

Loricata and Scale-Bearing Protists from Lützow-Holm Bay,
Antarctica I. Species of the Acanthoecidae and the
Centrohelida found at a Site Selected on the Fast Ice

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南極・リュツォ・ホルム湾の有被殻・有鱗片原生生物 I。
定着氷域産のエリ鞭毛虫と太陽虫

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要旨: 1981年1月, 観測船「ふじ」の停止点近くの定着氷上 (厚さ173 cm) の1点 (69°06.75'S, 37°24.6'E) を選び, 径9 cmの氷柱とその下の海水 (深度約160 m) 12層から, エリ鞭毛虫の Acanthoecidae 科所属の2新種, 6既知種と7未同定種, 太陽虫の Centrohelida 所属の1既知種と1未同定種, その他不明種の刺鱗片を見出した。

2新種は, *Parvicorbicula ongulensis* と *Saepicula leadbeateri* と命名された。エリ鞭毛虫の5種はウェッデル海にも産する。そのうちの1種と2新種以外の南極海産の8既知種は, 北極海, 北大西洋, 地中海, カリフォルニア沿岸, ケープタウン沿岸, ニューゼーランド, 日本などに広く分布する。また垂直的には, 海氷の下半分から海水100 m層まで分布し, 海氷底部と海水10 m層の2層に密度が高かった。その被殻数は珪藻殻の10%程度であるが, 本海氷域における亜優占生物群であった。

Abstract: By means of an electron microscopical study, two new species, six known species and seven forms of unidentified loricae of the Acanthoecidae (Choanoflagellida), two species of the Centrohelida (Heliozoa), and a type of spine scales of unknown taxon were found in the sea ice and sea water at a sampling site selected on the fast ice near the last mooring point (69°06.75'S, 37°24.6'E) of Icebreaker FUJI in Lützow-Holm Bay, Antarctica, in the 1979-1980 season. Two new species were named *Parvicorbicula ongulensis* and *Saepicula leadbeateri*. However, most of species dealt with in the present paper are distributed widely in the Northern Hemisphere.

The species collected were distributed in the lower half part of

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the sea ice and in the water column from just beneath the ice to the 100 meters deep layer.

1. Introduction

The taxonomical investigations of the loricate protists such as choanoflagellates concentrated in the Northern Hemisphere. About 60 taxa including many new species have been previously recorded from marine localities extending from the Arctic to New Zealand (ELLIS, 1929; LEADBEATER, 1972 a, b, 1973, 1975, 1978, 1980; LEADBEATER and MORTON, 1974; MANTON and LEADBEATER, 1978; MANTON and OATES, 1979 a, b; MANTON *et al.*, 1975, 1980; MOESTRUP, 1979; NORRIS, 1965; PARKE and LEADBEATER, 1977; REYNOLDS, 1976; THOMSEN, 1973, 1976, 1977 a, b, 1978 a, b, 1979; THRONDSSEN, 1970 a, b, 1974; TAKAHASHI, 1981).

In Antarctica, one of choanoflagellates, *Parvicorbicula socialis*, has been found in 1960 (DEFLANDRE, 1960), and then in 1980, eight species including one new species of the Acanthoecidae were recorded (BUCK, 1980). Expansion of knowledge in this field is expected.

The author participated in the summer party of the 21st Japanese Antarctic Research Expedition (JARE-21) in the 1979-1980 season. He collected sea ice and sea water samples from three sampling stations on the fast ice near the Ongul Islands in Lützow-Holm Bay, Antarctica. In this paper, the results obtained from one sampling station selected near the last mooring point of Icebreaker FUJI are reported.

2. Materials and Method

Water samples and sea ice used were collected at a site selected on the fast ice near the last mooring point of Icebreaker FUJI (69°06.75'S, 37°24.6'E) in the 1979-1980 season. The sampling was carried out on 21st to 23rd January 1980 (Fig. 1). An ice core sample of 9 cm diam. and 173 cm long was taken with an ice auger and was cut into five pieces; 20, 30, 40, 36, and 32 cm long from the bottom to the surface according to the appearance. Then each piece was melted at room temperature in the laboratory on board the FUJI. Water samples in two 500 ml bottles were collected from 12 layers; 0, 2, 4, 6, 8, 10, 15, 20, 30, 50, 100 and 150 meters in depth with a Van Dorn bottle through an ice hole. A half aliquot of melted water of an ice piece and

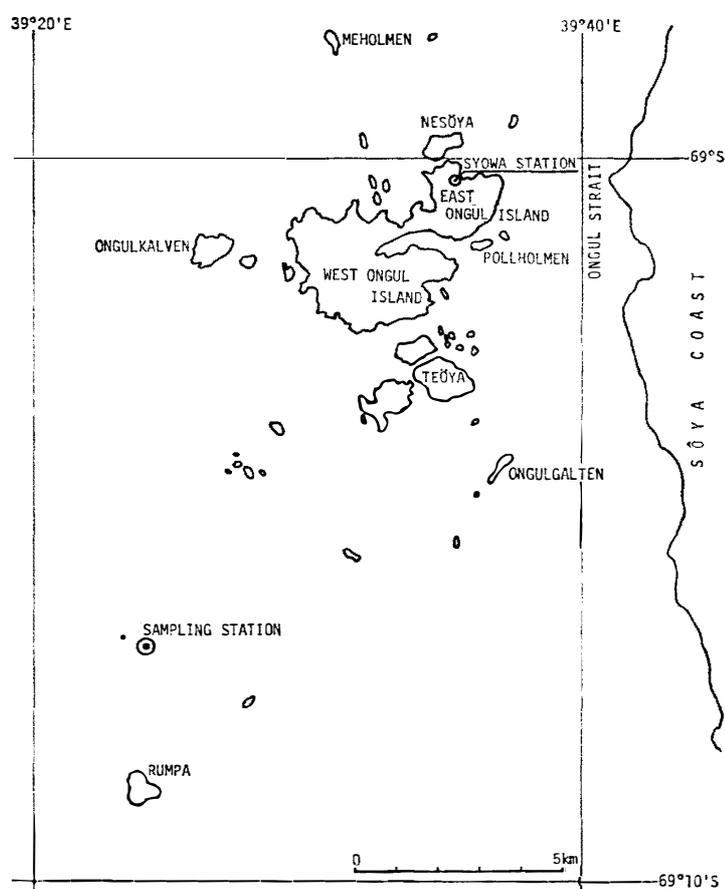


Fig. 1. Map showing the sampling station in Lützow-Holm Bay, Antarctica.

one of two water samples taken at every layer were fixed with 10 % glutaraldehyde (GA) and successively with formalin. All fixed samples were transported to the laboratory at Kobe University.

Melted but unfixed water of ice samples and the rest of sea water samples were separately filtered through 50 μm net and then concentrated to one milliliter by centrifuge (3000 rpm for 10 min). Drops of each of the concentrates were placed on five collodion-carbon coated grids. After being dried and rinsed with distilled water, the grids were dried again and preserved. The remains of the concentrates were fixed with 10 % GA for 30 seconds and subsequently with 1 % OsO_4 solution for two minutes, and then were washed twice with distilled water by centrifugation. Drops of the fixed samples were placed on five grids and dried at 40°C in an oven and then preserved. The grids were shadowcast with Pt-Pd alloy at an angle of *ca.* 20° and examined with a JEM-100B-STEM electron microscope.

3. Results and Discussion

Of the Acanthoecidae, 15 species including two new species and seven unidentified species together with two heliozoans and a type of undescribed scale were found. The species observed are listed in Table 1.

Table 1. List of the species collected from Lützow-Holm Bay, in January 1980.

Acanthoecidae (Choanoflagellida)	
1.	<i>Bicosta antennigera</i> MOESTRUP, 1979
2.	<i>B. spinifera</i> (THRONDSSEN) LEADBEATER, 1978
3.	<i>Calliacantha natans</i> (GRØNTVED) LEADBEATER, 1978
4.	<i>Crinolina aperta</i> (LEADBEATER) THOMSEN, 1976
5.	<i>Diaphanoeca multiannulata</i> BUCK, 1980
6.	<i>Parvicorbicula socialis</i> (MEUNIER) DEFLANDRE, 1960
7.	<i>P. ongulensis</i> sp. nov.
8.	<i>P.</i> sp. (Sp. no. 9)
9.	<i>Pleurasiga</i> sp. (aff. <i>P. orculaeformis</i> sensu LEADBEATER, 1973)
10.	<i>Saepicula leadbeateri</i> sp. nov.
11.	Sp. "N" in MOESTRUP, 1979
12.	Sp. no. 15
13.	Sp. no. 17
14.	Sp. no. 21
15.	Sp. no. 24
Centrohelida (Heliozoa)	
1.	<i>Pinaciophora fluviatilis</i> GREEFF, 1875 in PENARD, 1904
2.	<i>Acanthocystis</i> sp.
Unknown species	
1.	Sp. "S"

3.1. Description of the species

Acanthoecidae (Choanoflagellida)

1. *Bicosta antennigera* MOESTRUP in N. Z. J. Bot., 17, 61-95, 1979.

