

Synedropsis gen. nov., a genus of araphid diatoms associated with sea ice

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A new araphid diatom genus, *Synedropsis* Hasle, Medlin et Syvertsen, is described from sea ice. The generitype, *Synedropsis hyperborea* (Grunow) Hasle, Medlin et Syvertsen from the Arctic, was first described as a species of *Synedra*, as was the antarctic *Synedropsis fragilis* (Manguin) Hasle, Syvertsen et Medlin. A second antarctic species of *Synedropsis* is a new combination of *Cymatosira laevis* Heiden in Heiden & Kolbe. In addition four new taxa, *S. hyperboreoides* Hasle, Syvertsen et Medlin, *S. recta* Hasle, Medlin et Syvertsen, *S. lata* Hasle, Medlin et Syvertsen and *S. lata* var. *angustata* Hasle, Medlin et Syvertsen are described from the Antarctic. The valve wall is laminar with uniseriate, often poorly developed striae and a wide sternum. Each valve possesses apical fields composed of slits. A labiate process is positioned near one apical slit field. The valve outline for most species exhibits considerable stadal variation. The girdle has several bands, most with one row of poroids close to the pars interior. Thus *Synedropsis* is closely related to the marine *Fragilaria striatula* Lyngbye except in the structure of the apical fields and the number of bands. Species observed in uncleaned material appeared in stellate or, more seldom, ribbon-shaped colonies. *Synedropsis hyperborea* is a common epiphyte on the ice-associated *Melosira arctica* Dickie in the Arctic. The antarctic species were found mainly in the bottom ice community, *S. fragilis* as an epiphyte on other diatoms.

INTRODUCTION

Raphe-bearing diatoms are abundant, often dominant, in sea ice biota in the Arctic (de Sève & Dunbar 1990; Poulin 1990; Syvertsen 1991) and in the Antarctic (Garrison *et al.* 1987; Garrison 1991). Records of araphid diatoms identified below the generic level are, on the other hand, scarce from polar benthic habitats. Even so, in an investigation of algal assemblages in antarctic pack-ice and ice-edge plankton an unidentified species of the araphid genus *Synedra* Ehrenberg was one of the more common diatoms in the ice assemblages, and was present in 21 of 33 ice samples compared to one of 74 water samples (Garrison *et al.* 1987). The paucity of identifications at the species level may be explained by a lack of taxonomic electron-microscopic investigations.

Araphid diatoms, in general, were neglected by taxonomists for a long time. Recently more attention has been paid to this heterogeneous group, especially to species traditionally allocated to *Fragilaria* Lyngbye and *Synedra*. One recent approach has been to split the genera into a number of smaller ones (Williams & Round 1986, 1988a, 1988b). Circumscription of the new genera has been based on valve striation, presence or absence of labiate processes, and structure of labiate processes, apical fields and the girdle. Using these same criteria we have been able to define a group of araphid diatoms from sea ice that we regard as sufficiently homogeneous morphologically and distinctive from other diatoms to be described as a new genus.

MATERIAL AND METHODS

The material examined consists of (1) diatom slides belonging to the Natural History Museum, London (BM); the Manguin Collection in the Muséum National d'Histoire Naturelle, Paris (PC); the P.T. Cleve Collection in the Naturhistoriska Museet,

Stockholm (S); the Heiden and Kolbe Collection at the Friedrich-Hustedt-Arbeitsplatz für Diatomeenkunde, Bremerhaven (BRM); the Grunow Collection in the Naturhistorisches Museum, Wien (W); and the Department of Biology, Marine Botany, University of Oslo (IMBB), (2) ice and plankton samples (IMBB) (Table 1), and (3) cultures established by one of us (EES). Samples were rinsed and cleaned following Hasle (1978) and were examined with a Leitz Orthoplan and a Nikon Optiphot. Preparation for electron microscopy follows Hasle (1978) and samples were examined on a Jeol JSM 35C scanning electron microscope (SEM) or a Jeol 100C transmission electron microscope (TEM) at the Electron Microscopical Unit for Biological Sciences, University of Oslo.

Morphometric measurements of each taxon are presented in Table 2. Terminology follows Anonymous (1975) and Ross *et al.* (1979) with a few additions. Sternum is used for the former axial area, meaning 'an elongate part of the valve where areolae are sparse or missing' (Mann 1978, p. 27). The term is thus not used exclusively for a central regular rib extending the length of the valve but for the whole part of the valve face lacking areolae, and also the former 'central area'. Since the valve apices of the new genus have long slits and bars in an apical direction and no crossing bars or circular pores, the term apical slit field (Takano 1983) is adopted as more appropriate than apical pore field. Following Ross & Sims (1985) the term projection is used for rostrate, prolonged distal parts of the valves, more or less sharply delimited from the central part of the valve.

RESULTS

Synedropsis Hasle, Medlin et Syvertsen gen. nov.

DESCRIPTION: Cellulae elongatae, singulares, in coloniis stellatis vel, raro, vittiformibus. In quaque cellula chloroplasti duo, lami-

niformes, unus sub fronte quaque subjectus. Cellulae in facie connectivali visae anguste elongatae. Limbus in speciebus nonnullis profundus, striatus, plerumque margine lato, non perforato, instructus. Cingulum ex aliquot taeniis finibus acutis constans, taeniis pluribus seriem unam areolarum prope partem interiorem ferentibus, aliis non perforatis. Valvae anguste ellipticae vel lanceolatae sine vel cum apicibus rostratis. Striae in valva parallelae, uniseriatae, areolis poroidibus, circularibus. Striae in partibus valvae oppositae, alibi alternae. Sternum inter foramen certe angustam et late lanceolatam varians. Rimoportula una, prope apicem unum, in latere uno sterni, vulgo ad axem apicalem perpendicularis vel paene obliqua. Uterque apex valvae agro apicali ex rimis longitudinalibus per valvam penetrantibus constanti instructus.

Cells elongate, single, in stellate colonies or rarely in ribbons. Two plate-like chloroplasts per cell, each lying beneath one valve face. Cells in girdle view narrowly elongate. Valve mantle deep in some species, striated, mostly with a wide unperforated margin. Several open bands with pointed ends, most of the bands with one row of poroid areolae close to pars interior, others unperforated. Valves narrowly elliptical to lanceolate with rostrate ends. Valve striae parallel, uniseriate with circular poroid areolae. Striae opposite in some parts of the valve, alternate in others. Sternum varying from distinctly narrow to diffusely wide lanceolate. One labiate process located close to one apex on one side of sternum, usually perpendicular or slightly oblique to apical axis. Each valve pole with an apical field composed of longitudinal slits through the valve wall.

