slides 40-45 x 30-31 µm. Outline elliptical, broadest in or behind mid-body, right margin convex, left almost straight, anteriorly broadly rounded; posteriorly with 1 distinct thorn-like projection (prostomial spur; CORLISS & SNYDER 1986) on left, associated with indentation of cell, sometimes right border of indentation also spur-like (Figs. 51a, c). Dorso-ventrally flattened about 2.5-3:1. 3 long and 1 shorter dorsal ridge, slightly oblique to main body axis, conspicuous even at low

magnification (Fig. 51b). Pellicle rigid. Macronucleus horseshoe-shaped, 4-7 µm wide, macronuclear figure about 26 µm long, with spherical nucleoli (2.5-4 µm across). Contractile vacuole right of median, at level of adoral zone of membranelles. Cytoplasm hyaline, feeds on pennate diatoms. Movement slowly crawling, sometimes hectically jerking, remains on same spot for long periods; rotates about main body axis when swimming.

Cirri strong, rather stiff, 13-16 µm long. Dorsal kineties with 4 (on margin) to 10 basal body pairs centrally, cilia ca. 2.5 µm long. Adoral zone of membranelles about 14-15 x 9 µm, longest cilia about 8 µm (Figs. 51a, b).

Occurrence and ecology: Infrequently found in the endopagial of pancake and mainly older (multiyear) sea ice of the Weddell Sea, between latitude 68° 38'-70° 24' S and longitude 06° 05'-12° 08' W. Occurs in low numbers, i.e. up to 786 active ind./l melted ice were found (biomass 0.01 mg/l) comprising up to 17% of the total ciliate community. Environmental parameters in brine: temperature -3.4 to -2.0°C, salinity 38.0-59.4‰; in melted ice (1 measurement): PO_4 2.8 µmol/l, NO_2 0.1 µmol/l, NO_3 6.1 µmol/l, NH_4 3.5 µmol/l, Si 14.8 µmol/l, chlorophyll *a* 80.1 µg/l. In raw cultures also at a salinity of 16.4‰ and +1°C. Biomass of 10^6 individuals: 19 mg.

Comparison with original description: The infraciliature of protargol impregnated specimens is identical with that in the original description (CORLISS & SNYDER 1986). A morphometric characterization is not given because too few non-dividers were found.

Uronychia transfuga (MUELLER, 1776) STEIN, 1859c

Remarks: This species is a common and well known marine ciliate (HARTWIG 1973). There is, however, great confusion in the literature concerning its macronucleus, i.e. whether nodulated and C-shaped or composed of 2 parts. In recent studies, this problem is often neglected (e.g. HILL 1990). We thus provide a redescription and a comprehensive morphometric characterization.

Neotype specimens: 1 neotype as a slide of protargol impregnated specimens has been deposited.

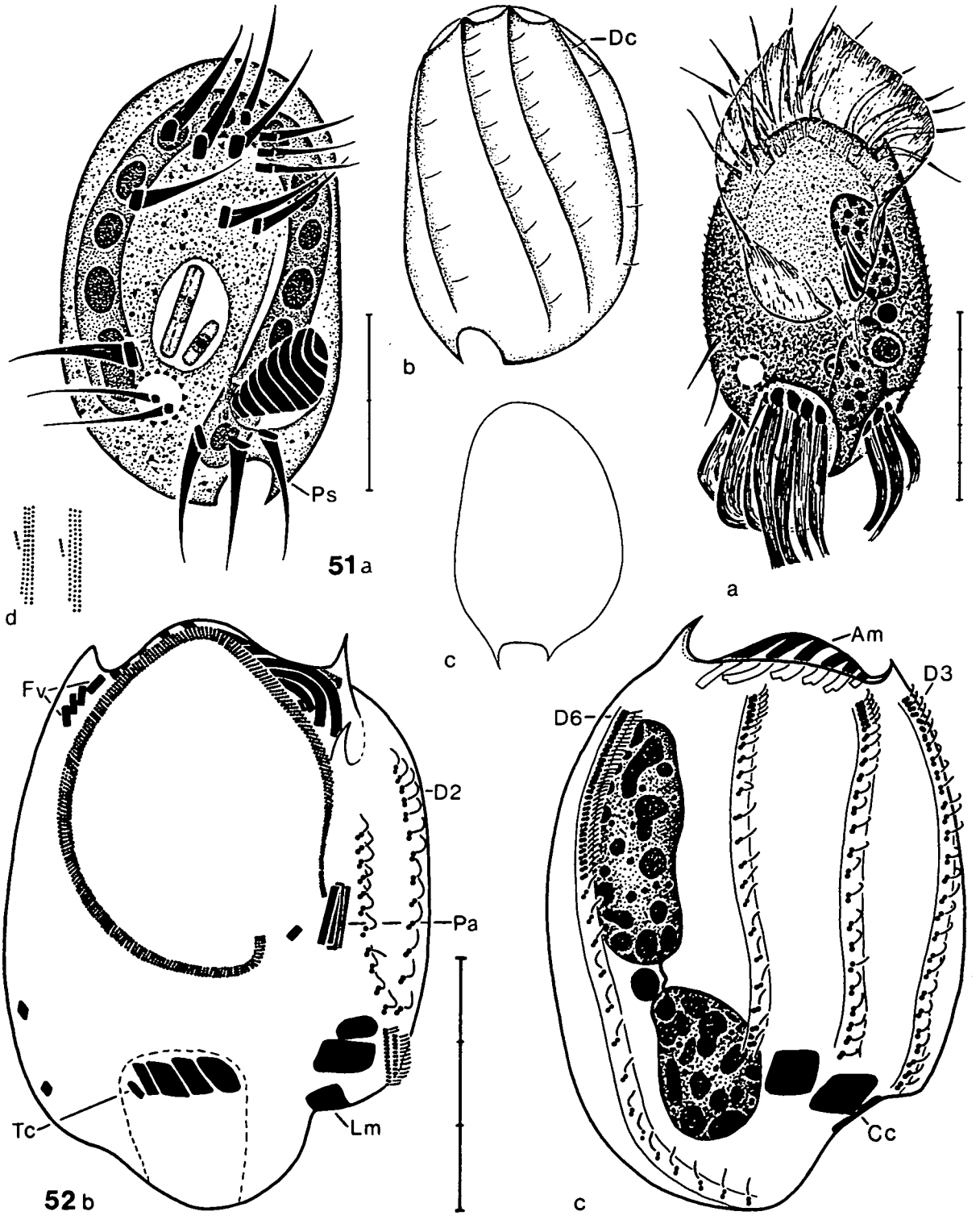
Table 25. Morphometric characteristics of *Uronychia transfuga* (n = 30); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	84.6	81.5	16.3	2.97	19.2	62	116
Body, width	57.4	54.0	12.7	2.32	22.2	40	91
Macronucleus, length anterior nodule	33.3	31.0	6.7	1.23	20.0	23	48
Macronucleus, width anterior nodule	14.2	13.0	5.1	0.94	36.1	10	32
Macronucleus, length posterior nodule	24.9	25.0	5.4	0.99	21.8	14	40
Macronucleus, width posterior nodule	14.5	13.0	3.1	0.56	21.4	11	21
Micronucleus, length	4.6	4.0	1.4	0.25	29.2	3	10
Micronucleus, width	4.4	4.0	1.3	0.24	30.4	3	10
Undulating membrane, length	48.6	46.0	6.9	1.39	14.3	41	62
Macronuclear nodules, number	2.0	2.0	0.2	0.03	9.3	1	2
Dikinetids, number in dorsal kinety 1[1]	11.6	12.0	2.1	0.55	17.7	9	17
Dikinetids, number in dorsal kinety 2[1]	15.2	15.0	3.1	0.82	20.2	10	21
Dikinetids, number in dorsal kinety 3	52.8	53.5	6.3	2.24	12.0	41	60
Dikinetids, number in dorsal kinety 4	25.9	26.0	2.5	0.80	9.7	22	29
Dikinetids, number in dorsal kinety 5	28.6	28.5	2.6	0.83	9.2	24	34
Dikinetids, number in dorsal kinety 6	25.8	25.0	3.3	1.00	12.8	21	32
Spines, number	4.2	4.0	1.6	0.30	39.4	1	7

[1] Without densely spaced basal bodies posteriorly.

Figs. 51a-c: *Aspidisca antarctica* from life. a, b: Ventral and dorsal views. c: Dorsal view of other shape.

Figs. 52a-d: *Uronychia transfuga* from life (a) and after protargol impregnation (b-d). a: Ventral view. b, c: Ventral and dorsal view of same specimen. d: Bases of anterior adoral membranelles. Scale bar divisions = 10 µm. Am, anterior adoral membranelles; Cc, caudal cirri; D2, D3, D6, dorsal kineties 2, 3, 6; Dc, dorsal cilia; Fv, frontoventral cirri; Lm, left marginal cirri; Pa, posterior adoral membranelles; Ps, prostomial spur. Tc, transverse cirri.



Improved diagnosis: In vivo usually 80-110 x 50-65 µm. Shape almost rectangular. 6 frontoventral, 5 transverse, 3 left marginal, 3 mighty caudal cirri. 6 dorsal kineties. 11 anterior, 5 posterior adoral membranelles. Undulating membrane almost surrounding oral cavity. 2 macronuclear nodules, 1 micronucleus.

Redescription (Figs. 52a-d, Table 25): Shape almost rectangular, right and left margins slightly convex, posteriorly rounded to slightly tapering, anteriorly distinctly convex, with 5-7 µm long spur-like protrusion each on right and left side; additional spines dorsally, usually near anterior ends of dorsal kineties (Fig. 52a). Dorso-ventrally flattened about 1.5:1. Ventral area deeply caved in region of transverse and left marginal cirri. Pellicle rigid. 2 macronuclear nodules (once only 1, distinctly larger, 78 µm long; reorganizer?), near left body margin, elongate ellipsoidal, connected by short funiculus, ends of funiculus apparently terminating in nucleoli; nucleoli globular (2.5 µm across) and longish. Micronucleus spherical to slightly ellipsoidal, between macronuclei. Contractile vacuole anterior and right of transverse cirri. Cytoplasm with numerous greasily shining globules (up to 3 µm in diam.) and some food vacuoles (12-34 µm across) containing mainly flagellates, very likely ciliates, sometimes pennate and centric diatoms and dinoflagellates. This renders specimens almost black at low magnification. Movement usually jumping and swimming very fast, rests with adoral membranelles and cirri stiffly spread; swimming may also be slow and wobbly.