Lorica Y-shaped, composed of seven costal strips. Anterior spines, 32-33 μm long, consist of two costal strips each; longer anterior costal strip *ca.* 25 μm long and shorter basal costal strip 7.5-8 μm long. Lorica chamber V-form, composed of two costal strips, *ca.* 8 μm long. Posterior spine, *ca.* 25 μm long, tapered and joined with the end of lorica chamber.

This species was first found in Kaikoura, New Zealand (MOESTRUP, 1979), and then it was collected from the Weddell Sea, Antarctica (BUCK, 1980),

and Arctic (MANTON *et al.*, 1980).

2. *Bicosta spinifera* (THRONDSEN) LEADBEATER in J. Mar. Biol. Assoc. U. K., **58**, 511-515, 1978.

Basionym: *Salpingoeca spinifera* THRONDSEN in Br. Phycol. J., **5**, 87-89, 19-70. (Pl. 1, Figs. 2-4)

Lorica Y-shaped, whole length 63-80 μm , composed of seven costal strips; two unequal anterior long spines, longer one 24-30 μm long, the other 18-22 μm long, four costal strips of lorica chamber and one posterior costal spine. Lorica chamber composed of four costal strips usually crossing each other. Posterior spine tapered, 24-32.4 μm long. Cell long ellipsoidal, 5-9 μm long and 3 μm wide, with one acronematic flagellum of 36 μm long.

This species was first found in Bear Island, 74°30'N, 25°E (THRONDSEN, 1970 b), subsequently in the coast of Norway (LEADBEATER, 1972 a), the Barents Sea (REYNOLDS, 1976), the Weddell Sea, Antarctica (BUCK, 1980), the Arctic and South Africa (near Cape Town) (MANTON *et al.*, 1980).

3. *Calliakantha natans* (GRØNTVED) LEADBEATER in J. Mar. Biol. Assoc. U. K., **58**, 511-515, 1978.

Basionym: *Salpingoeca natans* GRØNTVED in Meddr Danm. Fisk. og Havsunders, N. S. **1**, 3-13, 1956. (Pl. 2, Figs. 5, 6)

Lorica composed of one chamber, 8-10 μm long, with three anterior spines, 20 μm long, and one posterior spine, 25 μm long. Lorica chamber consists of five to six longitudinal costae and two transverse costae, one of which formed the anterior costal ring, 5-6 μm wide. Anterior spines join with the anterior transverse ring, posterior spine with the converged end of lorica chamber. Overall lorica length 55-60 μm .

This species is distributed widely in coastal waters of both hemispheres (MANTON and LEADBEATER, 1978). There are minor differences in spine length and lorica size between specimens from each locality (LEADBEATER, 1972 b; MANTON and LEADBEATER, 1978; THOMSEN, 1973). The specimen from Lützow-Holm Bay is larger in size than those from other localities.

4. *Crinolina aperta* (LEADBEATER) THOMSEN in Norw. J. Bot., **23**, 33-51, 1976.

Basionym: *Diaphanoeca aperta* LEADBEATER in MANTON *et al.*, in Proc. R. Soc. Lond. Ser. B, **189**, 15-27, 1975. (Pl. 2, Figs. 7, 8)

Lorica trapezoid in side view, overall height 41 μm , open at both ends, composed of 12 longitudinal costae and two transverse costal rings, 15-15.5 μm diam. at the anterior transverse ring, 19 μm diam. at the posterior transverse

ring. Longitudinal costae consist of nine costal strips each. Anteriorly, one costal strip of each longitudinal costa projects beyond the anterior costal ring, and posteriorly, four costal strips project beyond the posterior costal ring. The posterior free end costal strips reduced in thickness and length towards apex, from $5\ \mu\text{m}$ to $4\ \mu\text{m}$ in length. Both the anterior and posterior transverse costal rings consist respectively of 12 costal strips, each $5\ \mu\text{m}$ long and L-shaped, and located at a distance of 4 longitudinal costal strips from each other.

The present specimen differs from the type in having smaller sized lorica, only one anterior free end costal strip (two in the type), and four longitudinal costal strips between two transverse costal rings (five in the type), but are similar to the specimens from the Weddell Sea, Antarctica in size of lorica. Further investigations on this species from more localities are needed in order to determine whether the above-mentioned differences in lorica structure are caused by environmental factors in each locality or other factors.

5. *Diaphanoeca multiannulata* BUCK in CRREL Rep., 80 (16), 1-26, 1980.

(Pl. 3, Figs. 9, 10)

Lorica barrel-shaped, $55-60\ \mu\text{m}$ high excluding posterior spine, $24-25\ \mu\text{m}$ wide (maximum), composed of 12 (or 11) longitudinal costae converging at posterior end and five transverse costal rings. Longitudinal costa consists of 12 (or 13) costal strips, each $6\ \mu\text{m}$ long, one and a third costal strips project as free end spines beyond the anterior transverse costal ring. Transverse costal rings consist of 10-11 costal strips each, *ca.* $6\ \mu\text{m}$ long, and spaced at intervals of one and a third, four and a half, six, eight and nine costal strips from anterior end of longitudinal costae. Overall length $61-66\ \mu\text{m}$.

This species was found in the sea water, sea ice and puddle water of the Weddell Sea, Antarctica in February and March 1977 (BUCK, 1980). The loricae from Lützow-Holm Bay are larger in size than the type ($33\pm 6-43\pm 3\times 21\pm 2-25\pm 2\ \mu\text{m}$ in BUCK, 1980). At present, it is recorded from Antarctica only.

6. *Parvicorbicula socialis* (MEUNIER) DEFLANDRE in Rev. Algol., 3, 183-189, 1960. (Pl. 3, Figs. 11, 12)

Lorica funnel-shaped, $12-13\ \mu\text{m}$ high, $15\ \mu\text{m}$ wide at anterior transverse costal ring, composed of 10 longitudinal costae and two transverse costae. Longitudinal costal strips between the anterior transverse costal ring and the posterior one, 10 in number, $6\ \mu\text{m}$ long, rounded and flattened at the anterior end and joined by T-junction with the anterior transverse costal strips, each

5 μm long, about four pairs of third longitudinal costal strips converged with each other at posterior end and connected with the cell chamber.

This species is distributed widely, in the Arctic, Denmark, the Atlantic Ocean between Ireland and Portugal, the Mediterranean, and Antarctica (DEFLANDRE, 1960; THRONDSSEN, 1974; BUCK, 1980).

7. *Parvicorbicula ongulensis* sp. nov. (Pl. 4, Figs. 13, 14)

Diagnosis: Lorica funnel-shaped, 34–35 μm high including posterior spine, composed of 14 longitudinal costae and three transverse costal rings. Longitudinal costae consist of five costal strips each, converged at posterior end, strips 5–5.5 μm long. Posterior spine consists of two or three costal strips, 10–10.5 μm long. Anteriorly, one costal strip of each longitudinal costa projects as free end spine beyond the anterior transverse costae. Transverse costal strips slightly curved, 4–4.2 μm long, slightly thicker than longitudinal costal strips, reduced in thickness at both ends, and 1/4 to 1/5 of each loosely overlapped. Anterior and second transverse costal rings consist of 14–15 costal strips respectively, posterior transverse costal ring of five to seven strips. Transverse costal rings spaced at intervals of one, one and a half, and one and a half costal strips from anterior end of longitudinal costae.

Cell ovoid, 3.5 \times 3.0 μm , with one acronematic flagellum, 8 μm long, situated in the posterior half of lorica.

Type figure: Fig. 13.

Habitat: Sea water under sea ice, found in Lützow-Holm Bay, Antarctica, January 21, 1980.

This species resembles *P. pedicellata* LEADBEATER in the basic lorica composition and lorica appearance but differs in having larger sized lorica and larger number of longitudinal costae. Both related species are less like other species belonging to genus *Parvicorbicula* in lorica structure, and have some resemblance to members of genera *Campanoeca* and *Acanthoecopsis*. It must be investigated whether both species should be kept within this genus, *Parvicorbicula*.