TYPE SPECIES: *Synedropsis hyperborea* (Grunow) Hasle, Medlin et Syvertsen comb. nov.

BASIONYM: *Synedra hyperborea* Grunow 1884, p. 106, pl. II (B), fig. 4.

***Synedropsis hyperborea* (Grunow) Hasle, Medlin et Syvertsen comb. nov.**

Figs 1–12, 17–21, 24–26, 31–38,
45–47, 142a, Table 2

SYNONYMS: *Synedra hyperborea* var. *flexuosa* Grunow 1884, p. 106, pl. 2, fig. 5a–g; *S. hyperborea* var.? *rostellata* Grunow 1884, p. 106, pl. 2, fig. 6a, b.

LECTOTYPE: Grunow slide 2550 c, Franz Josef Land No. 2. 2/8 872. 431/67 (W).

TYPE LOCALITY: 74°48'4"N, 54°52'8"E (Franz Josef Land).

MORPHOLOGY: Stellate colonies (Figs 9, 37) were observed in clonal cultures and epiphytic on *Melosira arctica* Dickie attached to the under-surface of 3-m thick multi-year ice. The cells are spindle-shaped with 5–6 open bands per cell. The bands are narrow with pointed ends and one row of irregularly spaced poroid areolae or no perforations (Figs 24–26).

The valve outline varies considerably and is correlated with the gradual reduction in apical axis length during vegetative cell division ('stadial variation'). Specimens of maximum size are rostrate (Figs 1, 2, 8, 12). The prolonged valve projections are reduced in length as the specimens become smaller (Figs 2–7) and the smallest valves are almost lanceolate (Fig. 10). Some valves of various sizes have irregular inflations and indentations (Figs 3, 5, 6, 11, 19, 20).

The uniseriate striae are parallel and alternate in some parts of the valve (Figs 2, 18, 47) or are very slightly radiate (Figs 18–21, 27). The vela of the poroid areolae are highly branched and similar to volae (Fig. 47). The interstriae are usually wider than the striae (Figs 17–20) and lie flush with the striae on the

external valve surface (Figs 35–38). The sternum varies from narrow and linear (Figs 8, 20, 31) with a central widening (Figs 7, 18), to in the most extreme cases, a wide extension filling most of the valve face (Fig. 19). The valve mantle is shallow with a broad, unperforated margin (Figs 33, 38).

The labiate process is located two or three striae from the valve apex (Figs 6, 17–21, 32). Its broad, thickened lips are slightly raised above the valve surface with a narrow slit somewhat oblique to the apical axis (Figs 32, 34). The process opens externally into an elongate hole larger than the surrounding areolae (Fig. 36).

The apical fields are composed of 4–6, usually 5, slits (Fig. 21), and each pole contains the same number of slits (Figs 45, 46).

Synedropsis hyperborea is weakly silicified but, even so, the striation and the labiate process are resolved in LM on cleaned valves mounted in a medium. The apical fields are visible as dense spots close to the apices although electron microscopy is needed to reveal the apical slits.

TAXONOMY: This diatom was first reported by Grunow at the varietal level in the text to the Cleve and Møller Diatom Exsiccata (slide No. 314). Grunow (1884, p. 106) reported it under the genus *Synedra* as '*S. hyperborea* Grun. in Cleve et Moeller's Diat. Nr. 314' with a Latin diagnosis and illustrations. We have examined Cleve and Møller slide No. 314 (BM 13043), the slides (W 2250a–d) Grunow referred to in his notebook for *Synedra investiens* var. *hyperborea*, var. *flexuosa* and var. *rostellata*, the P.T. Cleve slide VI-2-32 (S) prepared from the same material and two clonal cultures: one from the Barents Sea (EES clone B.S.1, 77°05.3'N, 32°25.7'E, 13 July 1979) and the other from the Oslofjord, Norway (EES Oslofjord clone).

The examination of this and additional arctic samples showed that *Synedra hyperborea* var. *rostellata* represents part of the size range of *Synedropsis hyperborea* and var. *flexuosa* aberrant forms. These varieties are therefore rejected as separate taxa. The rejection accords with Grunow's comment (1884, p. 102) that the varieties might partly be *Verkümmerungsformen*, i.e. cells that continue to divide under unfavourable conditions.

DISTRIBUTION: Both previous records (e.g. Grunow 1884; Østrup 1895; Cleve 1896; Hsiao 1983) and our own studies characterize *Synedropsis hyperborea* as an arctic, planktonic as well as epiphytic, circumpolar species, associated with sea ice and *Melosira arctica* (Hasle & Syvertsen 1985).

The southernmost records in the Arctic are from the east coast of Greenland (c. 66°N) and Frobisher Bay (Iqaluit) (c. 63°N). *Synedropsis hyperborea* has also been found as a member of a so-called arctic element in the Oslofjord and the Baltic Sea (Hasle & Syvertsen 1990). It was originally described from the under-surface of ice collected in August 1872 (Grunow 1884). In our investigation it was found associated with *M. arctica* in the Denmark Strait in late June and far north in the Barents Sea in August (IMBB Sample 2439); in the plankton outside the ice-edge in the Denmark Strait in April and in the plankton in the Barents Sea in July (IMBB Samples 1782, 1784).

The circumpolar distribution and the great abundance in which this species is found (EES, pers. obs.) may be explained by its association with the widespread ice-associated *Melosira arctica*.