Always 3 left marginal cirri, bases hypertrophied, about 7 x 4 µm, base of anteriormost cirrus smaller (ca. 4 x 2 µm), composed of basal body rows; left and right cirrus 25-30 µm long, middle cirrus 36-55 µm long. Constantly 6 frontoventral cirri; 4 on anterior right, resembling short membranelles, bases ca. 3 µm long; 2 on posterior right margin, fine, bases about 1 x 1.5 µm, cirri ca. 12 µm long. 5 transverse cirri always; bases of 4 cirri large, cirri about 38 µm long, rightmost cirrus rather small. 3 mighty caudal cirri, bases 6-8 µm across, cirri 40-46 µm long. 6 dorsal kineties, in narrow longitudinal grooves of pellicle, consist of dikinetids, with 1 cilium each; cilia densely spaced anteriorly, 2.5-3.5 µm long; kineties 1 and 2 on ventral side, each terminating in about 7 µm long row of probably tightly spaced dikinetids, adjacent to left marginal cirri, cilia ca. 2 µm long; kinety 3 extends over entire length of body, others terminate anterior of caudal cirri (Figs. 52b, c).

Adoral zone of membranelles bipartite; always 11 anterior adoral membranelles frontally, some extending to dorsal side, bases composed of 4 basal body rows, i.e. 2

equally long, 1 slightly shorter and 1 very short (ca. 2.5 µm long), often as in Fig. 52d; longest bases about 15 µm, cilia 20 µm long; leftmost membranelle very small, 3-rowed; always 5 posterior adoral membranelles in oral cavity, viz. 4 long (bases 9-10 µm, 4-rowed) and, slightly right of these, 1 small cirrus-like membranelle (base ca. 1.5 µm long); cilia about 9 µm long. Undulating membrane mighty, almost surrounding very large buccal field, left portion behind distinct cytoplasmic flap, right end usually bent anteriad about 90°; composed of about 5 basal body rows, cilia ca. 23 µm long (Fig. 52b).

Occurrence and ecology: One of the most common ciliate species in the endopagial of pancake, multiyear land-fast sea and multiyear sea ice of the Weddell Sea; found between latitude 67° 47'-71° 00' S and longitude 06° 05'-12° 08' W. Up to 2 658 active ind./l melted ice were counted (biomass 0.32 mg/l) comprising up to 33% of the total ciliate community. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Environmental parameters in brine: temperature -3.4 to -1.8°C, salinity 33.1-59.4‰, PO_4 1.1-2.3 µmol/l, NO_2 0.1-0.3 µmol/l, NO_3 5.6-45.8 µmol/l, NH_4 3.2-17.5 µmol/l, Si 12.1-56.3 µmol/l; chlorophyll *a* 0.4-85.6 µg/l melted ice. In raw cultures also at a salinity of about 16‰ and +1°C. Do not burst at room temperature. Biomass of 10^6 individuals: 120 mg.

Comparison with related species: This population is rather similar to *U. transfuga* as described by BORROR (1963), HILL (1990), KAHL (1932) and REIFF (1968). According to, e.g., CAREY (1992) and CURDS & WU (1983), *U. transfuga* comprises populations having a horseshoe-shaped macronucleus consisting of several nodules (e.g. AGAMALIEV 1983; BUDDENBROCK 1920; BULLINGTON 1940; CALKINS 1911; DRAGESCO & DRAGESCO-KERNÉIS 1986; RICCI et al. 1982; SAUERBREY 1928; WILBERT & KAHAN 1981; YOUNG 1922) and forms with only 2 ellipsoid macronuclei (e.g. BORROR 1963; CZAPIK & JORDAN 1976; FENCHEL 1965; KAHL 1932, 1933; REIFF 1968; TAYLOR 1928).

All the present specimens (>50) collected from a wide area of the Weddell Sea had 2 macronuclei (once only 1; see above). The horseshoe-shaped macronucleus of other populations apparently never comprised fewer than several nodules (DRAGESCO & DRAGESCO-KERNÉIS 1986; WILBERT & KAHAN 1981). This indicates that macronuclear shape, like in other euplotid species, is a constant and good character. The earliest note concerning the nucleus of *U. transfuga* is apparently by BÜTSCHLI (1889) who reported that it consists of perhaps 2 parts. Thus, we propose to

designate populations having 2 macronuclear nodules as *U. transfuga*; *U. uncinata* TAYLOR, 1928 is very likely synonymous with it.

Specimens having a nodulated C- or horseshoe-shaped macronucleus may be identified with *Uronychia heinrothi* BUDDENBROCK, 1920. The improved diagnosis for this species is based mainly on data by WILBERT & KAHAN (1981) and DRAGESCO & DRAGESCO-KERNÉIS (1986): Size 60-90 x 40-60 µm; at least 5 frontoventral, 5 transverse, 3 large left marginal, 3 mighty caudal cirri; 6 dorsal kineties; at least 10 anterior, 5 posterior adoral membranelles; undulating membrane almost enclosing oral cavity; macronucleus nodulated C-shaped, long; 1 micronucleus; silverline system very fine-meshed lattice.

Uronychia antarctica VALBONESI & LUPORINI, 1990c differs from *U. transfuga* only in having slightly fewer anterior adoral membranelles (9 vs. 11); 2 of these are, however, very small and easily overlooked in scanning micrographs. The length of dorsal kinety 4, as used by VALBONESI & LUPORINI (1990c), is not a good discriminating character because it is rather variable in the present specimens (Table 25). *Uronychia antarctica* is thus very likely synonymous with *U. transfuga*.

Cytharoides balechi TUFFRAU 1974

Synonymy: *Cyatharoides balechi* TUFFRAU, 1975 – CURDS & WU (1983), incorrect subsequent spelling, par lapsus.

Morphology and infraciliature (Figs. 53a-g, Table 26): In vivo 150-220 x 100-120 µm, usually about twice as long as broad. Shape elongate, left margin slightly convex, right straight to slightly concave, anteriorly more or less obliquely truncate, ventral area anteriorly slightly projecting, posteriorly asymmetrically tapering; buccal area distinctly concave (Figs. 53a, e). Dorsoventrally flattened about 2:1. Dorsally arched, many low ridges extending over entire length of cell (Fig. 53c). Macronucleus usually C-shaped, rarely slightly 3-shaped, contains numerous spherical nucleoli (Fig. 53d). Micronucleus not impregnated with protargol. Single contractile vacuole at level of transverse cirri, near right margin. Cytoplasm contains many greasily shining globules, 4-5 µm across, rendering cells almost black at low magnification. Feeds mainly on dinoflagellates, sometimes on pennate diatoms. Movement slowly crawling on substrate, usually in circles around same spot.

Frontoventral cirri about 53-58 µm long, transverse 47-50 µm, left marginal ca. 60 µm and right marginal cirri 43-61 µm long. Buccal cirrus (cirrus II/2) always anterior of or at level of cirrus III/2 (Fig. 53f). Right marginal cirri usually join dorsal kinety n. Leftmost dorsal kinety (row 1) shortened, extends from posterior pole to adoral zone, cilia about 5 µm long; middle row with 22-33 ($\bar{x}$ = 26) basal body pairs. Dorsal kineties extending over entire length of body (Fig. 53g). Silverline system (argyrome) of double-patella type (Fig. 53b).

Buccal field large. Adoral zone of membranelles about 74% of body length, distal portion on dorsal side; membranelles densely spaced, bases 4-rowed, i.e. 2-3 equally long (1 sometimes slightly shorter) and 1 very short row (sometimes not recognizable; lacking?), longest bases about 25 µm, cilia ca. 35 µm long. Undulating cilia about 18 µm long.

Occurrence and ecology: Regularly found in the endopagial of multiyear and sometimes also pancake sea ice of the Weddell Sea, between latitude 69° 77'-70° 99' S and longitude 07° 59'-11° 80' W. Environmental parameters in brine: temperature ca. -3.0 to -2.3°C, salinity 40.6-51.8‰, PO_4 2.1-2.8 µmol/l, NO_2 0.1 µmol/l, NO_3 27.4 µmol/l, NH_4 4.0 µmol/l, Si 58.9 µmol/l; chlorophyll *a* 0.7-80.1 µg/l melted ice. In raw cultures also at a salinity of 21.3‰ and +1°C. Biomass of 10^6 individuals: 430 mg.

Comparison with related species: The specimens are rather similar to *C. balechi* found by TUFFRAU (1974) and AGATHA et al. (1990) and thus considered conspecific. The population studied by TUFFRAU (1974) has slightly fewer (viz. 13-26) dorsal kineties than that investigated by AGATHA et al. (1990; 27-28, n = 2) and ourselves ($\bar{x}$ = 29, Table 26). The 2 left marginal cirri might have been overlooked by TUFFRAU (1974) as these were also found by AGATHA et al. (1990). We could not observe a separate endoral and paroral membrane as mentioned by TUFFRAU (1974). The present population has an intensively impregnated undulating membrane which is a rather narrow arch of basal bodies (Fig. 53f).

As concerns size and infraciliature, *C. australis* AGATHA et al., 1990, is rather similar to *C. balechi*, viz. on average 140 x 106 µm, 83 adoral membranelles, 10 right marginal cirri and 22 dorsal kineties. The former species differs in silver nitrate slides only in the shape of the peristomial lip, frontal scutum and the lack of argentophilic particles in the ventral pellicle (AGATHA et al. 1990). These might, however, be preparation artifacts, suggesting that *C. australis* is conspecific with *C. balechi*.