8. *Parvicorbicula* sp. (Sp. no. 9). (Pl. 4, Figs. 15, 16)

Lorica funnel-shaped, 17–18 μm high, 18–19 μm wide, composed of four longitudinal costae, two transverse costal rings and posterior cell chamber. Longitudinal costae consist of three each costal strips, stretched from the anterior costal ring to the posterior end. Both transverse costal rings consist of eight costal strips each, equal in diameter. Anterior tip of the anteriormost costal

strips of the longitudinal costa biforked and joined with the center of every second of the anterior transverse costal strips (T-conjunction), posterior end of it rounded and connected to end of every second of the posterior transverse costal strips (end-to-end conjunction). Second costal strips of the longitudinal costae identical to the anteriormost strips in the structure. Posterior strips of the longitudinal costae rounded at both ends but swollen at anterior end, forming a small cell chamber. Total costal strips composed of the lorica 28 in number.

The present specimen is similar to *P. circularis* THOMSEN in lorica composition and in structure of costal strips, but there are some differences between them. The lorica of *P. circularis* is composed of 26 costal strips; eight of anterior transverse costa, six of posterior transverse costa, and three of each longitudinal costa. However, it is maintained that the actual number of costal strips is larger because of duplication of costal strips in the posterior transverse costa and presence of supernumerary strips in the hind end of the lorica (THOMSEN, 1976), but the diameter of the posterior transverse costa ($20\ \mu\text{m}$) is smaller than that of the anterior transverse costa ($30\ \mu\text{m}$) as is illustrated in the type figure (Fig. 29 in THOMSEN, 1976). On the other hand, in this specimen from Lützow-Holm Bay, both transverse costal rings are the same in the number of costal strips and in diameter.

It is difficult to judge whether the specimen from Lützow-Holm Bay is within the normal variation of *P. circularis*. Further investigation is required.

9. *Pleurasiga* sp. (Sp. no. 4). (Pl. 5, Figs. 17-19)

Lorica barrel-shaped, $25\text{--}28\ \mu\text{m}$ high, $16\text{--}20.5\ \mu\text{m}$ wide, composed of 12 longitudinal costae and three transverse costal rings. Longitudinal costae converged at posterior end, each consists of four costal strips of $6.7\ \mu\text{m}$ long; transverse costal ring consists of 12 costal strips of $5\text{--}5.2\ \mu\text{m}$ long. Anteriorly, $1/4$ of the longitudinal costal strip projects as free end spine beyond the anterior transverse costal ring. Costal strips of second and third transverse costal rings and longitudinal costal strips connected with each other by "end-to-end conjunction". Transverse costal rings spaced at intervals of $1/4$, $1+3/4$, and one of costal strips from anterior end of longitudinal costae. Cell with collar, spherical, $3\ \mu\text{m}$ diam., collar $5\ \mu\text{m}$ high, situated in posterior half of lorica.

This specimen is very similar to *P. orculaeformis* sensu LEADBEATER but differs in having free end costae, though they are very short, and larger sized lorica.

10. *Saepicula leadbeateri* sp. nov. (Pl. 5, Fig. 20)

Diagnosis: Lorica bell-shaped, with two slight constrictions, 16.5 μm high, composed of open anterior part consisting of nine to 10 thick and slightly curved costal strips, cell chamber consisting of *ca.* 18 slightly oblique costal strips, and *ca.* 20 thick transverse costal strips on the anterior part. Longitudinally or obliquely arranged costae consist of three costal strips each, the anterior and second costal strips cut sharply and pointed at anterior end and abruptly cut at other end, strips 5.8–6 μm long. Transverse costal strips botuliformic, 2.5 μm long and 0.22 μm thick, loosely deposited.

Type figure: Fig. 20.

Habitat: Sea ice, found in Lützow-Holm Bay, Antarctica, in January 21, 1980.

This species is distinguishable from other species (LEADBEATER, 1980) in having elegant lorica proportion, peculiar transverse costal strips, no anterior ring and no transverse costae on the posterior chamber. It has some resemblance to *Calliacantha* in having diverging anterior costal strips and conical lorica chamber, but it can be distinguished at a glance by its elaborate and conspicuous lorica construction. It seems to be the best at present to place it in this genus.

11. Sp. "N" in MOESTRUP, 1979. (Pl. 5, Fig. 21)

Several disturbed loricae were collected from 100 meters deep layer. This is distributed in both hemispheres (MOESTRUP, 1979).

12. Choanoflagellate Sp. no. 15. (Pl. 6, Fig. 22)

Lorica bell-shaped, composed of one lorica chamber, 10 μm high and 8 μm wide, with 12 free end costal strips, each 3.8 μm long, and one long delicate peduncle, 14–15 μm long. Lorica chamber composed of 12 spirally arranged costae and transverse costae. Anteriorly, one costal strip of each spiral costa projects as free end costa beyond the anterior transverse costae. Posterior peduncle composed of lorica receptacle consisting of 12 diverging thick costal strips of 3.8 μm long and long stalk consisting of five to seven costal strips. Posterior end of lorica chamber held by lorica receptacle.

The undescribed lorica was collected from the bottom part of sea ice.

Furthermore, three kinds of undescribed loricae were collected.

Lorica of one kind (representing Sp. no. 17) is 6.5 μm high and 4 μm wide, and is composed of curved costal strips of 2.8–3.7 μm long and 0.05 μm thick (Pl. 6, Fig. 23).

Lorica of the second species (representing Sp. no. 21) is 5.4 μm high and 5–6 μm wide, with short free end costae, and is composed of relatively close arranged costal strips of 2.7–3.4 μm long and 0.05 μm thick (Pl. 6, Fig. 24).

Lorica of the third kind (representing Sp. no. 24) is bell-shaped, 12.6–14.5 μm high and 7–11 μm wide, and is composed of longitudinal costae, spirally or transversely arranged costal strips, and 12–18 free end costal strips, 7–9.7 μm long. Transverse costal strips are deposited mainly at anterior end of lorica and spiral ones scattered on the lorica chamber, 3.8–5.9 μm long (Pl. 6, Figs. 25, 26).

Centrohelida (Heliozoa)

1. *Pinaciophora fluviatilis* GREEF, 1875 sensu PENARD, 1904 in THOMSEN, *Protistologica*, **16**, 359–373, 1978.

Syn. *Potamodiscus kalbei* GERLOFF (1968). (Pl. 7, Figs. 27, 28)

Plate scale circular to slightly elliptical, 5.8–5.9 $\mu\text{m} \times 4.8$ –5.2 μm , with 10–11 large holes arranged in concentric hexagonal rings, 0.7 μm diam., and scattered internal struts which are seen as black dots in transmission electron micrographs.

This species is covered with one type of plate scale with 10 large holes to typically 19 ones. The present specimens have a smaller number of large holes than those from other localities in the Northern Hemisphere. This record is the first from Antarctica.

2. *Acanthocystis* sp. (Pl. 7, Fig. 29)

Plate scales elliptic with one longitudinal central rib, 1.7–1.8 $\mu\text{m} \times 1.2 \mu\text{m}$, spine scales consist of reniformic base plate, 0.8–0.9 $\mu\text{m} \times 0.5 \mu\text{m}$, and long, tapered and slightly spiralled spine, 6–6.5 μm long and 0.07 μm max. across.

Some fragments of lorica were collected from the surface part of sea ice.

Spine scales of unknown species (representing Sp. "S") were collected from the bottom part of sea ice. The scale is composed of triangular base plate with complicated structure and spine with triforked base and thickened apex. As the same scales were collected from an ice-covered lagoon, Lake Saroma, Japan, this species seems to be of world-wide distribution (Pl. 7, Fig. 30).

A new family, Acanthoecidae was described in 1965 by NORRIS (NORRIS, 1965). Eight new genera of this family and about 45 new species have been described during the past twenty years, and specific lorica compositions of about 15 known species have been revealed by electron microscopical studies

(BUCK, 1980; LEADBEATER, 1972a, b, 1973, 1975, 1978, 1980; LEADBEATER and MORTON, 1974; MANTON and LEADBEATER, 1978; MANTON and OATES, 1979 a, b; MANTON *et al.*, 1975, 1980; MOESTRUP, 1979; NORRIS, 1965; REYNOLDS, 1976; THOMSEN, 1973, 1976, 1977a, b, 1978a, b, 1979; THRONDSSEN, 1970a, b, 1974). Almost all of these species have been recorded from the Northern Hemisphere because of the intensive research works there.