Table 1. Samples examined

Arctic samples			
Number	Date	Location	Collector
IMBB 2439	2 Aug. 1984	82°15'N 26°51'E Under c. 3 m ice (SCUBA coll.)	E.E. Syvertsen Univ. of Oslo
IMBB 1921 YMER St.2A	17 Aug. 1980	81°37'N 20°27'E Ice surface	L. Edler Univ. of Lund
IMBB 572	14 Aug. 1973	80°20'N 26°30'E Under-surface of c. 1 m ice	T. Benjaminsen IMR, Norway
IMBB 568	11 Aug. 1973	80°18'N 28°30'E Under-surface of c. 1 m ice	T. Benjaminsen IMR, Norway
IMBB 1615	24 Aug. 1977	79°03'N 27°40'E Svalbard Pond on ice	M. Schaanning Univ. of Oslo
IMBB 1784 G.O.Sars St.658	18 July 1979	77°02'N 33°14'E Plankton outside ice edge	E.E. Syvertsen Univ. of Oslo
IMBB 1782 G.O.Sars St.551	12 July 1979	76°45'W 30°04'E Plankton outside ice edge	E.E. Syvertsen Univ. of Oslo
	17 Apr. 1960	c. 68°N c. 20°W Denmark Strait Plankton outside ice edge	
	20 June 1960	c. 67°N Denmark Strait Plankton	
IMBB 2039	Aug. 1980	c. 76°N c. 85°W Jones Sound Plankton	P. Lawrence Canada
		South Atlantic Ocean	
IMBB 58 (12)	23 Nov. 1976	60°42.5'S 45°36'W Signy Island in the South Orkney Is Iceberg shelf	T.A. Whitaker BAS
IMBB 2698 EPOS	10 Nov. 1988	60°45'S 45°40'E Signy Island Sub-ice (SCUBA coll.)	E.E. Syvertsen Univ. of Oslo
R 154	31 Jan. 1957	62°30'S 19°42'W Under-surface of pack ice	R.W. Riedel Scripps Inst. USA
		Weddell Sea	
IMBB 2596 AMERIEZ St.11	12 Mar. 1986	65°39.5'S 48°12.3'W Brown lump in 2 m ice (SCUBA coll.)	E.E. Syvertsen Univ. of Oslo
IMBB 2695 ANT III 13 Core 12b, 10–20 cm	23 Feb. 1985	c. 70°30'S c. 08°00'W Atka Bay	A. Bartsch AWI, Germany
IMBB 2693B ANT III 13 Core 5b, 20–210 cm	31 Jan. 1985	72°43.3'S 19°23'W Dietscher Inlet	A. Bartsch AWI, Germany
IMBB 2694 ANT III 13 Core 6b, 0–10 cm	4 Feb. 1985	77°41.6'S 36°58.2'W Fast ice	A. Bartsch AWI, Germany

Table 1. Continued

Arctic samples			
Number	Date	Location	Collector
IMBB 2486	14 Feb. 1986	75°35'S 26°46'W Halley Bay Under-surface of pack ice (SCUBA coll.)	S.Z. El-Sayed TAMU, USA
IMBB 1592 NARE 1976/77	Feb. 1977	77°45'S 41°44'W Broken shelf ice	S. Fevolden Univ. of Oslo
Ross Sea			
Quad 1 Quad 1-7	18 Nov. 1981	c. 78°S 166°E Cape Armitage Bottom 20 cm of annual congelation sea ice	C.W. Sullivan USARP
IMBB 2727, 2728 Site G		NW McMurdo Sound 76°57'S 162°35'E Congelation sea ice	A. Leventer USGS
IMBB 2729, 2730 Site S		NW McMurdo Sound 76°59'S 162°50'E Congelation sea ice	A. Leventer
Site I	3 to 24 Nov. 1984	W McMurdo Sound 76°56'S 163°13'E Sediment trap, 592 m	A. Leventer
Site L	11 to 21 Dec. 1984	E McMurdo Sound 77°51'S 166°36'E Sediment trap, 37 m	A. Leventer
IMBB 2588	25 Jan. 1981	Near Sydowa St. (69°00'S, 39°35'E), East Antarctica Kita-no-ura Cove Shallow, rocky sea bottom under fast ice (SCUBA coll.)	K. Watanabe NIPR
IMBB 2589	28 Oct. 1981	Sydowa St. Bottom of 60 cm sea ice	K. Watanabe
IMBB 2590	12 Nov. 1983	500 m west of Ongulkalven Sea ice	K. Watanabe
IMBB 2591	9 Dec. 1983	Kita-no-seto Strait Bottom of sea ice (SCUBA coll. by syringe)	K. Watanabe

IMR = Institute for Marine Research, Norway; BAS = British Antarctic Survey; AWI = Alfred-Wegener-Institut für Polar- und Meeresforschung, BRD; TAMU = Texas A & M University, USA; USARP = United States Antarctic Research Program; USGS = United States Geological Survey; NIPR = National Institute of Polar Research, Japan.

***Synedropsis hyperboreoides* Hasle, Syvertsen et Medlin sp. nov.**

Figs 13–16, 22, 23, 39–44,
48–50, 142b, Table 2

DESCRIPTION: Valva portione centrali lineari ad lanceolata, projecturis rostratis prolongatis. Projecturae portioni centrali aequantes ad duplo longiores. Axis apicalis longitudine 137–38 μm , axis transapicalis longitudine 2.5–3 μm . Striae in valva 35–40 in 10 μm , areolis poroidibus 5–7 in 1 μm . Sternum angustum, costiformis, saepe ad centrum latius quam alibi. Limbus plerumque non altus, ad polis valvae parum altior. Rimoportula, labiis latis elevatis. Agri apicales ambo 3–5 rimis instructus.

Valves linear-lanceolate with rostrate, prolonged projections equal to the central portion to twice as long. Apical axis 137–

38 μm long, transapical axis 2.5–3 μm long. Striae 35–40 in 10 μm with 5–7 poroid areolae in 1 μm . Sternum narrow, linear rib-like, often broader at the centre than elsewhere. Valve mantle usually shallow, slightly deeper at the poles of the valve. Labiate process with broad raised lips. Both apical fields with 3–5 slits.

HOLOTYPE: IMBB 97.

ISOTYPES: BM 82216, BRM Zu 4/37, PH G.C. 91007.

TYPE LOCALITY: 69°48'S, 03°42'E (NARE 1992/93, St. 18, 19 Jan 1993).

HABITAT: Antarctic sea ice.

MORPHOLOGY: *Synedropsis hyperboreoides* appeared in stellate colonies in live material collected from dense drift-ice in the Antarctic (type material).

Table 2. Morphometric data of *Synedropsis* spp. recorded from sea ice assemblages. The length of the apical axis is given from maximum to minimum, reflecting the way the cell length of diatoms decreases during cell division

Taxa name	Apical axis in μm	Transapical axis in μm	Striae in 10 μm	Areolae in 1 μm	Slits at apex
<i>S. hyperborea</i>	96–13	2.5–4	25–27	5–6	4–6
<i>S. hyperboreoides</i>	137–38	2.5–3	35–40	5–7	3–5
<i>S. recta</i>	48–17	3.5–5	11–14		5–8
<i>S. laevis</i>	62–14	c. 4	12–14		4–8
<i>S. lata</i> var. <i>lata</i>	77–16	4.5–5	18–22 (14–16)***	3–4	4–7*, 5–8**
<i>S. lata</i> var. <i>angustata</i>	55–26	2.5–3.5	18–20	5	2–3*, 4–6**
<i>S. fragilis</i>	58–26	3–4	21–24 (18; 27)***	5–6	6–7

* Apex with labiate process; ** Apex without labiate process; *** Uncommon data.