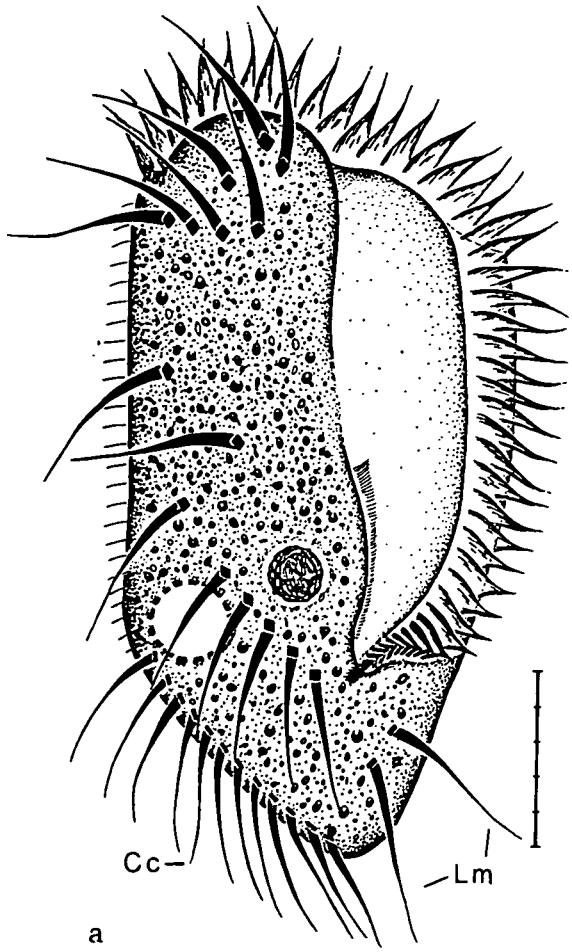
Table 26. Morphometric characteristics of *Cytharoides balechi* (n = 30); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	161.6	159.5	27.6	5.63	17.1	102	208
Body, width	129.0	125.5	26.1	5.32	20.2	79	177
Macronuclear figure, length	128.2	125.5	26.6	5.68	20.8	68	164
Macronucleus, width	22.5	20.0	6.1	1.32	27.5	12	37
Adoral zone of membranelles, length	114.1	122.5	30.4	6.21	26.7	74	158
Undulating membrane, length	40.7	42.0	11.2	2.45	27.6	16	58
Adoral membranelles, number	91.9	91.0	15.5	3.09	16.8	61	144
Frontoventral cirri, number	10.0	10.0	0.0	0.00	0.0	10	10
Left marginal cirri, number	2.0	2.0	0.0	0.00	0.0	2	2
Transverse cirri, number	5.0	5.0	0.0	0.00	0.0	5	5
Caudal cirri, number	11.9	12.0	1.5	0.29	12.3	10	16
Dorsal kineties, number	28.7	27.0	3.3	0.80	11.5	25	38

The position of the frontoventral cirri used in conjunction with other characters is of good taxonomic value in euplotids (CARTER 1972). In *Cytharoides*, cirrus II/2 is always anterior of or at the same level as cirrus III/2. In most *Euplotes* spp., cirrus II/2 is distinctly posterior of cirrus III/2. Based on this and previous studies (AGATHA et al. 1990; TUFFRAU 1974), an improved diagnosis for *Cytharoides* is provided: Body widest in anterior portion, posteriorly tapering. Adoral zone of membranelles mighty, crescentic. Numerous right marginal cirri. Many dorsal kineties. Frontoventral cirrus II/2 anterior of or at same level as cirrus III/2. 1 or 2 undulating membranes.

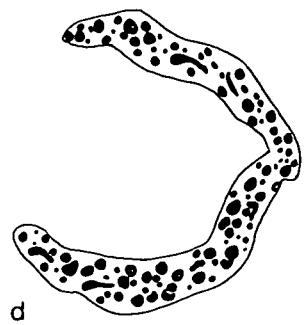
According to this definition, *Euplotes polycarinatus* CARTER, 1972 can be included in *Cytharoides*: *C. polycarinatus* (CARTER, 1972) nov. comb. Information on the undulating membrane of this species is not available.

Figs. 53a-g: *Cytharoides balechi* from life (a, c, e), after protargol (d, f, g) and silver nitrate impregnation (b). a: Ventral view. b: Detail of silverline system. c: Left ventrolateral view. d: Different shapes of macronuclei. e: Cross section in anterior area. f, g: Ventral and dorsal view of same specimen. Scale bar divisions = 10 µm. Cc, caudal cirri; Lm, left marginal cirri.



a

e



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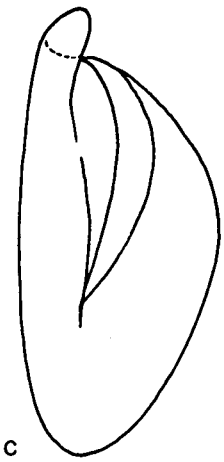

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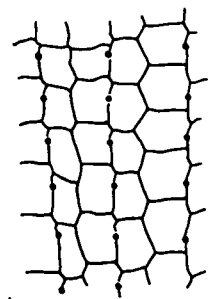

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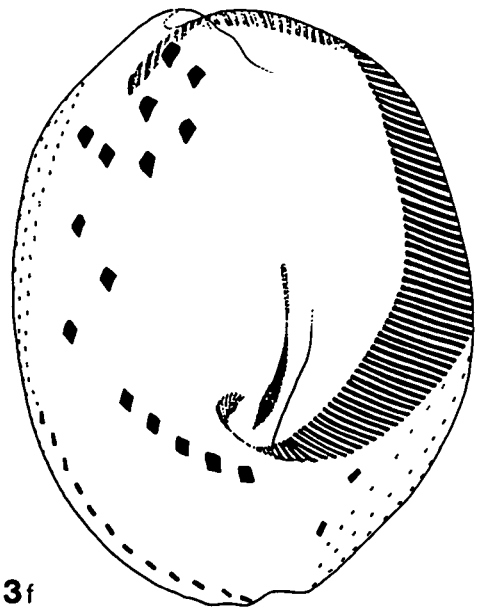
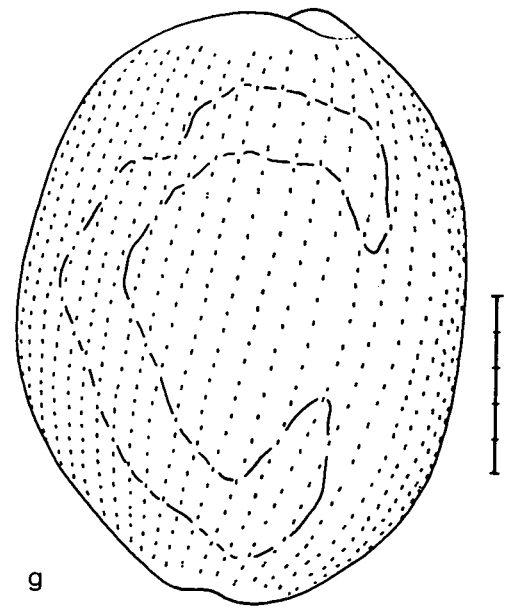


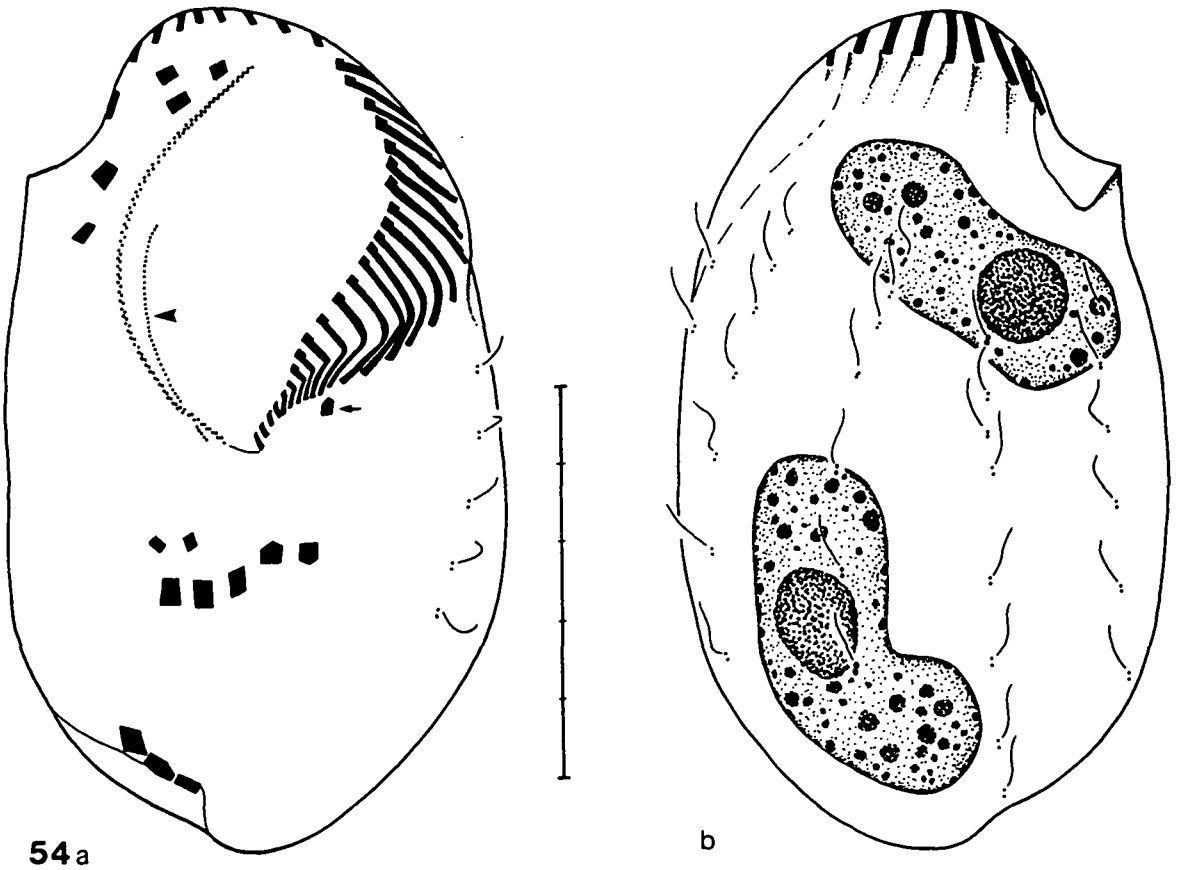
53f



g

Diophrys appendiculata (EHRENBERG, 1838) LEVANDER, 1894

Morphology and infraciliature (Figs. 54a, b): Size in protargol slides 99-110 x 54-68 µm. Outline elliptical, slightly indented on posterior right, spur-like edge on anterior right. 2 macronuclei, elongate elliptical to reniform, 43-48 x 21-23 µm, with 1 large and several smaller nucleoli (Fig. 54b). Micronuclei not impregnated with protargol. Food vacuoles contain small pennate diatoms.



Figs. 54a, b: *Diophrys appendiculata* after protargol impregnation. Ventral and dorsal view of same specimen. Arrowhead marks endoral membrane, arrow points to left marginal cirrus. Scale bar divisions = 10 µm.

7 frontoventral cirri (about 28 µm long), 4-5 transverse (23-29 µm long), 1 left marginal (12-13 µm long) and 3 right marginal cirri (ca. 26 µm long; Fig. 54a). 5 dorsal kineties, extending almost over entire length of cell, composed of 6-9 (often 7) cilia each (8-11 µm long; Fig. 54b). Adoral zone of membranelles about 53% of body length, on left and anterior cell margin; composed of 33-36 membranelles, gradually

shortened towards cytostome, longest bases about 17 µm, each consists of 2 long, 1 slightly shorter and 1 very short row of kinetids; cilia ca. 42 µm long. Paroral membrane curved, about 50 µm long, composed of 2 basal body rows; endoral membrane about 31 µm long, single-rowed (Fig. 54a).