In the Southern Hemisphere, a few species have been recorded from the coastal waters near Cape Town, RSA, and Galapagos Islands (MANTON *et al.*,

Species	Locality	Lützow-Holm Bay	Weddell Sea	New Zealand	Lake Saroma
	Author		Buck 1980	Moestrup 1979	Takahashi 1981
<i>Acanthoecopsis apoda</i>				○	○
<i>A. apinifera</i>			○		
<i>A. unguiculata</i>					○
<i>Bicosta antennigera</i>		○	○	○	
<i>B. minor</i>				○	
<i>B. spinifera</i>		○	○		
<i>Calliacantha multispina</i>			○		
<i>C. natans</i>		○		○	○
<i>C. simplex</i>			○		
<i>Crinolina aperta</i>		○	○		
<i>C. isefjordensis</i>				○	
<i>Diaphanoeca grandis</i>					○
<i>D. multiannulata</i>		○	○		
<i>Parvicorbicula ongulensis</i>		○			
<i>Parvicorbicula socialis</i>		○	○		
<i>P. pulchella</i>				○	
<i>P. sp.</i> (Sp. no. 9)		○			
<i>Pléarasiga sp.</i> (Sp. no. 4)		○			
<i>P. reynoldsii</i>				○	
<i>P. sphyrelata</i>				○	
<i>Saepicula leadbeateri</i>		○			
<i>Salpingoeca cruciformis</i>				○	
<i>Savillea micropora</i>					○
<i>Stephanoeca urnula</i>					○
Sp. "N" in Moestrup		○		○	
Sp. no. 15		○			
Sp. no. 17		○			
Sp. no. 21		○			
Sp. no. 24		○			
<i>Pinaciophora fluviatilis</i>		○			
<i>Acanthocystis sp.</i>		○			
Sp. "S"		○			●

○ ... Presence

Fig. 2. Occurrence of the Acanthoecidae and Heliozoa in Antarctica, New Zealand and Japan.

1980), 10 species from New Zealand (MOESTRUP, 1979). In Antarctica, *Parvicorbicula socialis* has been recorded in the Adelie Land (DEFLANDRE, 1960) and eight species from the Weddell Sea (BUCK, 1980). By the present investigation, two new species of the Acanthoecidae and *Pinaciophora fluviatilis* of the Heliozoa were found for the first time in Antarctica. Almost all identified species distributed in the Antarctic sea water excluding three species, *Diaphanoeca multiannulata* BUCK, *Parvicorbicula ongulensis* and *Saepicula leadbeateri*, have been recorded from the Northern Hemisphere. However, there are still eight kinds of unidentified loricae and a type of spine scale of unknown taxon even in the samples from the one sampling station in Lützow-Holm Bay. It is expected that more species will be discovered in Antarctica.

3.2. Vertical distribution of the species (Fig. 3)

Of the Acanthoecidae, only one species was distributed in both the sea ice and sea water. There are six species in the sea ice and eight in the sea water only. The distribution of species which inhabit in the sea ice is restricted in the lower half part of sea ice. The distribution of the family observed in Lake Saroma, Hokkaido (TAKAHASHI, 1981) is similar to the present results. In Lake Saroma, one species among seven species was distributed in both the sea ice and sea water, three species in the sea ice, and the remaining three in the sea water, though the species compositions of the Acanthoecidae population in both localities differ from each other. On the other hand, among eight species of the Acanthoecidae from the Weddell Sea (BUCK, 1980), one species was collected from the sea water only but it was collected from the sea ice of Lützow-Holm Bay. The other seven species were obtained from the sea water, sea ice and puddle of the Weddell Sea. Six species among them were collected from Lützow-Holm Bay. Two of six were found in the sea ice and three in the sea water. One species occurred commonly in both habitats.

The lorica number of the choanoflagellates per one grid may be considered to indicate their densities in habitats. The vertical distribution of choanoflagellates is shown in Fig. 3. Two peaks were seen in the bottom part of the sea ice and in 10 meters layer of sea water. This fluctuation pattern in lorica number coincided with that of diatom valves.

Through the present work, it is clarified that the Antarctic Ocean is one of the most interesting areas as the habitats of choanoflagellates and scale bearing protists. Therefore, more extensive surveys of the species should be made.

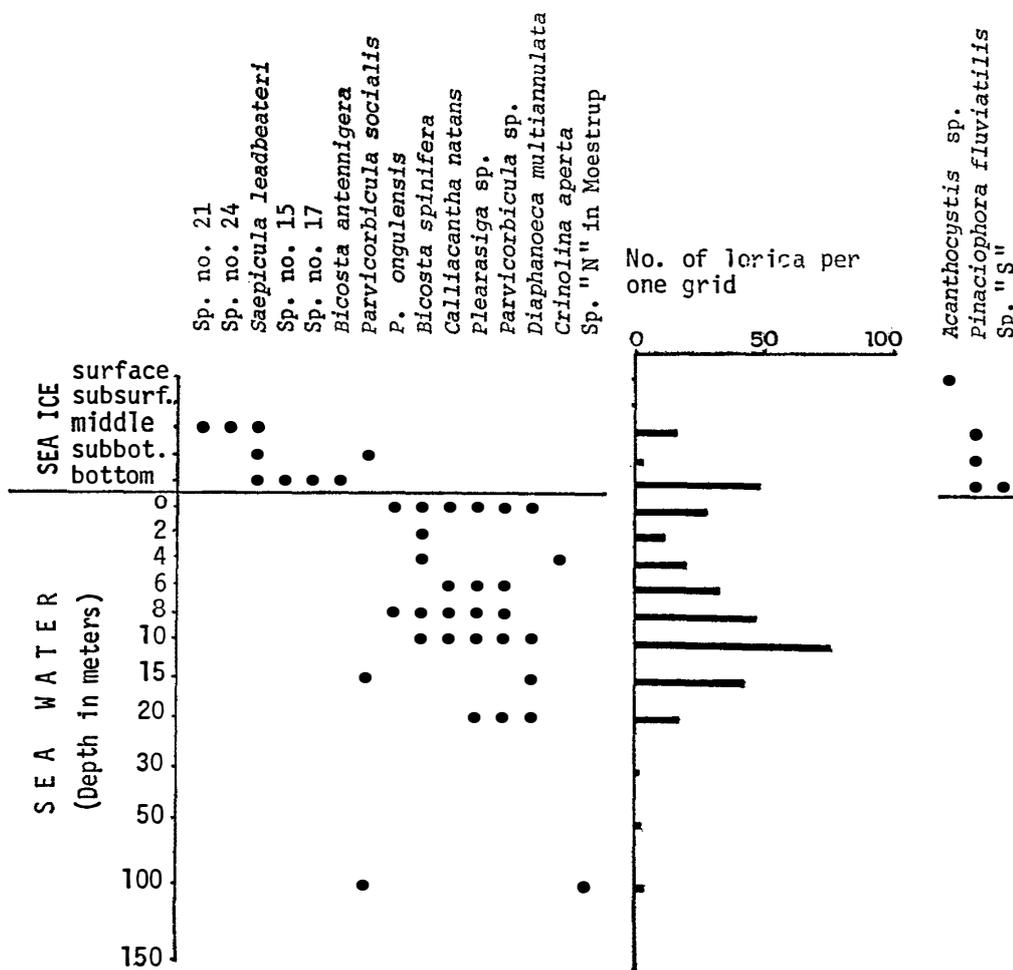


Fig. 3. Vertical distribution of species and vertical change of number of lorica of the choanoflagellates per one grid at a sampling station of Lützow-Holm Bay, Antarctica, January 21 1980.