The bands are open with pointed ends and one row of poroids. They are wider in the ligula area (Fig. 44). The valves are typically linear-lanceolate in the central part with rostrate and prolonged projections. Smaller and longer specimens are rostrate. The dilated central part varies little in length, whereas the projections are once to twice the length of the central part (Figs 13–16). The striae are parallel to slightly radiate and limited to a few areolae in the projections. The areolae appear to be slightly sunk into the valve wall from the inside (Fig. 43). No vela were observed. Some valves have only a narrow rib-like sternum and, in others, it is irregularly widened centrally (Figs 22, 23, 43). The valve mantle is generally shallow but somewhat deeper at the poles (Fig. 40).

The labiate process is located on the second to the fifth stria from the apex (Figs 39, 42, 49) and may be perpendicular (Fig. 39), slightly oblique or parallel to the apical axis (Figs 39, 42, 49). The apical fields so far examined had 3–5 slits (Figs 39–42, 48, 49).

The sternum is occasionally resolved in LM but the striation is not. The labiate process is large enough to be discernible but is easily obscured by the mantle of the narrow valve end and by the adjacent apical field (Figs 14–16).

TAXONOMY: The distinction between *Synedropsis hyperborea* and *S. hyperboreoides* is obvious when the valve outlines of specimens of similar size are compared (e.g. Figs 2 and 14, Figs 18 and 22). Other distinctive morphological characters are (i) the proportion between the length of the central part of the valves and the projections (cf. Figs 8 and 15), (ii) the width of the projections (cf. Figs 34 and 39) and (iii) the more closely spaced striae of *S. hyperboreoides* (cf. Figs 38 and 43, Figs 47 and 50).

DISTRIBUTION: *Synedropsis hyperboreoides* is endemic to the antarctic ice biota. It was the predominant diatom in a sample of 'brownish undersurface of pack-ice' (R 154). It was scarce in another sample from the Weddell Sea, from ice-berg shelf [IMBB Sample 58(12)] and in a sample from East Antarctica collected on shallow, rocky sea bottom under fast ice (IMBB Sample 2588). It was also present in a core from the Weddell Sea (IMBB Sample 2695). In crude cultures established from dense drift-ice waters off Queen Maud Land (EES culture, type material) it became the predominant diatom. It seems to have a preference for non-planktonic habitats, as indicated by the attachment of the cells to the walls of the culture vessels.

A search for this species in the literature proved negative; we assume that it has been overlooked in previous antarctic

investigations including those of diatoms of benthic affinity (e.g. van Heurck 1909; Heiden & Kolbe 1928; Peragallo 1921; Manguin 1957, 1960).

Synedropsis recta Hasle, Medlin et Syvertsen sp. nov.

Figs 27–30, 51–55, 57–60,
68–75, 142c, Table 2

DESCRIPTION: Cellulae ad polos in coloniis stellatis vel fastigiatis conjunctae. Cingula ambo ex taeniis 4 constantia. Valvocopula verosimiliter non perforata, taenia alia unaquaque serie una areolae instructa. Taeniae circumferentia cellulae breviores. Portio centralis valvae lineari-lanceolata. Specimina majora parum rostrata apicibus rotundatis et subcapitatis. Longitudo axis apicalis 48–17 μm , axis transapicalis 3.5–5 μm . Interstriae multo latiores quam striae, 11–14 in 10 μm . Sternum latum, praecipue in portione centrali valvae; costa centralis ab polo ad polum aliquando visibilis. Limbus manifeste striatus, altus, praecipue ad apices. Rimoportula una, labiis latis. Ager apicalis uterque 5–8 rimis instructus, in superficie externa limbi parum impressus.

Cells united at poles in stellate or bundle-shaped colonies. Four bands per theca; valvocopula probably unperforated and the three other bands each with one row of areolae. Bands shorter than cell circumference. Valves linear-lanceolate with rostrate or subcapitate apices. Apical axis 48–17 μm , transapical axis 3.5–5 μm . Interstriae much wider than striae, 11–14 in 10 μm . Sternum usually broad, especially in the central part of the valve, or sometimes rib-like and straight from one pole to the other. Valve mantle distinctly striated, deep, especially at apices. Labiate process with broad lips. Both apical fields with 5–8 slits, slightly sunk into external surface of valve mantle.

SYNONYM: *Fragilaria* (?) sp. a Tanimura in Tanimura *et al.* 1990, p. 28, figs 4, 5, 7.

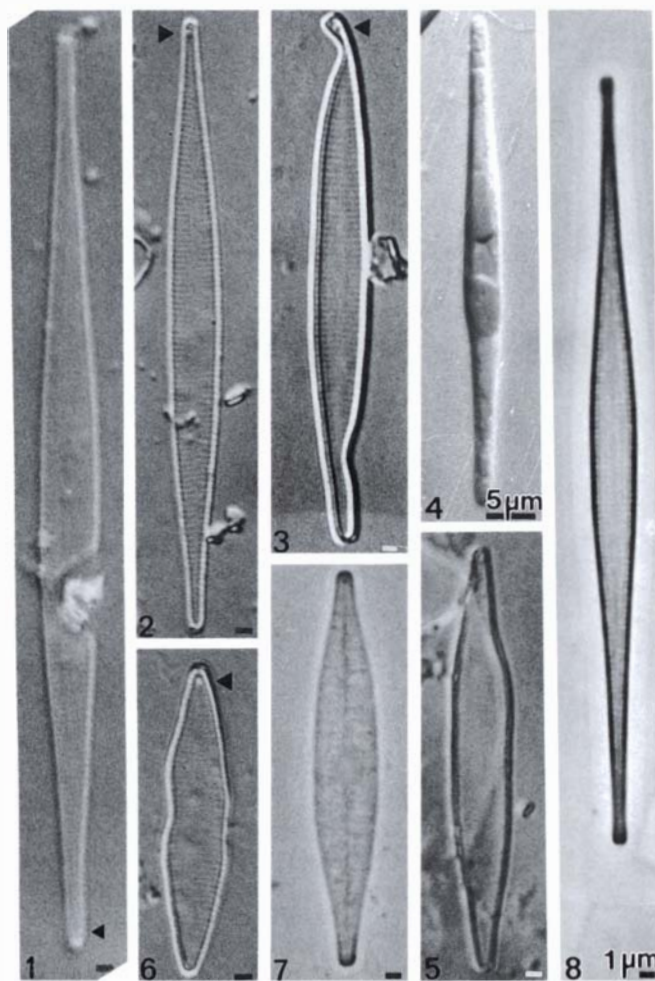
HOLOTYPE: IMBB 98.

ISOTYPES: BM 82217, BRM Zu 4/41, PH G.C. 91012

TYPE LOCALITY: 75°35'S, 26°46'W (IMBB Sample 2486).

HABITAT: Antarctic sea ice.