Occurrence and ecology: Found very rarely in pancake and multiyear sea ice of the Weddell Sea, between latitude 69° 26'-70° 21' S and longitude 07° 19'-08° 53' W. Occurs together with diatoms, flagellates and ciliates. Environmental parameters in brine: temperature <-2.1°C, salinity >37.6‰, NO_2 0.2 µmol/l, NH_4 >15.5 µmol/l. Biomass of 10^6 individuals (from fixed specimens): 110 mg.

Comparison with related species: Very few specimens of this species were found in protargol slides. Live observations are not available. The identification is thus only tentative.

As concerns macronuclei and oral and somatic ciliature, this population matches the description of *D. appendiculata* (BORROR 1963; CURDS & WU 1983; HILL & BORROR 1992; KAHL 1932). It differs, however, in the thorn-like edge on the anterior right (preparation artifact?).

Diophrys sp. found by THOMPSON (1972) in an Antarctic tidal pool is smaller (about 60 µm long), has a comparatively longer adoral zone of membranelles, 2 left marginal cirri and lacks an anterior spur. This rather superficially described species can be identified with *D. appendiculata*.

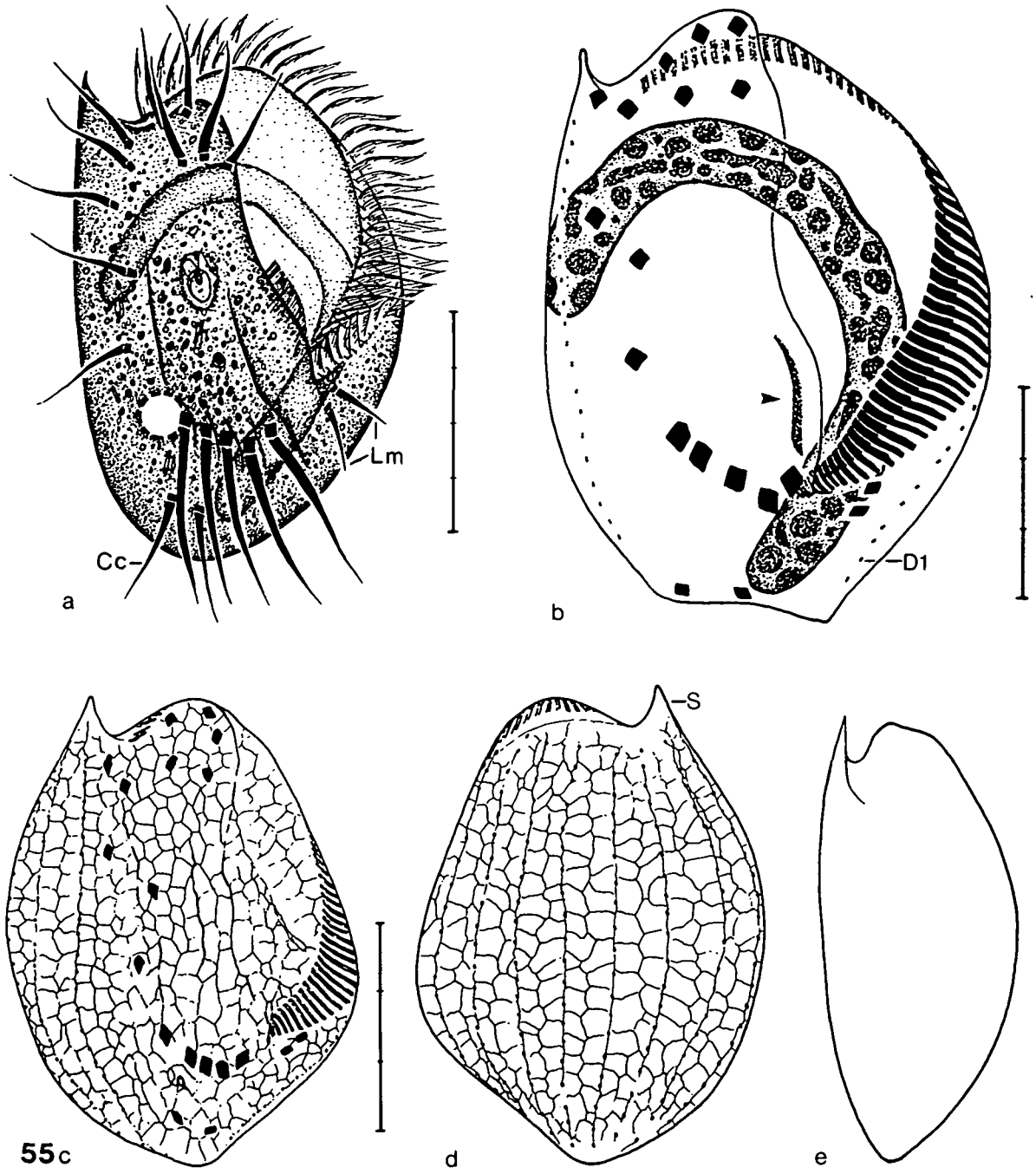
***Euplotes acanthodus* nov. spec.**

Diagnosis: In vivo about 90 x 60 µm. Outline inverted triangular, with prominent spur on anterior right. 10 frontoventral, 5 transverse, 2 left marginal, 2 caudal cirri. Usually 66 adoral membranelles and 12 dorsal kineties. Macronucleus inverted C-shaped. Silverline system of double-eurystomus type. Marine.

Type location: Sea ice of Weddell Sea, Antarctica, 69° 58' S, 07° 27' W (core number AN 103102).

Type specimens: 1 holotype as a slide of protargol impregnated cells and 1 paratype of silver nitrate stained specimens have been deposited.

Derivatio nominis: „akanthodes", Greek, thorny.



Figs. 55a-e: *Euplotes acanthodus* from life (a, e), after protargol (b) and silver nitrate impregnation (c, d). a, b: Ventral views. Arrowhead points to undulating membrane. c, d: Ventral and dorsal view of same specimen. e: Lateral view. Scale bar divisions = 10 µm. Cc, caudal cirri; D1, dorsal kinety 1; Lm, left marginal cirri; S, spur.

Description (Figs. 55a-e, Table 27): Shape broadly oval to inverted triangular, widest or slightly anterior of mid-body, posteriorly tapering, anteriorly

broadly rounded; left margin distinctly convex, right almost straight, terminating anteriorly in spur-like protrusion, ca. 7 µm long (Fig. 55a).

Dorso-ventrally flattened about 2:1 (Fig. 55e). Frontal portion of adoral zone on dorsal side. 2 ventral ridges near transverse cirri, extending anteriad, very short ridges between transverse cirri; about 8 indistinct dorsal ridges along kineties. Pellicle rather delicate, i.e. specimens burst easily. Macronucleus inverted C-shaped in ventral view, contains roundish and elongated nucleoli (Fig. 55b). Micronucleus not impregnated with protargol. Contractile vacuole and excretory pore at level of transverse cirri, near right margin. Cytoplasm colourless, contains numerous small globules (1-2 µm across) and food vacuoles (about 20 µm in diam.) with green algae, many small diatoms and probably flagellates rendering specimens almost black at low magnification. Movement slowly crawling on substrate.

Cirri usually strong, frontal cirri very close to anterior margin; frontoventral cirri ca. 25 µm long in protargol slides, transverse cirri 30-45 µm, caudal cirri 20-36 µm, left marginal cirri very short (8-10 µm), close to adoral zone of membranelles (Figs. 55b, c). Dorsal kinety 1 shortened, others extending over entire length of cell, about 17 cilia in central rows, cilia about 2 µm long (Figs. 55b, d; Table 27).

Buccal field large, wide, cytoplasmic lip along right border indented. Adoral zone of membranelles conspicuous, about 74% (61-81%, n = 9) of body length, longest bases about 13 µm, cilia 25 µm long. Undulating membrane rather long, below lip, cilia ca. 20 µm long (Figs. 55a, b).

Dorsal silverline system of double-eurystomus type (Fig. 55d).

Occurrence and ecology: Rarely encountered in the endopagial of multiyear land-fast and multiyear sea ice of the Weddell Sea, between latitude 69° 12'-70° 31' S and longitude 07° 27'-09° 00' W. Environmental parameters in brine (1 measurement): temperature about -3.0°C, salinity 51.8‰; in melted ice: PO_4 2.8 µmol/l, NO_2 0.1 µmol/l, NO_3 6.1 µmol/l, NH_4 3.5 µmol/l, Si 14.8 µmol/l, chlorophyll *a* 80.1 µg/l. Biomass of 10^6 individuals: 145 mg.

Comparison with related species: We could find no species in the literature which matches *E. acanthodus* (e.g. CARTER 1972; CURDS 1975; KAHL 1932; TUFFRAU 1960). This species is characterized by shape, 12 dorsal kineties, 10 frontoventral, 2 caudal and 2 left marginal cirri. The prominent anterior spur was constant, i.e. found in every specimen. A similar spine was also observed in the

Antarctic *E. algivorus*, *E. antarcticus* and the population of *E. rariseta* found here (see below; AGATHA et al. 1990; CORLISS & SNYDER 1986; FENCHEL & LEE 1972).