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References

- BUCK, K. (1980): Morphology and distribution of the Acanthoecidae (Choanoflagellata) from the Weddell Sea during the austral summer, 1977. *CRREL Rep.*, **80** (16), 1-26.
- DEFLANDRE, G. (1960): Sur la présence de *Parvicorbicula* n. g. *socialis* (MEUNIER) dans le plancton de l'Antarctique (Terre Adélie). *Rev. Algol.*, **3**, 183-189.
- ELLIS, W. N. (1929): Recent researches on the Choanoflagellata (Craspedomonadines) (Fresh-water and marine) with description of new genera and species. *Ann. Soc. R. Zool. Belg.*, **60**, 49-88, pls. 2.
- LEADBEATER, B. S. C. (1972a): Fine structural observations on some marine choanoflagellates from the coast of Norway. *J. Mar. Biol. Assoc. U. K.*, **52**, 67-79.
- LEADBEATER, B. S. C. (1972b): Ultrastructural observations on some marine choanoflagellates from the coast of Denmark. *Br. Phycol. J.*, **7**, 195-211.
- LEADBEATER, B. S. C. (1973): External morphology of some marine choanoflagellates from the coast of Yugoslavia. *Arch. Protistenkd.*, **115**, 234-252.
- LEADBEATER, B. S. C. (1975): A microscopical study of the marine choanoflagellate *Savillea micropora* (NORRIS) comb. nov., and preliminary observations on lorica development in *S. micropora* and *Stephanoeca diplocostata* ELLIS. *Protoplasma*, **83**, 111-129.
- LEADBEATER, B. S. C. (1978): Renaming of *Salpingoeca* sensu GRØNTVED. *J. Mar. Biol. Assoc. U. K.*, **58**, 511-515.
- LEADBEATER, B. S. C. (1980): Four new species of loricate choanoflagellates from South Brittany, France. *Cah. Biol. Mar.*, **21**, 345-353.
- LEADBEATER, B. S. C. and MORTON, C. (1974): A light and electron microscope study of the choanoflagellates *Acanthoeca spectabilis* ELLIS and *A. brevipoda* ELLIS. *Arch. Microbiol.*, **95**, 279-292.
- MANTON, I. and LEADBEATER, B. S. C. (1978): Some critical qualitative details of lorica construction in the type species of *Calliacantha* LEADBEATER (Choanoflagellata). *Proc. R. Soc. Lond. Ser. B*, **203**, 49-57.
- MANTON, I. and OATES, K. (1979a): Further observations on choanoflagellates in the genus *Calliacantha* LEADBEATER, with special reference to *C. multispina* sp. nov. from South Africa and Britain. *J. Mar. Biol. Assoc. U. K.*, **59**, 207-213.
- MANTON, I. and OATES, K. (1979b): Further observations on *Calliacantha* LEADBEATER (Choanoflagellata), with special reference to *C. simplex* sp. nov. from many parts of the world. *Proc. R. Soc. Lond., Ser. B*, **204**, 287-300.
- MANTON, I., SUTHERLAND, J. and LEADBEATER, B. S. C. (1975): Four new species of choanoflagellates from Arctic Canada. *Proc. R. Soc. Lond., Ser. B*, **189**, 15-27.
- MANTON, I., SUTHERLAND, J. and OATES, K. (1980): A reinvestigation of collared flagellates in the genus *Bicosta* LEADBEATER with special reference to correlations with climate. *Philos. Trans. R. Soc. Lond. Ser. B*, **290**, 431-447.
- MOESTRUP, Ø. (1979): Identification by electron microscopy of marine nanoplankton from New Zealand including the description of four new species. *N. Z. J. Bot.*, **17**, 61-95.
- NORRIS, R. E. (1965): Neustonic marine Craspedomonadales (Choanoflagellates) from Washington and California. *J. Protozool.*, **12**, 589-602.
- PARKE, M. and LEADBEATER, B. S. C. (1977): Check-list of British marine Choanoflagellida—second revision. *J. Mar. Biol. Assoc. U. K.*, **57**, 1-6.

- REYNOLDS, N. (1976): Observations on *Salpingoeca spinifera* THRONDSSEN and *S. minor* sp. nov. (Craspedophyceae). Br. Phycol. J., **11**, 13–17.
- TAKAHASHI, E. (1981): Floristic study of ice algae in the sea ice of a lagoon, Lake Saroma, Hokkaido. Mem. Natl Inst. Polar Res. Ser. E., **34**, 49–56.
- THOMSEN, H. A. (1973): Studies on marine choanoflagellates I. Silicified choanoflagellates of the Isefjord (Denmark). Ophelia, **12**, 1–26.
- THOMSEN, H. A. (1976): Studies on marine choanoflagellates II. Fine-structural observations on some silicified choanoflagellates from the Isefjord (Denmark), including the description of two new species. Norw. J. Bot., **23**, 33–51.
- THOMSEN, H. A. (1977a): External morphology of the choanoflagellate *Salpingoeca gracilis* JAMES-CLARK. J. Mar. Biol. Assoc. U. K., **57**, 629–634.
- THOMSEN, H. A. (1977b): Studies on marine choanoflagellates III. An electron microscopical survey of the genus *Acanthoecopsis*. Arch. Protistenkd., **119**, 86–99.
- THOMSEN, H. A. (1978a): On the identity between the heliozoan *Pinaciophora fluviatilis* and *Potamodiscus kalbei*; with the description of eight new *Pinaciophora* species. Protistologica, **14**, 350–373.
- THOMSEN, H. A. (1978b): Nannoplankton from the gulf of Elat (=Gulf of Aqaba), with particular emphasis on choanoflagellates. Isr. J. Zool., **27**, 34–44.
- THOMSEN, H. A. (1979): Electron microscopical observations on brackish-water nannoplankton from the Tvärminne area, SW coast of Finland. Acta Bot. Fenn., **110**, 11–37.
- THRONDSSEN, J. (1970a): Marine planktonic Acanthoecaceans (Craspedophyceae) from Arctic Waters. Nytt Mag. Bot., **17**, 103–111.
- THRONDSSEN, J. (1970b): *Salpingoeca spinifera* Sp. nov. A new planktonic species of the Craspedophyceae recorded in the Arctic. Br. Phycol. J., **5**, 87–89.
- THRONDSSEN, J. (1974): Planktonic choanoflagellates from North Atlantic waters. Sarsia, **56**, 95–122.

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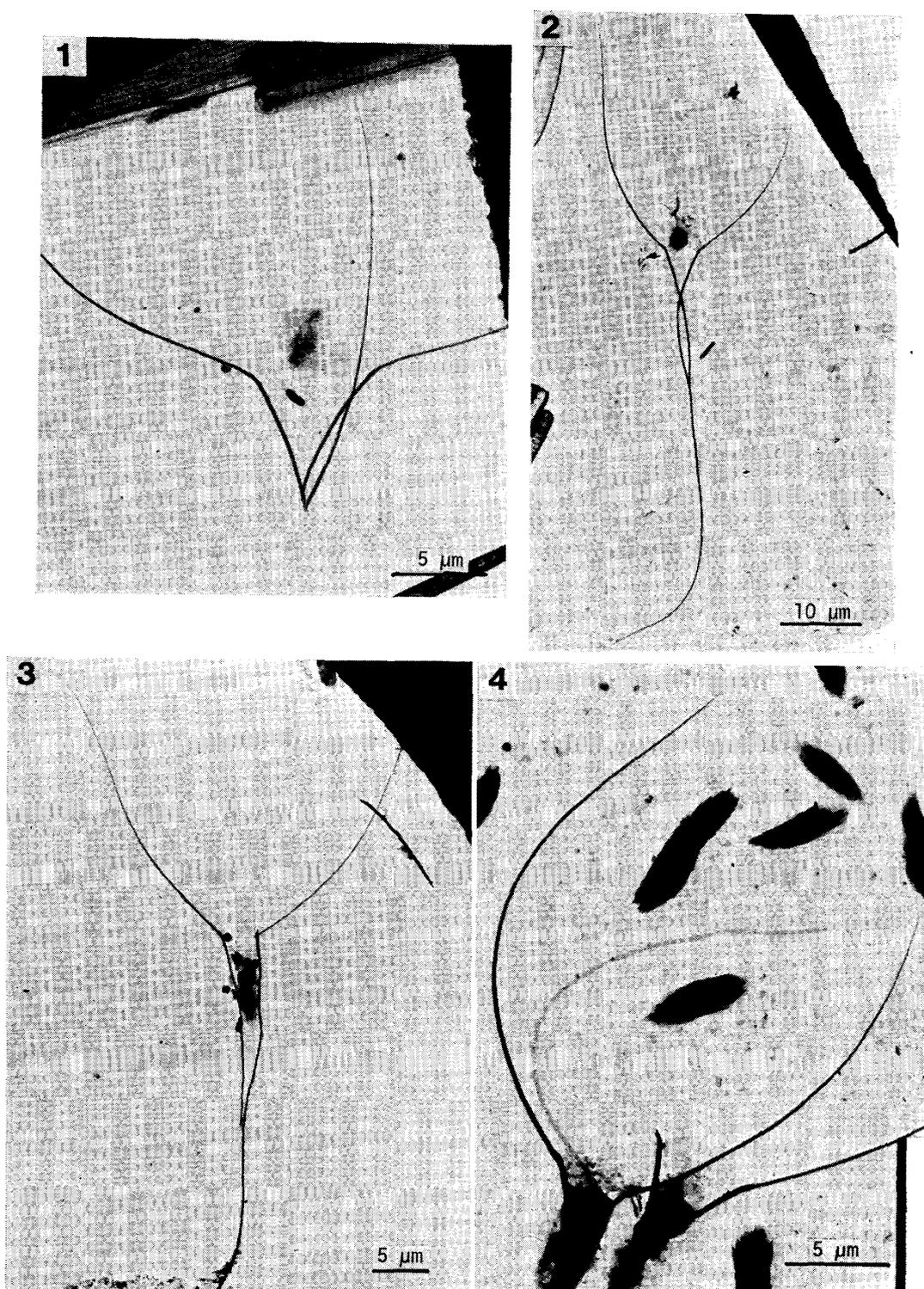


Plate 1.