MORPHOLOGY: The finding of a few cells united at the poles indicates the formation of stellate or bundle-shaped colonies. Frustules are narrowly linear in girdle view. In each theca the last of the four bands in an abvalvar direction may be extremely narrow (Fig. 73). The bands are open and the gap between the pointed ends is filled by the adjacent band (Fig. 74). The valvocopula appears unperforated, whereas the other bands have one row of areolae close to the pars interior (Fig. 73).



Figs 1–8. *Synedropsis hyperborea*, showing stadal variation in valve outline: arrowheads indicate labiate processes, LM. Scale bars equal 1 μm unless otherwise stated. Figs 1–3, 5, 6. P.T. Cleve slide VI-2-32, Novaja Zemlja, *Melosira* Sample 1157. Fig. 4. EES Oslofjord clone. Figs 7, 8. IMBB Sample 2439.

Figs 1, 2, 8. Cf. var. *rostellata*.

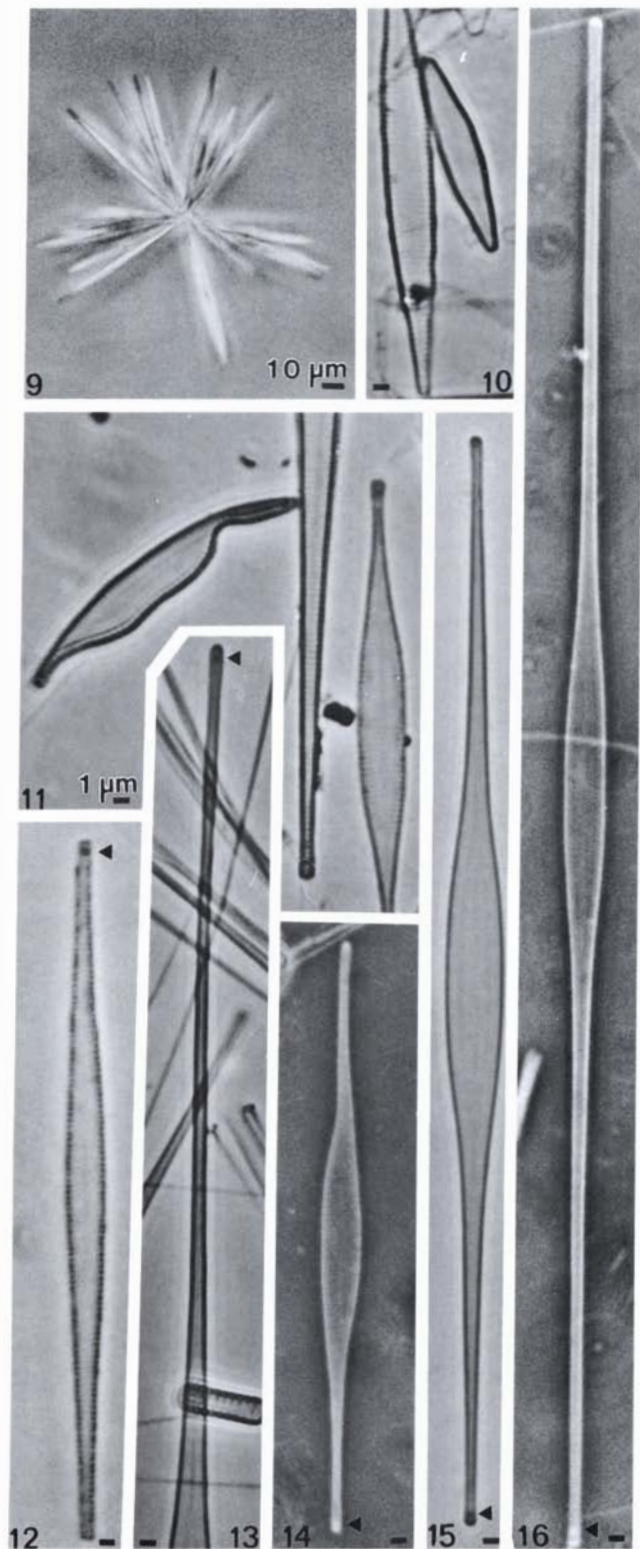
Figs 3, 5, 6. Cf. var. *flexuosa*.

Fig. 4. Chloroplasts.

Figs 7, 8. Cells epiphytic on *Melosira arctica*.

The length of the linear-lanceolate part of the valve decreases with the reduction of the length of the apical axis (Figs 51–55, 57–60). The areolae of the uniseriate striae are sunk into the internal valve face (Fig. 75). The interstriae may be slightly raised above the internal valve surface but flush with the outside surface (Figs 27, 51–54, 75). In most specimens the sternum fills the greater part of the valve face (Figs 29, 30, 59), especially in the central part where it runs from one margin to the other (Figs 28, 30, 51–54, 59). The valve mantle is areolated but with a wide unperforated margin (Figs 69, 75).

Figs 9–16. *Synedropsis hyperborea* with stadal variation in valve outline; *S. hyperboreoides* without stadal variation in valve outline, arrowheads indicate labiate processes, LM. Scale bars equal 1 μm unless otherwise stated.



Figs 9–12. *S. hyperborea*.

Fig. 9. Colony, EES clone B.S.1, 77°05'N, 37°25'E, 13 July 1979.