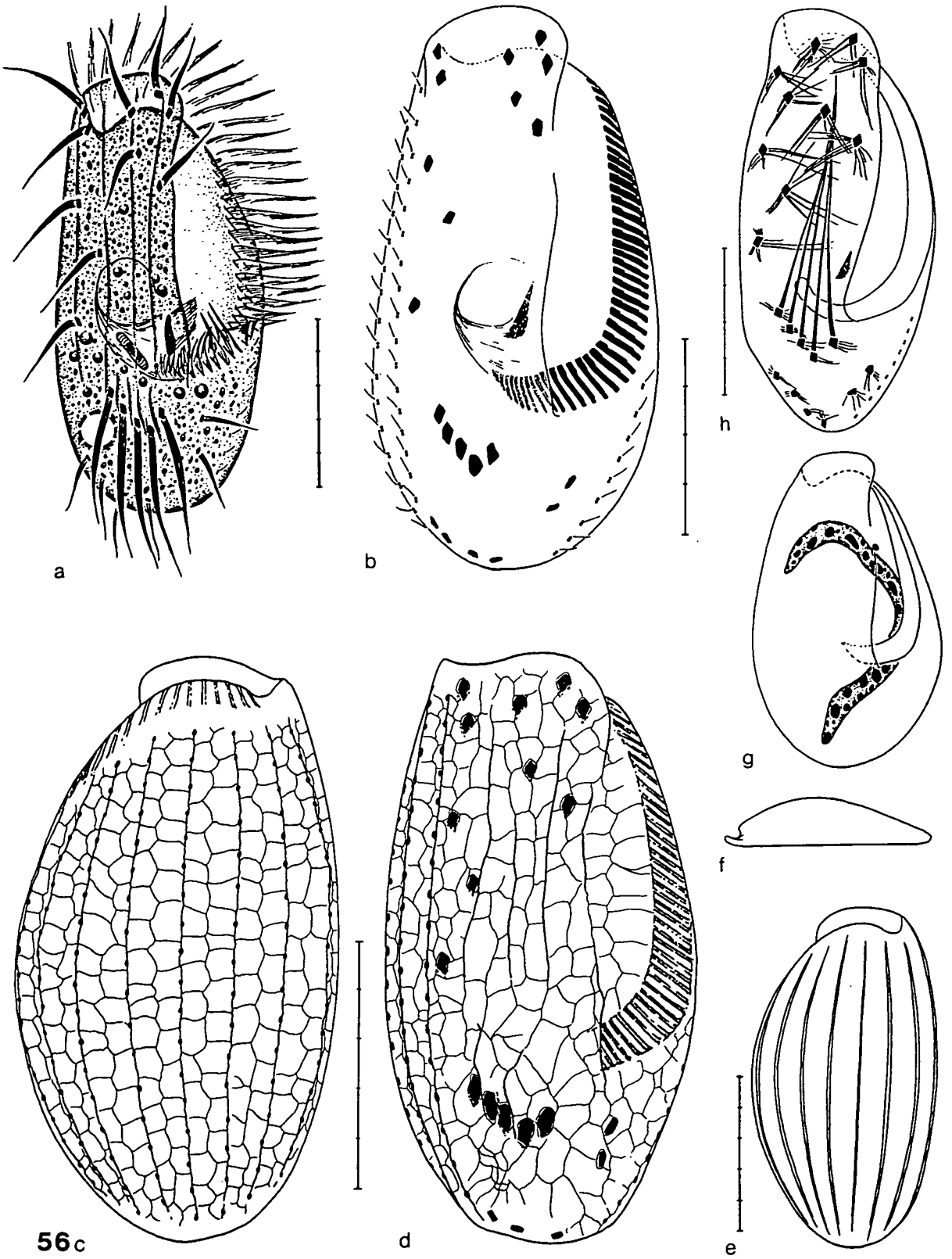
Of the species having a double-eurystomus-type silverline system, *E. charon* (MUELLER, 1773) EHRENBERG, 1830 is most similar. It differs in the higher number of caudal cirri (3-6 vs. 2) and dikinetids in mid-dorsal rows (about 40 vs. 15-20), the horseshoe-shaped macronucleus and the lack of the anterior spur (BORROR 1968, 1972a; KAHL 1932; TUFFRAU 1960). *Euplotes taylori* GARNJOBST, 1928, which was considered a variety of *E. charon* by KAHL (1932), is very similar in shape, size, number of dorsal ribs and possession of anterior spur but differs in more caudal cirri (3-5, usually 4) and apparently fewer adoral membranelles (about 50 vs. 60-76; GARNJOBST 1928; KAHL 1932).

Euplotes focardii VALBONESI & LUPORINI, 1990b described from the marine Antarctic has 9-12 (usually 10) dorsal kineties differs from *E. acanthodus* in usually having fewer adoral membranelles (50 vs. 66), a horseshoe-shaped macronucleus, long left marginal cirri and no spur (SERRANO et al. 1992; VALBONESI & LUPORINI 1990b). The size and ciliary equipment of *Euplotes* sp. (Fig. 22, THOMPSON 1972) from Antarctica is very similar to *E. acanthodus*, e.g. 12 dorsal rows with 11-16 dikinetids mid-dorsally. It lacks, however, the anterior spur and was perhaps found in freshwater; additional data, e.g. silverline system, number of adoral membranelles, ribs, are not available (THOMPSON 1972).

Euplotes antarcticus FENCHEL & LEE, 1972

Improved diagnosis: In vivo 90-145 x 30-80 µm. Outline elongate elliptical. Ventral surface distinctly protruding anteriad. 10 frontoventral, 5 transverse, 2 left marginal, usually 3-4 caudal cirri. About 46-56 adoral membranelles. Usually 10-11 dorsal kineties. Silverline system of double-eurystomus type. Marine.

Figs. 56a-h: *Euplotes antarcticus* from life (a, e, f), after protargol (b, g, h) and silver nitrate impregnation (c, d). a, b: Ventral views. c, d: Dorsal and ventral silverline system of same specimen. e: Dorsal ridges. f: Lateral view. g: Macronuclear position. h: Fibres. Scale bar divisions = 10 µm.



Morphology and infraciliature (Figs. 56a-h, Table 27): Outline elongate elliptical to sac-like, right margin usually straight, left convex, sometimes almost parallel-sided, broadest in or behind mid-body; ventral surface distinctly protruding anteriorly, posteriorly broadly rounded (Fig. 56a). Dorso-ventrally flattened about 2-3:1, well-fed specimens roundish in cross section (Fig. 56f). 3-4ventral ridges, inconspicuous, originate between and near transverse cirri, extend to anterior margin of cell. 7-10 dorsal ridges, low, extending over entire length of cell; in well-fed specimens evident only in posterior portion. Pellicle not very firm. Macronucleus questionmark-shaped, contains several large and few smaller chromatin bodies (Fig. 56g). Micronucleus spherical, on anterior half of macronucleus, rarely in small indentation; does not impregnate well with protargol. Contractile vacuole at level of transverse cirri, near right margin. Cytoplasm colourless, contains many greasily shining droplets (3-4 µm across) and food vacuoles with green contents (10-15 µm across), centric and small pennate diatoms and flagellates; well-fed specimens appear dark. Movement very slowly crawling on substrate, remains stationary for long periods.

Cirri fine, frontoventral cirri in vivo 30-45 µm long; transverse cirri rather stiff, 40-60 µm long, surpass caudal cirri; left marginal and caudal cirri 20-35 µm long; all bases associated with well impregnated fibres (Figs. 56b, d, h). Dorsal kineties along ridges, leftmost kineties (row 1 and 2, sometimes also 3) shortened, in posterior half of cell, others extending over entire length of cell, mid-dorsal rows with 11-21 basal body pairs, cilia 3-6 µm long in protargol slides (Figs. 56c, e; Table 27).

Buccal field with cytoplasmic lip along right border. Adoral zone of membranelles about 65% of body length, along left margin, anterior portion exclusively on dorsal side, terminates on right border next to distinct ridge (appears spur-like in transmitted light), posterior portion bent about 90°, bases composed of 4 basal body rows, cilia ca. 25 µm long. Undulating membrane below cytoplasmic lip, cilia ca. 10 µm long. Pharyngeal fibres long, rolled up anteriad in protargol slides.

Dorsal silverline system of double-eurystomus type (Fig. 56c). Slides of protargol impregnated specimens have been deposited for reference.

Table 27. Morphometric characteristics of *Euplotes antarcticus* population I (first line, n = 30), population II (second line, n = 30), *E. rariseta* (third line, n = 30) and *E. acanthodus* (fourth line, n = 11); measurements in µm.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Body, length	111.8	113.0	8.6	1.57	7.7	83.0	126
	88.1	86.0	9.8	1.71	11.1	72.0	111
	48.1	47.5	4.0	0.73	8.4	40.0	55
	98.1	92.0	12.8	3.87	13.1	86.0	124
Body, width	61.0	61.0	8.0	1.46	13.1	46.0	77
	49.0	49.0	9.2	1.70	18.7	34.0	74
	31.0	30.0	4.2	0.76	13.5	24.0	38
	69.8	67.0	11.4	3.42	16.3	59.0	90
Macronuclear figure, length	82.7	85.5	9.5	1.87	11.5	64.0	98
	66.5	61.0	8.4	2.64	12.6	58.0	84
	36.1	37.0	5.2	0.94	14.3	25.0	46
	70.9	71.5	5.4	1.89	7.6	64.0	77
Macronucleus, width	12.3	12.0	2.1	0.42	17.0	9.0	18
	12.3	11.5	2.4	0.75	19.2	9.0	16
	6.4	6.0	1.7	0.30	25.9	4.0	10
	11.2	11.0	2.0	0.66	17.7	9.0	14
Micronucleus, diameter	3.3	3.0	0.5	0.15	15.0	2.5	4
	3.6	3.5	0.7	0.19	19.7	3.0	5
	2.3	2.5	0.3	0.06	14.9	1.5	3
	–[1]	–	–	–	–	–	–
Adoral zone of membranelles, length	73.3	73.5	8.2	1.55	11.2	54.0	86
	57.0	55.0	5.4	1.64	9.5	53.0	72
	36.7	36.0	2.7	0.50	7.5	36.0	42
	72.1	72.0	4.5	1.34	6.2	66.0	81
Undulating membrane, length	10.5	11.0	2.3	0.44	21.8	7.0	17
	7.7	8.0	1.2	0.39	16.0	6.0	10
	5.1	5.0	1.0	0.18	19.5	4.0	8
	17.5	17.0	1.5	0.45	8.6	16.0	20
Anterior extension of ventral surface, length[2]	7.6	7.0	1.9	0.34	24.4	3.0	11
	6.4	6.0	1.0	0.31	15.1	6.0	9
Adoral membranelles, number	55.9	57.0	8.4	1.68	15.1	45.0	70
	45.9	45.0	5.9	1.30	12.9	38.0	65
	28.8	29.0	1.9	0.35	6.8	25.0	33
	66.0	65.5	4.4	0.94	6.7	60.0	76
Frontoventral cirri, number	10.0	10.0	0.0	0.00	0.0	10.0	10
	10.0	10.0	0.0	0.00	0.0	10.0	10
	10.0	10.0	0.0	0.00	0.0	10.0	10
	10.0	10.0	0.0	0.00	0.0	10.0	10

Table 27 continued.