- Fig. 1. *Bicosta antennigera*; a lorica, posterior spine is upturned.
 Fig. 2. *Bicosta spinifera*; a typical whole lorica.
 Fig. 3. *B. spinifera*; a lorica in which costal strips of cell chamber do not cross.
 Fig. 4. An acronematic flagellum of *B. spinifera*.

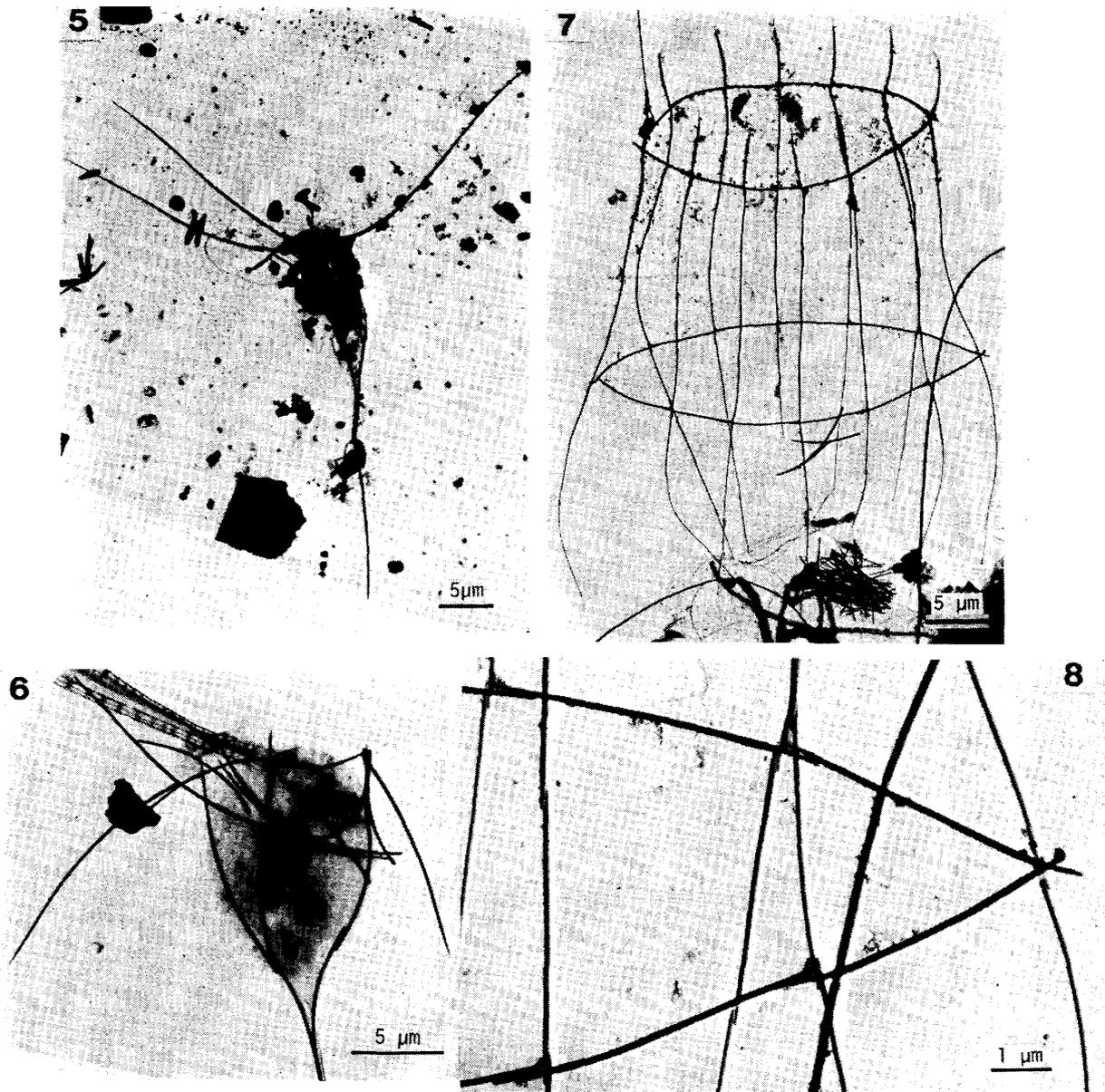
**Plate 2.**

Fig. 5. *Calliacantha natans*; a whole lorica.

Fig. 6. *C. natans*; other lorica.

Fig. 7. *Crinolina aperta*; an intact lorica.

Fig. 8. *C. aperta*; a part of lorica showing L-shaped transverse costal strips and "end-to-end conjunction" of transverse and longitudinal costal strips.