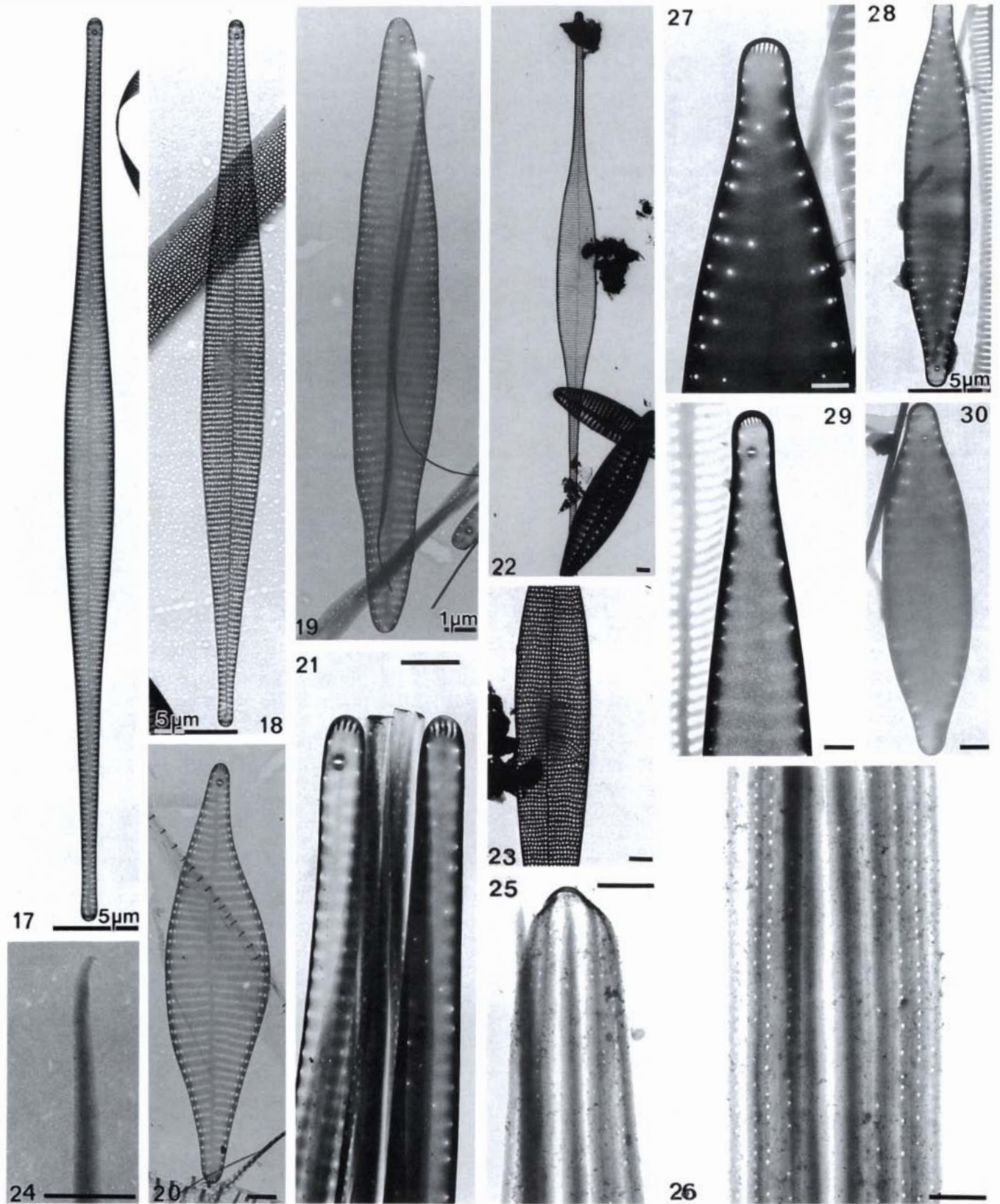
Figs 10, 11. Ice sample (IMBB Sample 572).

Fig. 12. Cleve and Möller slide No. 314 (BM 13043), Franz Josef Land.

Figs 13–16. *S. hyperboreoides*.

Figs 13, 14, 16. Ice sample (R 154).

Fig. 15. EES culture, 69°48'S, 03°42'E, 19 Jan 1993.



Figs 17-30. *Synedropsis* spp., TEM. Scale bars equal 1 μm unless otherwise stated. Samples of *S. hyperborea*: Figs 17, 18. *M. arctica* sample (IMBB Sample 2439). Figs 19, 20. Ice Samples (IMBB Sample 568, 572). Figs 21, 24. EES clone B.S.1. Figs 25, 26. EES Oslofjord clone. Samples of *S. hyperboreoides*: Figs 22, 23. Ice-berg shelf [IMBB Sample 58 (12)]. Samples of *Synedropsis recta*: Figs 27-30. Ice sample (IMBB Sample 2486).

When the sternum is at its maximum extension only isolated areolae, occasionally striae, appear on the valve face (Figs 27–30). The labiate process is usually located on the second stria from the valve apex, perpendicular or slightly oblique to the apical axis (Figs 29, 30, 71). It opens externally into an elongate hole much smaller than the internal slit (Figs 71, 72). The valve striation of *S. recta* is readily discernible in LM, whereas the labiate process can scarcely be observed (Figs 51–55, 57–60).

TAXONOMY: *Synedropsis recta* is more coarsely structured than *S. hyperborea* and *S. hyperboreoides* (Table 2). This feature has to be kept in mind when *S. recta* and *S. hyperborea* specimens of approximately the same size are compared (e.g. Figs 2 and 51, Figs 7 and 53, 54). The straight margins (occasionally pinched) of the middle part of the valve and the slightly sub-capitate ends are other distinctive features that differentiate *S. recta* from the other two species (Figs 14 and 51).

The number of striae in 10 μm and in the structure and shape of the middle part of the valve of *Synedropsis recta* are similar to the larger diatoms *Fragilaria islandica* var. *producta* (apical axis 80–90 μm , 12 striae in 10 μm) and *F. islandica* var. *stricta* (apical axis 100 μm , 14 striae in 10 μm) described by Peragallo (1921). However, the narrow size range and the single illustrations of his two taxa (Peragallo 1921, pl. 3, figs 7, 8, 10) offer no information on a possible stadial variation of valve outline. We have not examined type material of the two taxa, but we have seen diatoms from antarctic sea ice which may belong to Peragallo's taxa. They differ from *Synedropsis* in stria as well as apical field structure and therefore a synonymy with *S. recta* can be excluded.

Fragilaria islandica var. *adeliae* Manguin, which has been invalidly published (Latin diagnosis missing), is, as far as examined in LM, similar to *S. recta* in size, structure and shape, but not in the middle part of the valves where *F. islandica* var. *adeliae* has convex margins (Figs 56, 76–78; Manguin 1960, pl. 12, fig. 128). We have photographed *F. islandica* var. *adeliae* from the type material (Fig. 56, Manguin slide No. 1). Unmounted type material has not been available for EM but diatoms identified as *F. islandica* var. *adeliae* from other antarctic localities have been examined (Figs 76–78). They possess apical pore fields rather than the apical slit fields of *S. recta* (Figs 77, 78). There may also be a difference in the structure of the middle part of the valve mantle, which is unperforated in *F. islandica* var. *adeliae* (Fig. 76).