Character	$\bar{x}$	M	SD	SE	CV	Min	Max
Left marginal cirri, number	2.0	2.0	0.0	0.00	0.0	2.0	2
	2.0	2.0	0.0	0.00	0.0	2.0	2
	2.0	2.0	0.0	0.00	0.0	2.0	2
	2.0	2.0	0.0	0.00	0.0	2.0	2
Transverse cirri, number	5.0	5.0	0.0	0.00	0.0	5.0	5
	5.0	5.0	0.0	0.00	0.0	5.0	5
	5.0	5.0	0.0	0.00	0.0	5.0	5
	5.0	5.0	0.0	0.00	0.0	5.0	5
Caudal cirri, number	3.8	4.0	0.8	0.14	21.4	3.0	6
	3.3	3.0	0.5	0.08	14.4	3.0	4
	2.0	2.0	0.0	0.00	0.0	2.0	2
	2.0	2.0	0.0	0.00	0.0	2.0	2
Dorsal kineties, number	11.4	11.5	1.5	0.31	12.9	9.0	14
	9.6	10.0	2.5	0.55	25.8	9.0	13
	6.0	6.0	0.0	0.00	0.0	6.0	6
	12.0	12.0	0.0	0.00	0.0	12.0	12
Dikinetids, number in mid–dorsal rows	18.3	18.5	1.8	0.53	10.0	15.0	21
	13.5	13.0	1.8	0.50	13.4	11.0	18
	10.8	10.0	1.4	0.33	13.0	8.0	14
	17.8	17.0	1.5	0.43	8.8	15.0	20

[1] Not impregnated.
[2] In *E. antarcticus*.

Occurrence and ecology: Found mainly in the distinctly brownish coloured, densely populated layer of multiyear and sometimes in pancake (population II) sea ice of the Weddell Sea, between latitude 69° 26'-71° 00' S and longitude 07° 19'-11° 54' W. Up to 19 000 active ind./l melted ice were found (biomass 2.0 mg/l) comprising up to 33% (dominant species) of the total ciliate community. Environmental parameters in brine: temperature -4.5 to -2.1°C, salinity 37.6-59.1‰, PO_4 2.3-6.0 µmol/l, NO_2 0.3 µmol/l, NO_3 15.5-45.8 µmol/l, NH_4 15.5-18.0 µmol/l, Si 39.8-40.4 µmol/l; chlorophyll *a* 49.3-85.6 µg/l melted ice. In raw cultures also at a salinity of 21.3‰ and +1°C. Biomass of 10^6 individuals: 105 mg.

Comparison with related species: Two populations of slightly differing size were distinguished in the protargol slides (Table 27). The shorter population II (in vivo 90-125 x 50-80 µm) usually found in young sea ice has on average 46 adoral membranelles and 3-4 caudal cirri. Population I (in vivo 90-145 x 50-65 µm), which was often found in old sea ice, possesses 56 adoral membranelles

and 3-6 caudal cirri. Cell shape, characteristic anterior protrusion of ventral side, number and position of cirri and silverline system are identical.

The specimens studied here correspond well with the original description of *E. antarcticus* (FENCHEL & LEE 1972). They differ slightly in the rounded posterior end (vs. pointed; preparation artifact?), have more adoral membranelles (38-70 vs. about 30), dorsal kineties (9-14 vs. 8) and dorsal ridges (7-10 vs. 6; FENCHEL & LEE 1972). These features are quite variable in the 2 populations investigated here (Table 27). Thus, the species identification seems to be fairly certain.

Euplotes sigmolateralis AGATHA et al., 1993 differs from *E. antarcticus* mainly in the number of frontoventral (7 vs. 10) and caudal cirri (2 vs. 3-6), the massive cirrus II/2 and the only slightly bent macronucleus. *Euplotes longicirratus* AGATHA et al., 1993 also has only 7 frontoventral and 2 caudal cirri, but a markedly longer adoral zone (97% of body length) and cirri I/1 and II/2 are extraordinarily long.

Euplotes rariseta CURDS et al., 1974

Remarks: CURDS et al. (1974) apparently considered the species name „rariseta" as a noun in apposition because its termination does not agree with the masculine gender of *Euplotes*. It is thus not emended.

Morphology and infraciliature (Figs. 57a-f, Table 27): In vivo 40-67 x 30-45 µm. Outline elongate oval, sometimes slightly triangular, widest before mid-body, posteriorly slightly tapering, posterior margin usually transparent; spur on anterior right, 4-7 µm long (Fig. 57a). Dorso-ventrally flattened about 2:1 (Fig. 57b). About 3 inconspicuous ventral ridges, rather long, originate between and near transverse cirri. 2 longitudinal dorsal ridges, extending over entire length of body, conspicuous in vivo; in protargol slides, however, sometimes 4-5 indistinct ridges (Fig. 57d). Macronucleus inverted C-shaped, with many small and large (ca. 2 µm across) chromatin bodies (Figs. 57c, f). Contractile vacuole at level of transverse cirri. Cytoplasm colourless, contains greasily shining globules (ca. 3 µm across) and food vacuoles with numerous rather large pennate diatoms and light-green contents; well-fed specimens dark. Movement crawling on substrate, not fast, slightly jerking, rotating about main body axis when swimming.

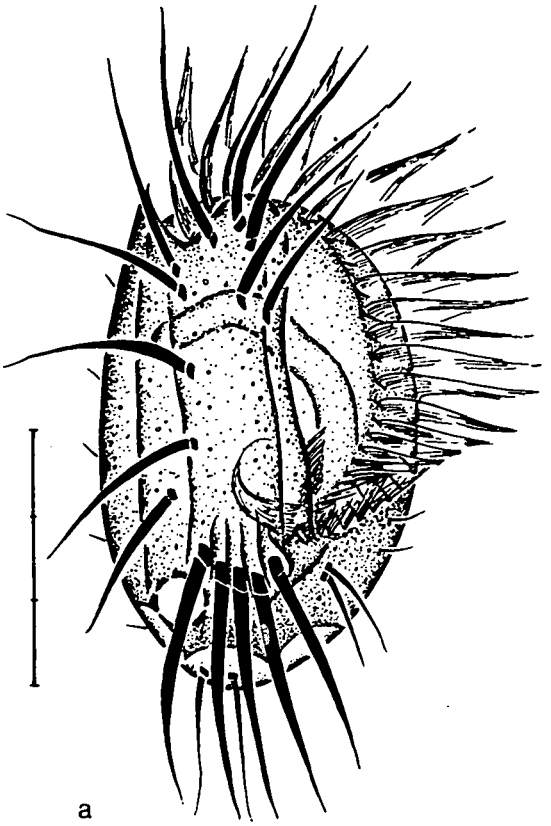
Frontal cirri conspicuous, in vivo about 20 µm long; transverse cirri strong, in vivo 25 µm long; caudal cirri fine, 16-26 µm long in protargol slides; 2 separate left marginal cirri, bases usually closely spaced; cirri fine, ca. 10 µm long in protargol. Dorsal kinety 1 (leftmost) usually composed of 2 basal body pairs, in posterior half of cell, others extending over entire length of body, mid-dorsal rows with about 11 dikinetids, posteriorly 2-3 cilia of each row more densely spaced, cilia 3-5 µm long in protargol slides; in central rows, basal body pairs about in mid-body probably non-ciliated (Figs. 57e, f; Table 27).

Adoral zone of membranelles about 75% of body length, anteriorly terminating near spur-like projection on dorsal surface, cilia ca. 22 µm long in protargol. Cilia of undulating membrane ca. 5 µm long. Cytoplasmic lip on right of buccal field distinctly indented in anterior portion (Figs. 57a, e). Pharyngeal fibres curved anteriad. Silverline system of double-patella type.

Occurrence and ecology: Widespread within pancake and multiyear sea ice of the Weddell Sea, between latitude 69° 02'-71° 00' S and longitude 07°19'-12° 08' W. Occurs together with diatoms, autotrophic and heterotrophic flagellates and ciliates. Up to 5 278 active ind./l melted ice were found (biomass 0.11 mg/l) comprising up to 9.3% of the total ciliate community. Environmental parameters in brine: temperature -5.3 to -2.1°C, salinity 38.7-81.8‰, PO_4 1.2-6.0 µmol/l, NO_2 0.1-0.5 µmol/l, NO_3 6.1-24.8 µmol/l, NH_4 3.5-19.3 µmol/l, Si 14.8-61.0 µmol/l; chlorophyll *a* 0.4-80.1 µg/l melted ice. In raw cultures also at a salinity of 17.4-21.3‰ and +1°C. Biomass of 10^6 individuals: 21 mg.

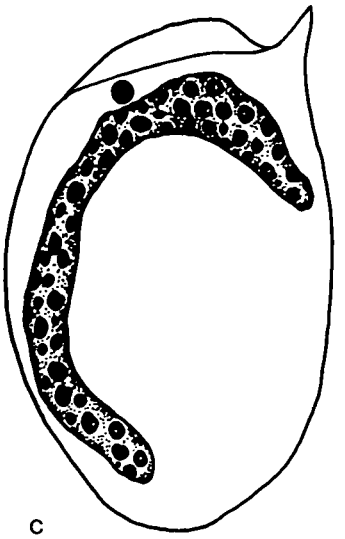
Comparison with related species: The specimens investigated here are very similar in body size, silverline system, C-shaped macronucleus, number of adoral membranelles, dorsal kineties and ventral and dorsal ribs to *E. rariseta*, *E. algivorus* AGATHA et al., 1990 and *E. nobilii* VALBONESI & LUPORINI, 1990a (AGATHA et al. 1990; BORROR 1963; CURDS et al. 1974; DALLAI et al. 1987; VALBONESI & LUPORINI 1990a; WILBERT & KAHAN 1981). In contrast to these, the present population possesses, however, constantly 2 vs. 1 left marginal cirrus (Table 27).