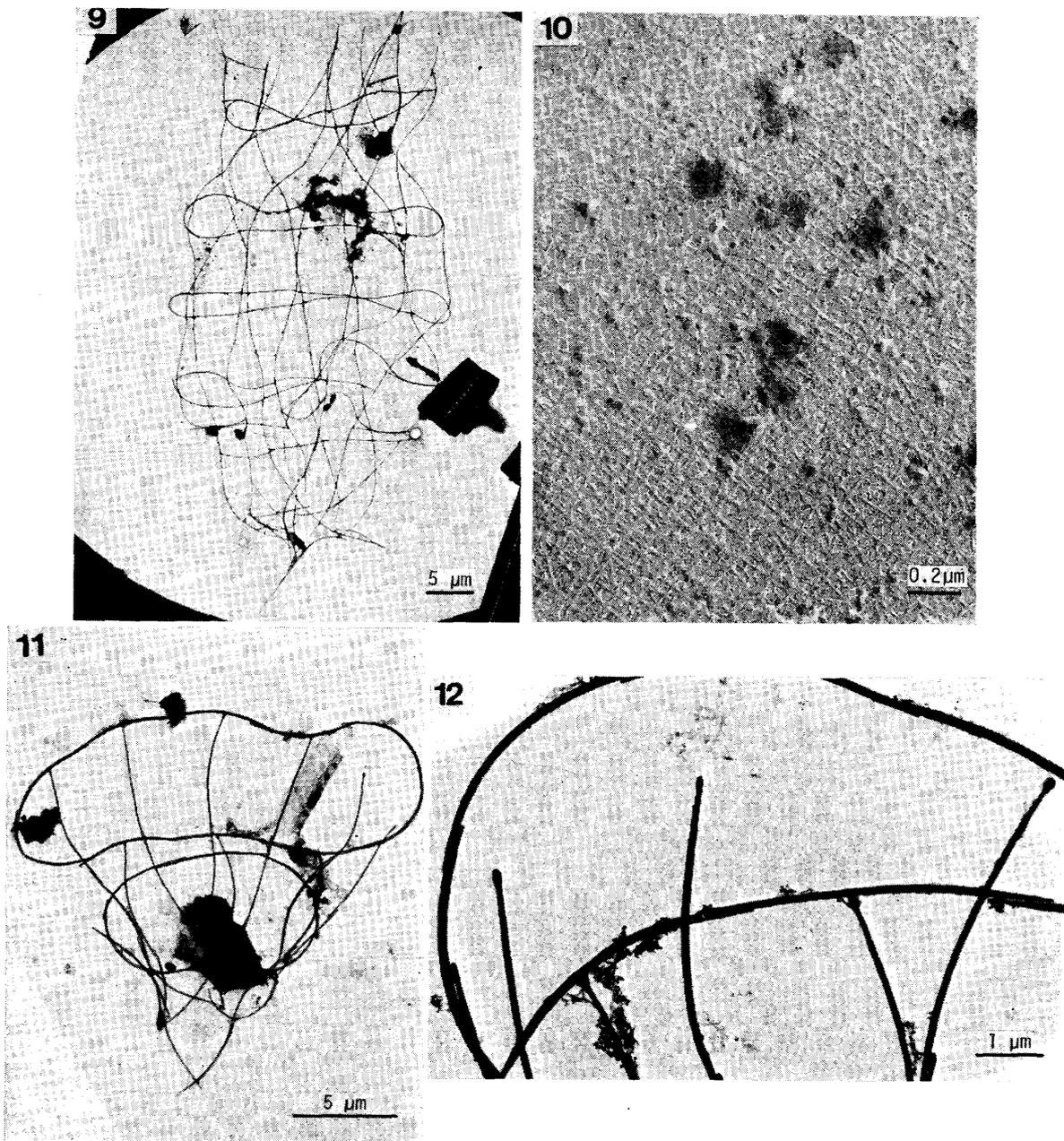


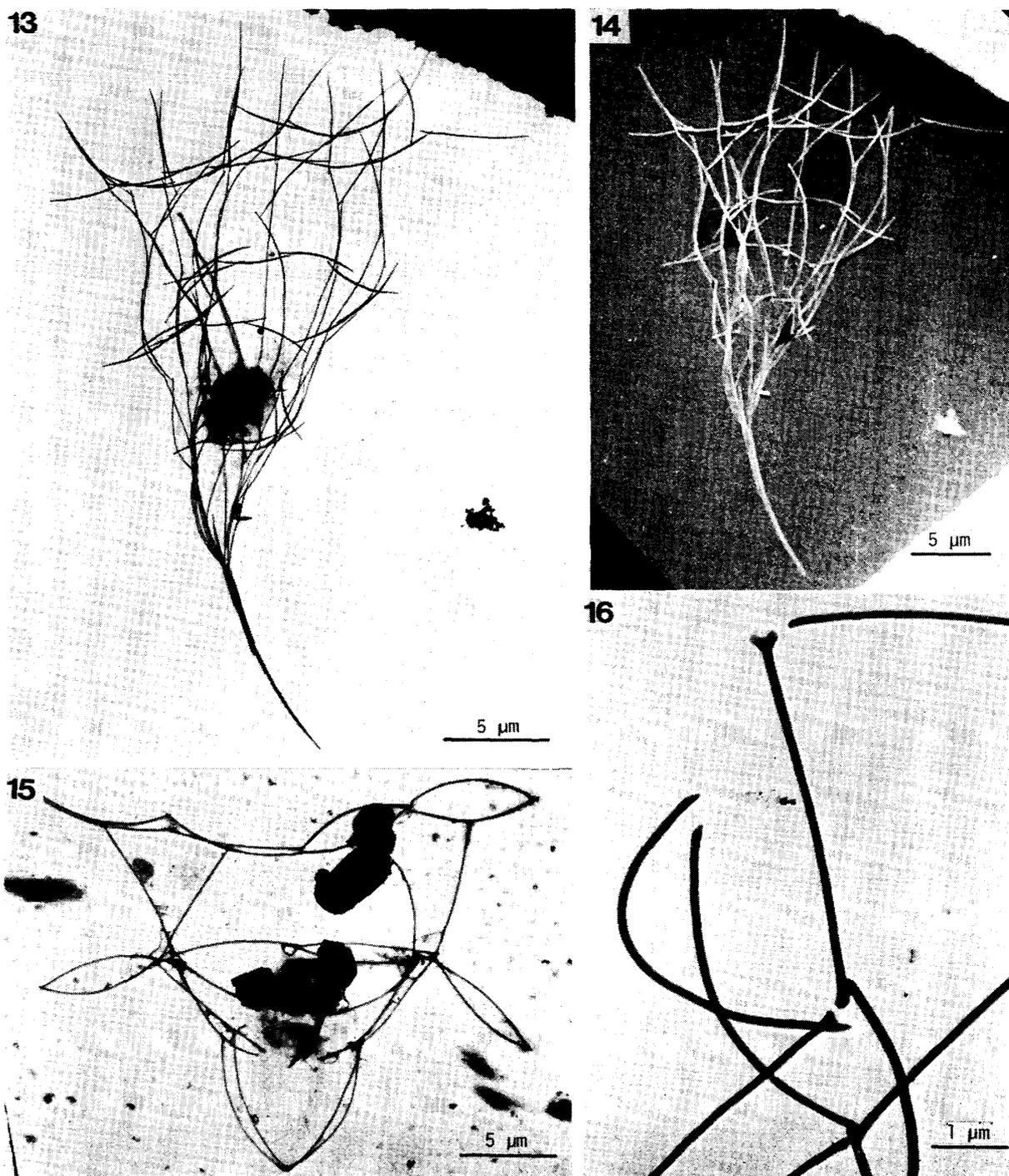
Plate 3.

Fig. 9. *Diaphanoeca multiannulata*; a whole lorica.

Fig. 10. A part of lorica membrane consisting of regularly arranged microfibrils.

Fig. 11. *Parvicorbicula socialis*; a whole lorica.

Fig. 12. *P. socialis*; apical tips of five longitudinal costal strips.

**Plate 4.**

- Fig. 13. *Parvicorbicula ongulensis* sp. nov.; an intact lorica containing uniflagellated cell.
- Fig. 14. The same lorica (SEM).
- Fig. 15. *Parvicorbicula* sp. (Sp. no. 9); a whole lorica.
- Fig. 16. *P.* sp. (Sp. no. 9); longitudinal costal strips with biforked apical tip and two curved transverse costal strips with obliquely cut both ends.

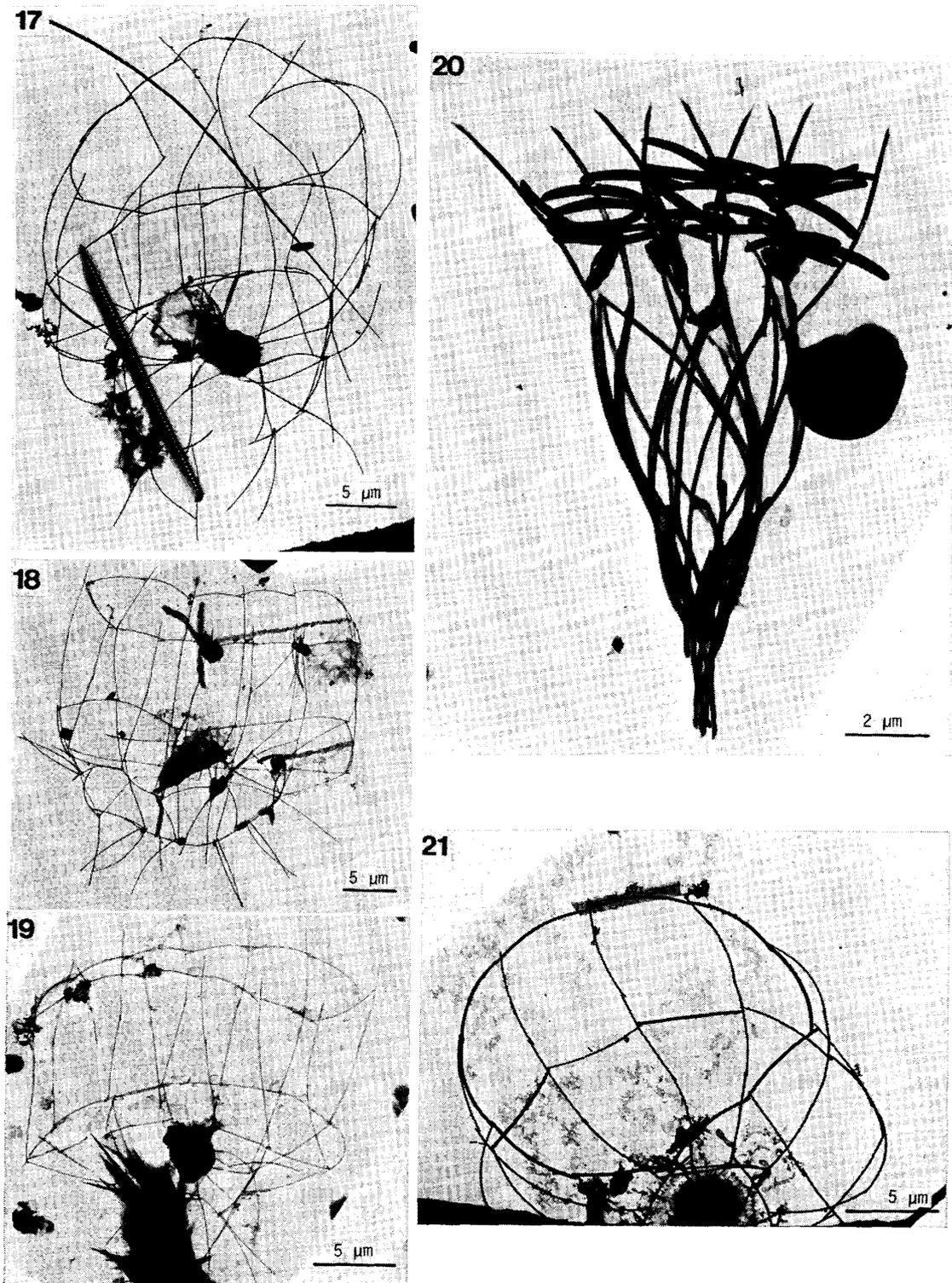


Plate 5.