DISTRIBUTION: *Synedropsis recta* was present in most of the ice samples: sub-ice (IMBB Sample 2698), melted brownish under-surface of pack-ice (IMBB Sample 2486), aggregation of algae inside 2-m ice (IMBB Sample 2596) and sea ice from 70°09'S, 04°40'E and 69°41'S, 02°38'E, Jan 1990 (C. Hellum, pers. comm.) from the South Atlantic and the Weddell Sea;

from Cap Margerie, Terre Adélie [Manguin slide No. 1 (A)] from fast ice in East Antarctica (IMBB Samples 2588–2591); from the bottom 20 cm of congelation ice at Cape Armitage, McMurdo (Quad 1), and from sea ice from west McMurdo Sound (IMBB Samples 2727–2730) in the Ross Sea. *Synedropsis recta*, identified as *Fragilaria* (?) sp. a Tanimura and examined with SEM, came from Lützow-Holm Bay, East Antarctica, as did the samples from the Ongul Islands. *Fragilaria* (?) sp. a was reported as a common form restricted to the water column and commonly found in the underlying sediments (Tanimura *et al.* 1990). According to SEM pictures of copepodite gut contents, *S. recta* was also part of the diet of an ice-associated copepod near Sydowa Station in the same area (Hoshiai *et al.* 1987). *Synedropsis recta* was collected in sediment traps in west and east McMurdo Sound (Sites I and L) and in two cores from the Weddell Sea (IMBB Samples 2693B, 2694) and may have been misidentified from the Pacific sector of the Antarctic as *Pseudonitzschia* (= *Nitzschia*) *prolongatoides* (Hasle) Hasle (Hasle 1965, text figs 1, 2). Thus it has a circumpolar distribution and is probably the most common species of the genus in the Antarctic.

Because of the great similarity to *Fragilaria islandica* var. *adeliae* in the LM the new species may well have appeared under this name in the literature (e.g. Grossi & Sullivan 1985, erroneously identified by two of us, GRH, LKM).

***Synedropsis laevis* (Heiden in Heiden & Kolbe)
Hasle, Medlin et Syvertsen comb. nov.**

Figs 61–67, 79–92, 142d, Table 2

BASIONYM: *Cymatosira laevis* Heiden in Heiden & Kolbe 1928, p. 558, pl. 6, fig. 131.

SYNONYM: *Nitzschia aciculariformis* Manguin 1957, p. 132, pl. 7, fig. 45.

LECTOTYPE: BRM 283/41 (see illustrations in Simonsen 1992, p. 21, pl. 17, figs 1–14).

TYPE LOCALITY: Gaussberg, 70 m. 33d, Gauss Exp. 8 Oct. 1902.

MORPHOLOGY: Our observations were made exclusively on single valves, which are lanceolate in the middle, tapering to elongate, rounded projections in larger specimens and to strictly rostrate apices in smaller ones (Figs 66, 67); the width and the length of the central parts of the valves are nearly constant (Figs 61–67, 79–84).

The valve mantle is deep, particularly at the apices (Figs 91, 92). The sternum is wide, occupying most of the central part of the valve and the elongate projections (Figs 61–67). The areolation present on the mantle continues over the valve face as a few scattered areolae (Figs 64, 66, 85–87). The broad interstriae, usually 12–14 in 10 μm , are raised above the in-

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Figs 17–21, 24–26. *S. hyperborea*.

Figs 17–20. Variation in size and valve outline, showing sternum and striation.

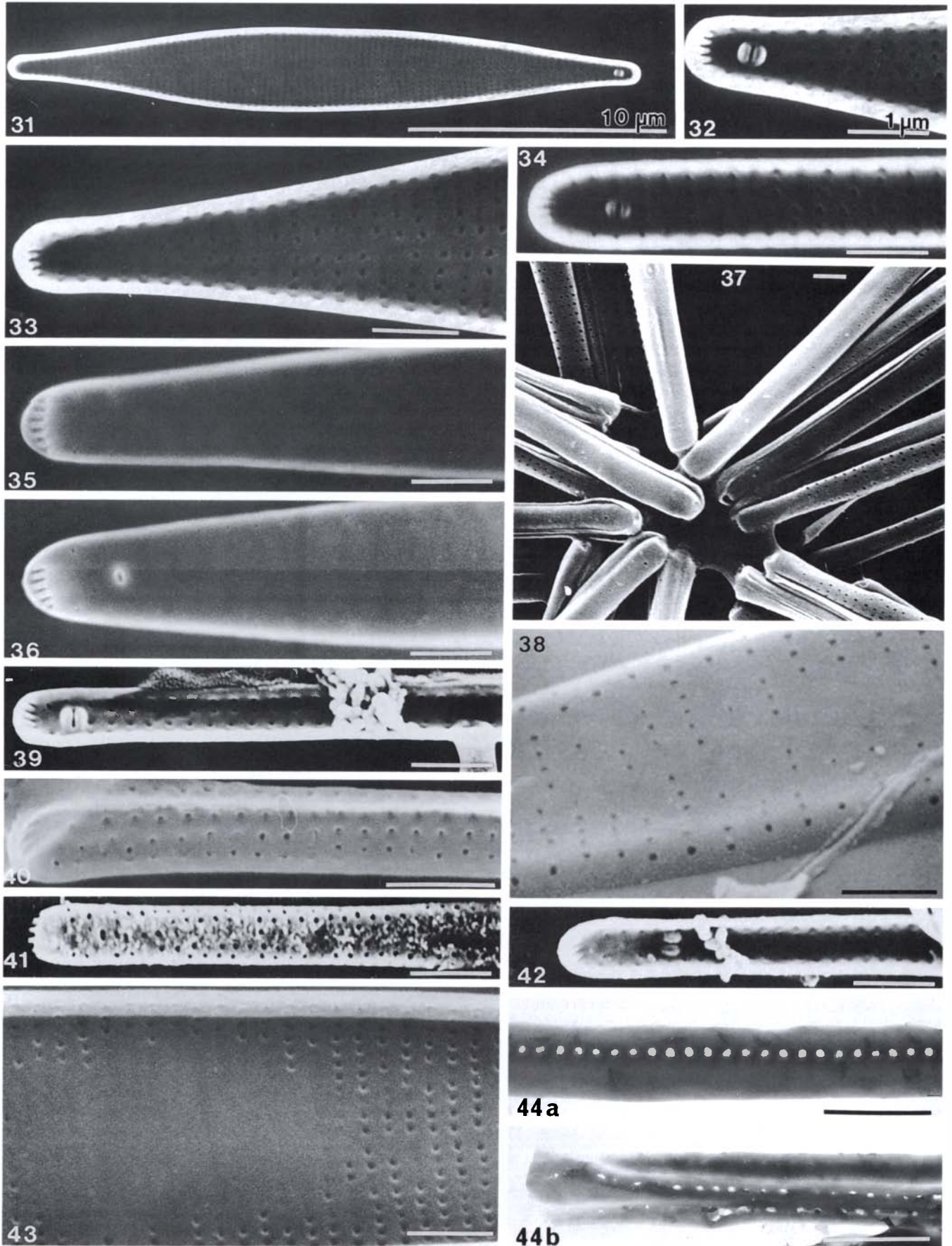
Fig. 21. Valve apices and bands of one cell, note apical slit fields and labiate process.