Figs. 57a-f: *Euplotes rariseta* from life (a, b) and after protargol impregnation (c-f). a: Ventral view. b: Lateral view. c: Macro- and micronucleus. d: Dorsal ridges. e, f: Ventral and dorsal view of same specimen. Scale bar divisions = 10 µm. D1, dorsal kinety 1; Lm, left marginal cirri.



a

b



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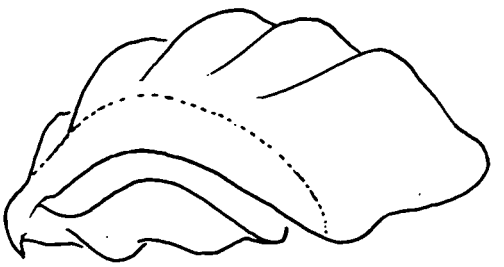

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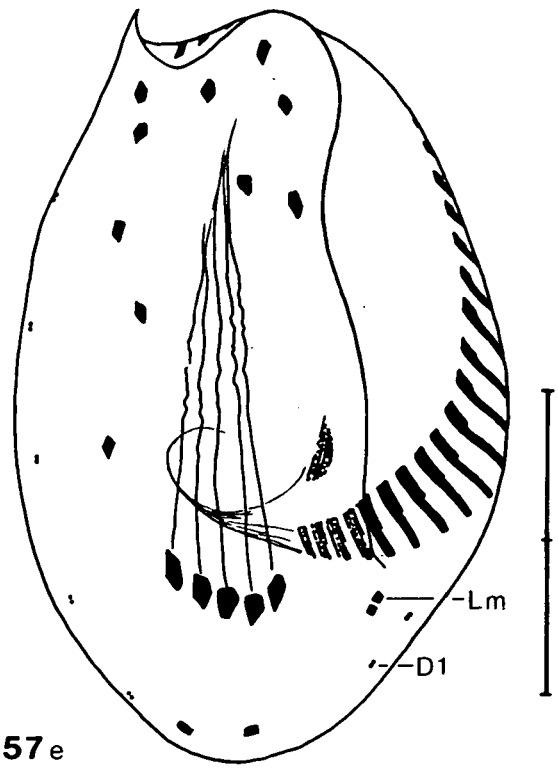
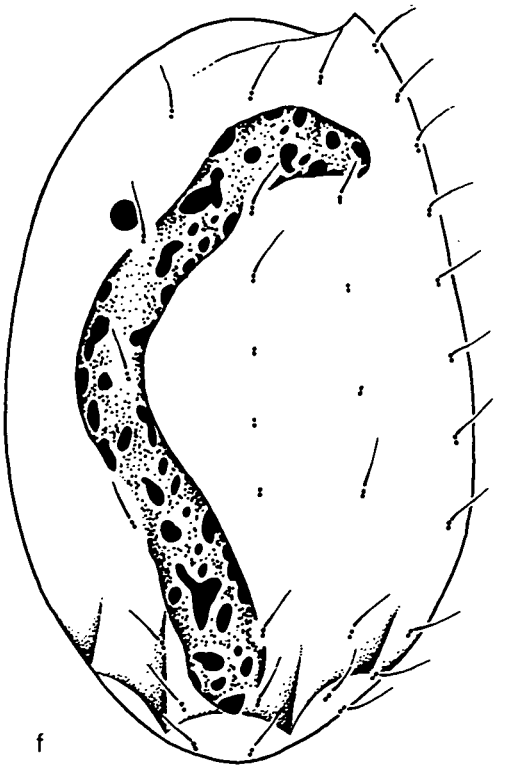


57 e



f

Euplotes rariseta was originally described having an S-like macronucleus (CURDS et al. 1974; VALBONESI & LUPORINI 1990a). According to DALLAI et al. (1987), its shape varies considerably, a C- or hook-shaped macronucleus being most common (cf. BORROR 1963; WILBERT & KAHAN 1981). In addition, the population studied by BORROR (1963) had 1-2 left marginal cirri and 5-7 dorsal kineties. We thus identified the present population with *E. rariseta*, which was already found in Antarctica (VALBONESI & LUPORINI 1990a).

A reinvestigation of type slides of *E. algivorus* showed that it has 6-7 dorsal kineties and very rarely also 2 left marginal cirri. *Euplotes algivorus* is thus very likely synonymous with *E. rariseta*. *Euplotes algivorus*, like the specimens studied here, has, however, an anterior spur (Fig. 57a; AGATHA et al. 1990), the significance of which is currently uncertain. The Antarctic *E. nobilii* is identical to *E. rariseta* except that it possesses slightly more, viz. 8 vs. 5-7, dorsal kineties (VALBONESI & LUPORINI 1990a). It is thus also considered junior synonym of *E. rariseta*. As concerns cirral and kinety number, *E. palustris* TEN HAGEN, 1980 is very similar to *E. nobilii*. The former species differs, however, in having 2 left marginal cirri, 2 groups of transverse cirri, the very weak development of cirrus IV/2 and V/2, a distinctly larger micronucleus and the freshwater habitat; additionally, it forms cysts which was not reported from *E. nobilii* (VALBONESI & LUPORINI 1990a).

Euplotes sp. found by THOMPSON (1972, Fig. 21) in Antarctic tidal pools might also be conspecific with *E. rariseta*. *Euplotes* sp. found by AGATHA et al. (1993) in the Arctic and Antarctic is very similar in the cirral equipment, e.g. 2 closely set left marginals, but differs in that it is larger (66-83 vs. 40-55 µm), has more adoral membranelles (42-61 vs. 25-33) and dorsal rows (7 vs. 6) and lacks a spur; silverline system unknown. Other euplotids from the marine Antarctic differ distinctly in size, shape and infraciliature (AGATHA et al. 1993; FENCHEL & LEE 1972; SERRANO et al. 1992; THOMPSON 1972; VALBONESI & LUPORINI 1990a,b; this study).

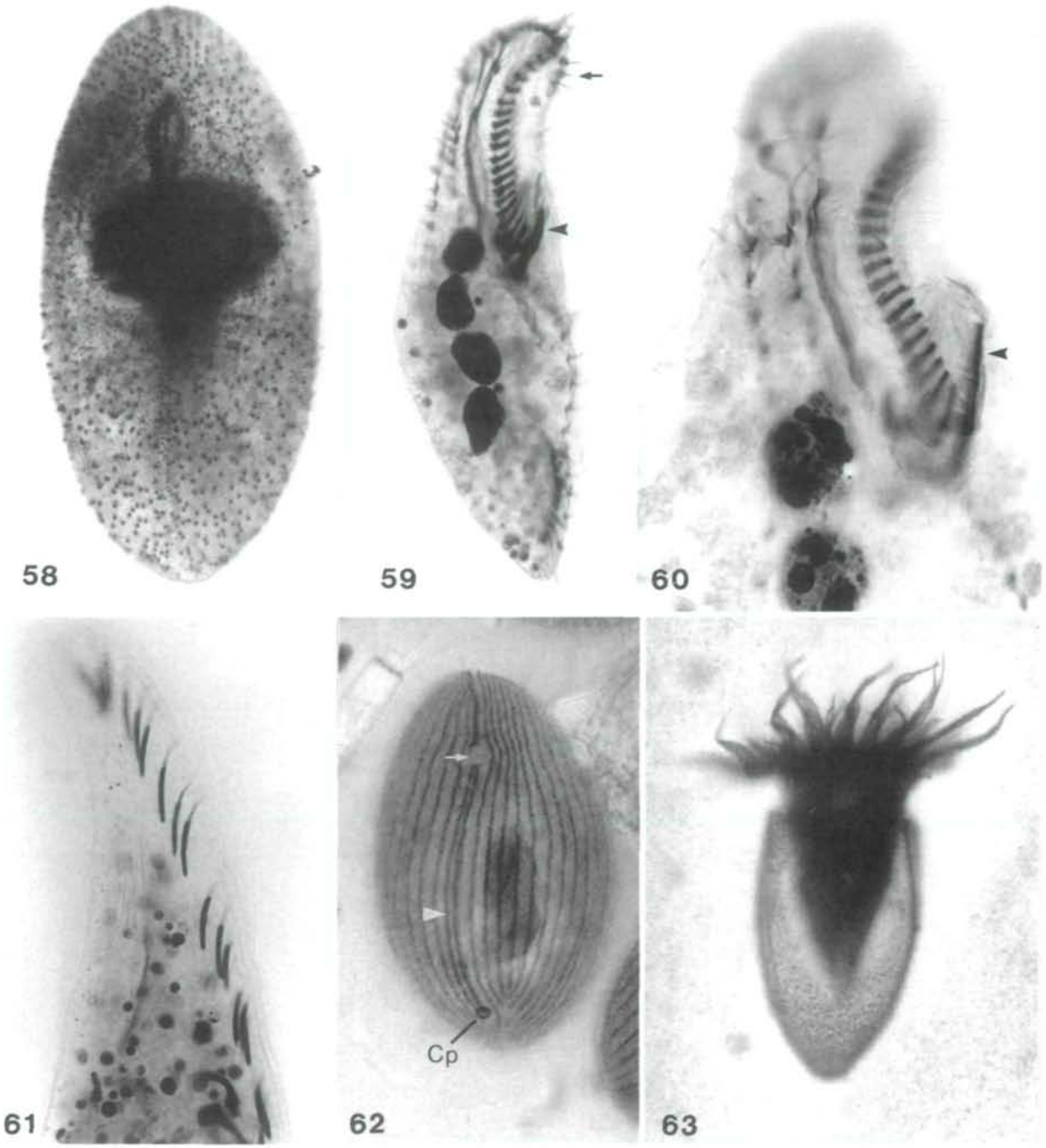
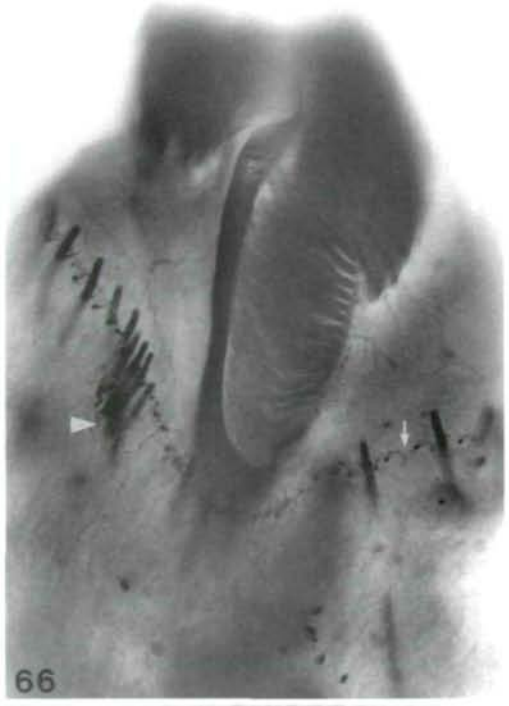


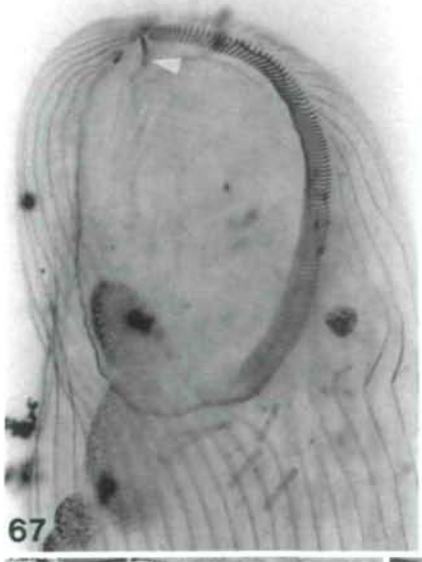
Fig. 58: *Frontonia frigida*, ventral view. Figs. 59, 60: *Holosticha spindleri*. 59: Ventral view. Arrow points to enigmatic globules. 60: Detail of oral area. Arrowhead marks elongated adoral membranelle. Fig. 61: *Litonotus kopimorphus*. Detail of anterior right side showing extrusomes. Fig. 62: *Placus antarcticus*, ventral view. Arrowhead marks postcavity kineties, arrow subapical cavity. Fig. 63: *Codonellopsis glacialis* with ptychocyliform lorica. 58-61, 63, protargol impregnation; 62, silver nitrate impregnation. Cp, pore of contractile vacuole.