Figs. 17-19. Three loricae of *Pleurasiga* sp. (Sp. no. 4)

Fig. 20. *Saepicula leadbeateri* sp. nov.; a whole loricula.

Fig. 21. Choanoflagellate sp. "N" in MOESTRUP.

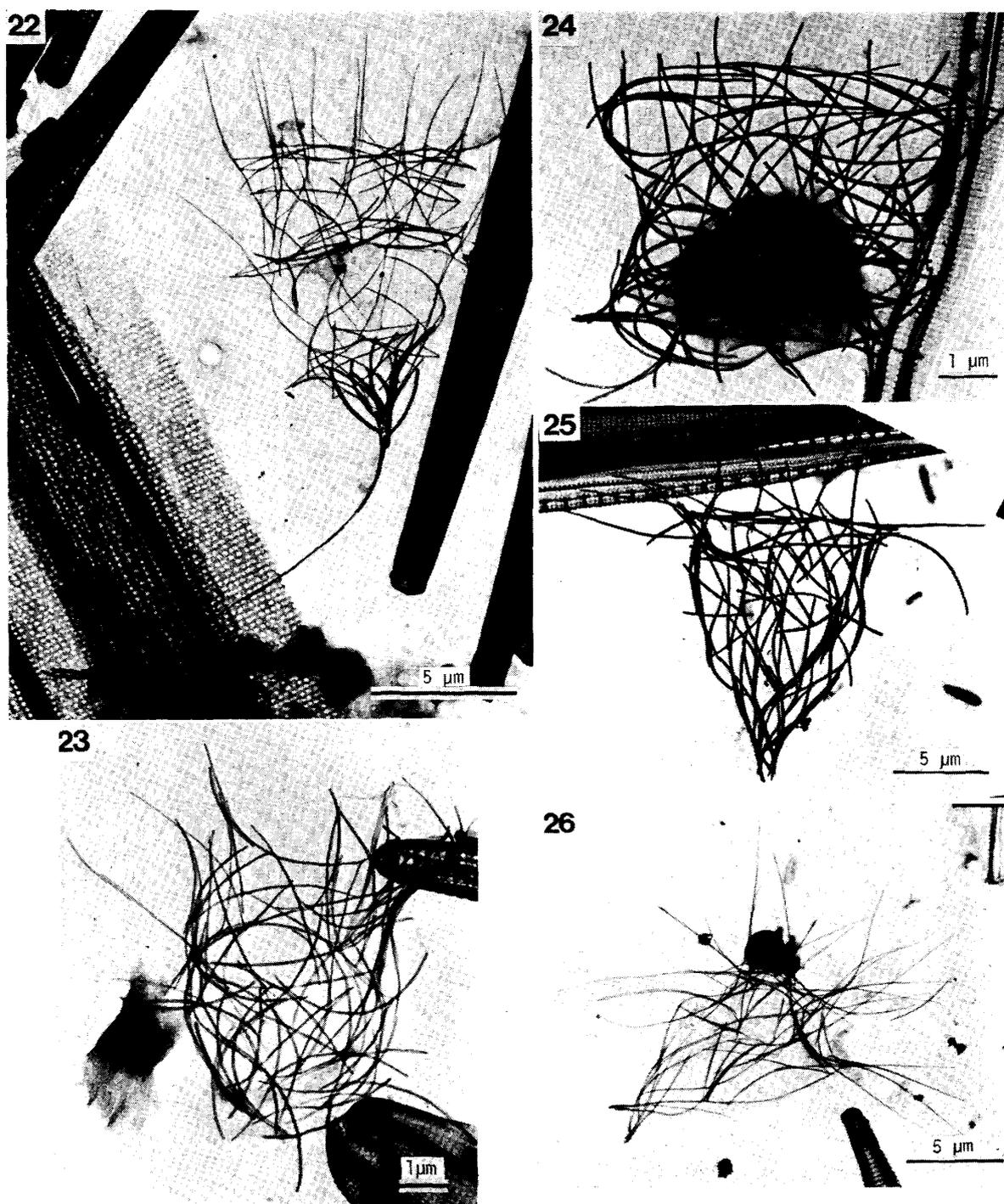
**Plate 6.**

Fig. 22. Sp. no. 15; a whole lorica.

Fig. 23. Sp. no. 17; a whole lorica.

Fig. 24. Sp. no. 21; a newly produced or disturbed lorica.

Figs. 25, 26. Sp. no. 24; a whole lorica and a probably newly produced lorica.

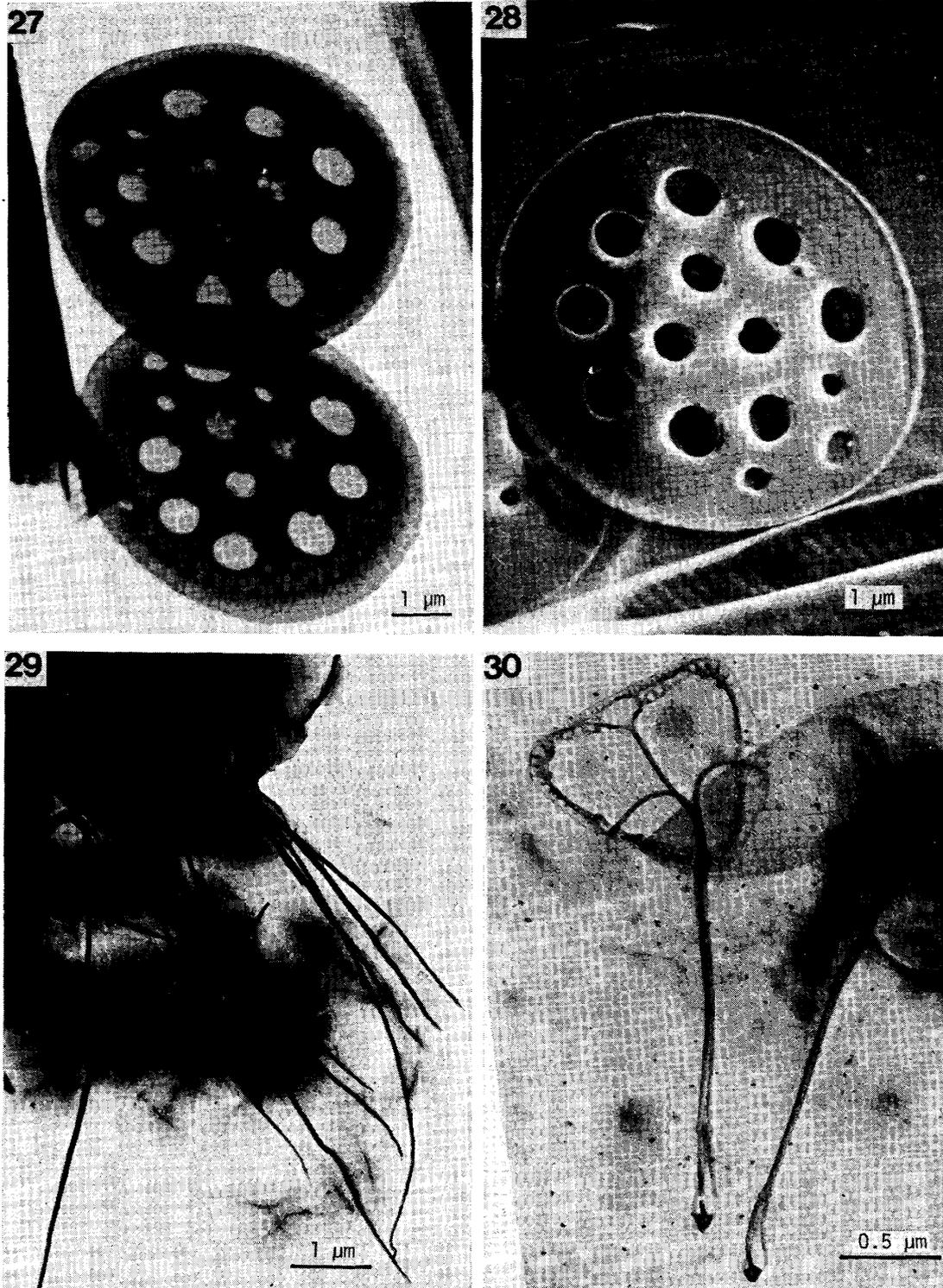


Plate 7.

Fig. 27. *Pinaciophora fluviatilis*; two plate scales.

Fig. 28. *P. fluviatilis*; a plate scale is the same as the upper scale in Fig. 27(SEM).

Fig. 29. *Acanthocystis* sp.; a part of envelope.

Fig. 30. A spine scale of unknown taxon (Sp. "S").