64

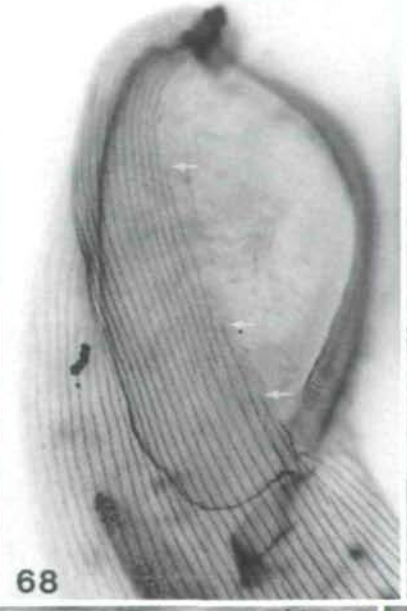
65



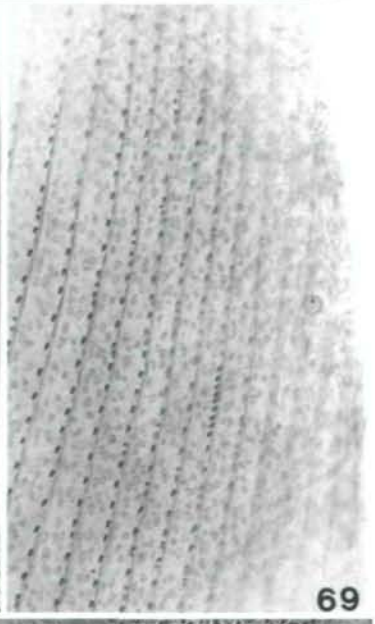
66



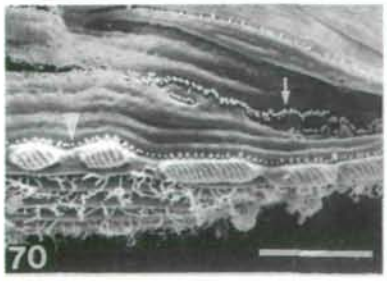
67



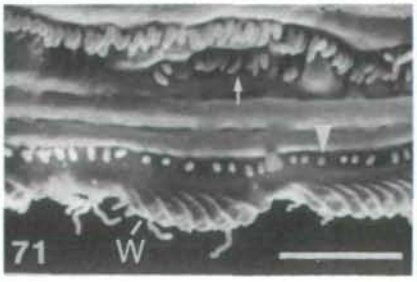
68



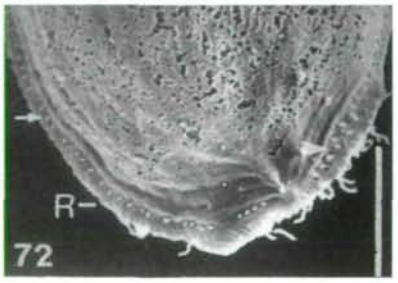
69



70



71 W



R

72

Other ciliates

Further species have been identified in very low abundances either only in vivo or in the slides: Suctoria gen. spec., 70° 31' S, 07° 59' W (Atka Bay). *Gymnozoum* sp. (perhaps more than 1 species), 68° 44'-70° 33' S, 06° 04'-12° 00' W; *Kentrophyllum* sp., 70° 21' S, 08° 53' W; *Monodinium* sp., 67° 47' S, 12° 01' W; *Pseudocohnilembus* sp., 70° 21' S, 08° 53' W, not conspecific with *P. longisetus* THOMPSON, 1965 described from Antarctica; *Strombidium* sp. 1, 69° 58' S, 07° 27' W; *Strombidium* sp. 2, Atka Bay, 70° 31' S, 07° 59' W; *Uropedalium* sp., 69° 26' S, 07° 19' W.

Empty loricae of some other tintinnids were found in the pelagial belonging, according to morphology, to *Codonellopsis gaussi* (LAACKMANN, 1907) LAACKMANN, 1910 (between latitude 70° 09'-70° 24' S and longitude 04° 59'-06° 18' W) and *Cymatocylis vanhoeffeni* (LAACKMANN, 1907) LAACKMANN, 1910 (between latitude 70° 09'-71° 16' S and longitude 04° 59'-12° 02' W; not illustrated).

In addition, we found at least 1 undetermined prostomatid, amphileptid, scuticociliatid and oligotrich species.

Fig. 64: *Lacrymaria spiralis* form I, side view. Figs. 65, 66: *Spirostrombidium rhyticollare*. 65: Ventral view. 66: Detail of anterior area. Arrowhead points to extrusomes, arrows to equatorial kinety. Figs. 67-69: *Condylostoma granulosum*. 67, 68: Detail of anterior area. Arrowhead marks apical membranelle, arrows shortened somatic kineties. 69: Detail of cortical granulation. Figs. 70-72: *Loxophyllum rostratum*. 70, 71: Detail of anterior dorsal portion. Arrow marks brosse, arrowhead dorsolateral kinety 2. 72: Detail of posterior left lateral portion. Arrow points to perioral kinety 1, arrowhead to dorsolateral kinety 2. 64-69: protargol impregnation; 70-72: scanning micrographs. 70, 72: bar = 10 μm; 71, bar = 4 μm. R, rope-like structure; W, trichocyst warts.

Summary

The ciliate colonization and community of Antarctic sea ice were studied in the austral autumn using a direct live counting method. Grease and very young pancake ice contained no or only very few ciliates (up to 200 active ind./l of melted ice); distinctly more (5 347 active ind./l on average) were found in up to 50 days old pancake ice; still higher abundances occurred in multiyear sea ice (max. 57 000 ind./l melted ice, 370 µg carbon/l) showing that ciliates are a significant part of the sea ice community. Population densities decreased towards the top of the ice. Very low numbers (333 active ind./l) were found in the pelagial. The plankton community differed markedly from that of sea ice: *Gymnozoum* spp. and *Strombidium* spp. dominate in the ice, tintinnids, mainly *Codonellopsis glacialis* and *Cymatocylis convallaria*, in the plankton. Species found within sea ice were usually not recorded in the pelagial and vice versa.

46 ciliate species predominantly from sea ice and 6 from the pelagial were investigated morphologically and ecologically. Descriptions are based on live observations, protargol and silver nitrate impregnations, morphometrical analyses and scanning electron microscopy. 17 new species are established: *Cryptochilum reniforme* nov. spec., *Euplotes acanthodus* nov. spec., *Frontonia frigida* nov. spec., *Fuscheria marina* nov. spec., *Gymnozoum sympagicum* nov. spec., *Holosticha foissneri* nov. spec., *H. spindleri* nov. spec., *Kentrophyllum antarcticum* nov. gen., nov. spec., *Leegaardiella elbraechteri* nov. spec., *Litonotus emmerichi* nov. spec., *L. kopimorphus* nov. spec., *Placus antarcticus* nov. spec., *Rimostrombidium glacicolum* nov. spec., *Strombidium glaciale* nov. spec., *Tontonia antarctica* nov. spec., *Uronema paramarinum* nov. spec. and *Zosterodasys kryophilus* nov. spec. are described. *Chlamydonella*, a nomen nudum, is validly established. 29 new combinations are suggested: *Chlamydonella pseudochilodon* (DEROUX, 1970) nov. comb., *C. alpestris* (FOISSNER, 1979b) nov. comb., *C. galeata* (DEROUX, 1970) nov. comb., *C. minuta* (PAETSCH, 1974) nov. comb., *C. rostrata* (VUXANOVICI, 1963) nov. comb., *C. stricta* (DEROUX, 1976a) nov. comb., *Cytharoides polycarinatus* (CARTER, 1972) nov. comb., *Gymnozoum arcticum* (ALEKPEROV & MAMAJEVA, 1992) nov. comb., *G. glaciale* (FENCHEL & LEE, 1972) nov. comb., *G. intermedium* (AGATHA et al., 1993) nov. comb., *Kentrophyllum fibrillatum* (DRAGESCO, 1954) nov. comb., *K. pseudosetigerum* (DRAGESCO, 1954) nov. comb., *K. raikovi* (DRAGESCO, 1965) nov. comb., *K. setigerum* (QUENNERSTEDT, 1867) nov. comb., *K. verrucosum* (STOKES, 1893) nov. comb., *Notocephalus parvulus* (CORLISS & SNYDER, 1986) nov. gen., nov. comb., *Pelagostrobilidium neptuni* (MONTAGNES & TAYLOR, 1994) nov. gen., nov. comb., *P. spirale* (LEEGAARD, 1915) nov. comb., *Porpostoma grassei* (CORLISS &

SNYDER, 1986) nov. comb., *Rimostrombidium undinum* (MARTIN & MONTAGNES, 1993) nov. comb., *R. veniliae* (MONTAGNES & TAYLOR, 1994) nov. comb., *Spirostrombidium cinctum* (KAHL, 1932) nov. comb., *S. elatum* (ALEKPEROV, 1985) nov. comb., *S. elegans* (FLORENTIN, 1901) nov. comb., *S. oblongum* (ENTZ, 1884) nov. comb., *S. pseudocinctum* (WANG, 1934) nov. comb., *S. rhyticollare* (CORLISS & SNYDER, 1986) nov. comb., *S. siculum* (MONTAGNES & TAYLOR, 1994) nov. comb., *Uronema antarcticum* (THOMPSON, 1972) nov. comb. Several species are redescribed, improved diagnoses are given for these, a few neotypes are designated and some synonyms are proposed. A key is provided for *Gymnozoum*.

The terms pagial (pagion), endopagial (endopagion), epipagial (epipagion), metapagial (metapagion) and hyperpagial (hyperpagion) are proposed for the biotope (biocoenosis) „sea ice", the brine-filled pore system, the aufwuchs on sea ice (underside), the infiltration layer and the snow covering the sea ice, respectively. Pagiotelma denotes a small pool on the sea ice surface.

K e y w o r d s : Ciliophora, Antarctica, sea ice, endopagial, plankton, morphology, taxonomy, ecology, terminology.

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Systematic index

Remarks: Species names appear in *italics*; invalid species names (junior homonyms, synonyms or misspellings) are given in (*italics*) and parentheses. Generic names are in ***boldface italics***; invalid generic names are in (***boldface italics***) and parentheses. Familial names are in Roman type and spaced.

A **boldface** page number refers to the beginning of a species description, a boldface letter „**T**" indicates the location of the table with the morphometric characterization.