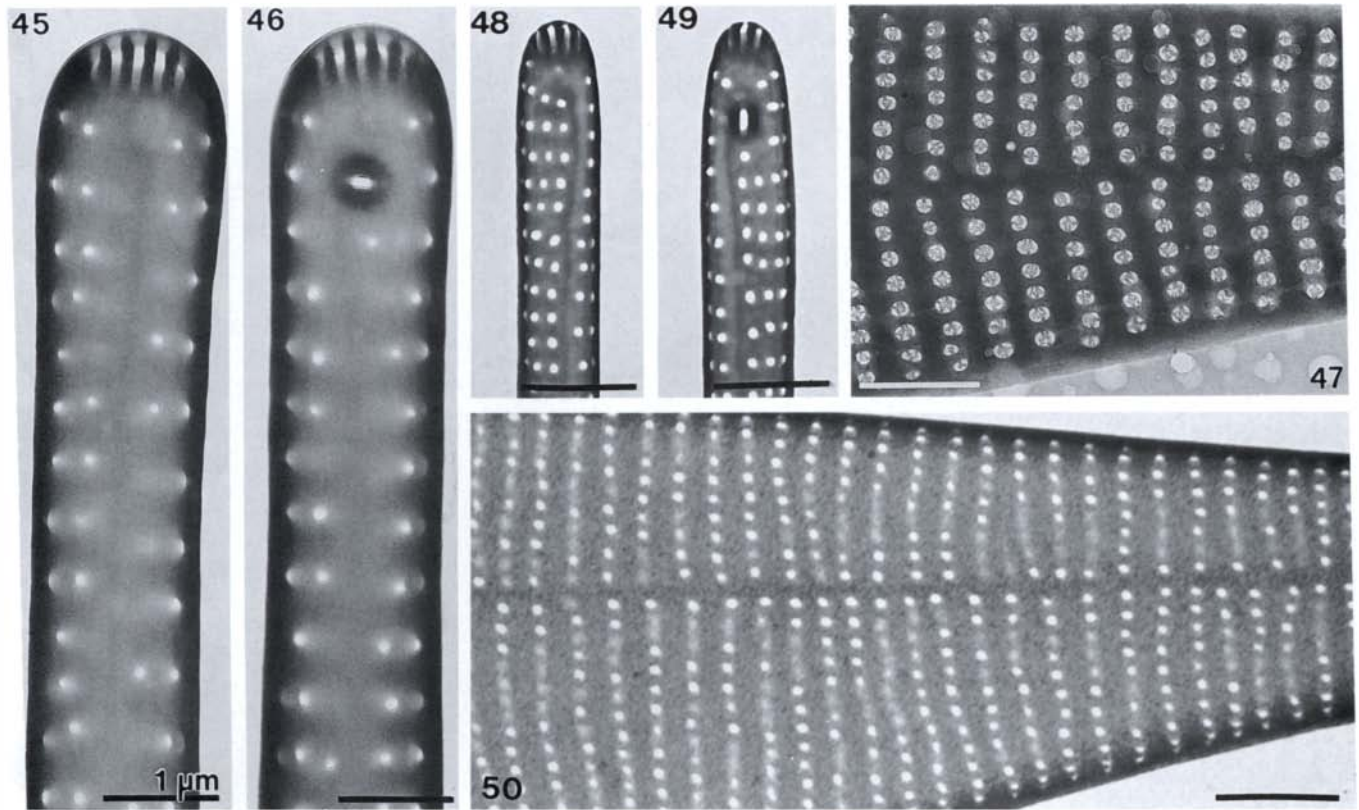
Fig. 24. End of pointed, unperforated band.

Figs 25, 26. Parts of the same cingulum with the unperforated valvocopula in the middle, 4 bands with one row of poroids.

Figs 22, 23. *S. hyperboreoides*. Valve with the central part at higher magnification.

Figs 27–30. *S. recta*, variation in sternum and valve outline, note apical slit fields and labiate process. Fig. 27: upper end of Fig. 28.





Figs 45–50. *Synedropsis hyperborea* and *S. hyperboreoides*, TEM. All of the same magnification. Samples for *S. hyperborea*: Figs 45–47. *M. arctica* sample (IMBB Sample 2439). Samples for *S. hyperboreoides*: Figs 48–50. EES culture, 69°48'S, 03°42'E, 19 Jan 1993.

Figs 45–47. *S. hyperborea*.

Figs 45, 46. Two apices of one valve; note apical slit fields and labiate process.

Fig. 47. Uniseriate striae, poroids with vela.

Figs 48–50. *S. hyperboreoides*.

Figs 48, 49. Two apices of one valve, note apical slit fields and labiate process.

Fig. 50. Uniseriate striae, no vela.

ternal valve surface (Figs 89–92) and may extend across the valve (Figs 62, 64).

The shallow labiate process, located on the second stria from one valve apex, is perpendicular or slightly oblique to the apical axis of the valve (Figs 85, 86, 88); its external opening is elongate and almost as large as the internal slit (Figs 85, 86, 88). The apical fields, with 4–8 slits, are located on the deep, slanting valve mantle close to the junction between valve face and mantle (Figs 89–92).

In LM the variation of the valve shape and the striation are readily seen (Figs 61–67), whereas the presence of the labiate process and the apical fields is only revealed in EM.

TAXONOMY: A search of the literature for a diatom corresponding to our specimens gave the following candidates: *Cyrtosira laevis*, *Fragilaria pseudoatomus* Manguin, and *Nitzschia aciculariformis* Manguin. Morphometric data of *C. laevis* include: apical axis 55–12.5 μm , transapical axis 3.7–5.6 μm and *Randstacheln* (in this diatom = marginal striae or

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Figs 31–34. *Synedropsis hyperborea* and *S. hyperboreoides*, SEM and TEM. Scale bars equal 1 μm unless otherwise stated. Samples for *S. hyperborea*: Figs 31–34, 37. *M. arctica* sample (IMBB Sample 2439). Figs 35, 36. EES clone B.S.1. Fig. 38. Pond on ice (IMBB Sample 1615). Samples for *S. hyperboreoides*: Figs 40, 43. Rocky sea bottom (IMBB Sample 2588). Fig. 44. EES culture, 69°48'S, 03°42'E, 19 Jan 1993. Figs 39, 41, 42. Under-surface of pack ice (R 154).

Figs 31–38. *S. hyperborea*.

Figs 31–33. Entire valve in internal view.

Figs 32, 33. Internal view of projections at higher magnification, tilt 10°.

Fig. 34. Internal view of longer projection.

Figs 35, 36. Projections of one valve in external view.

Fig. 37. Part of colony.

Fig. 38. Middle part of valve, external view, low mantle.

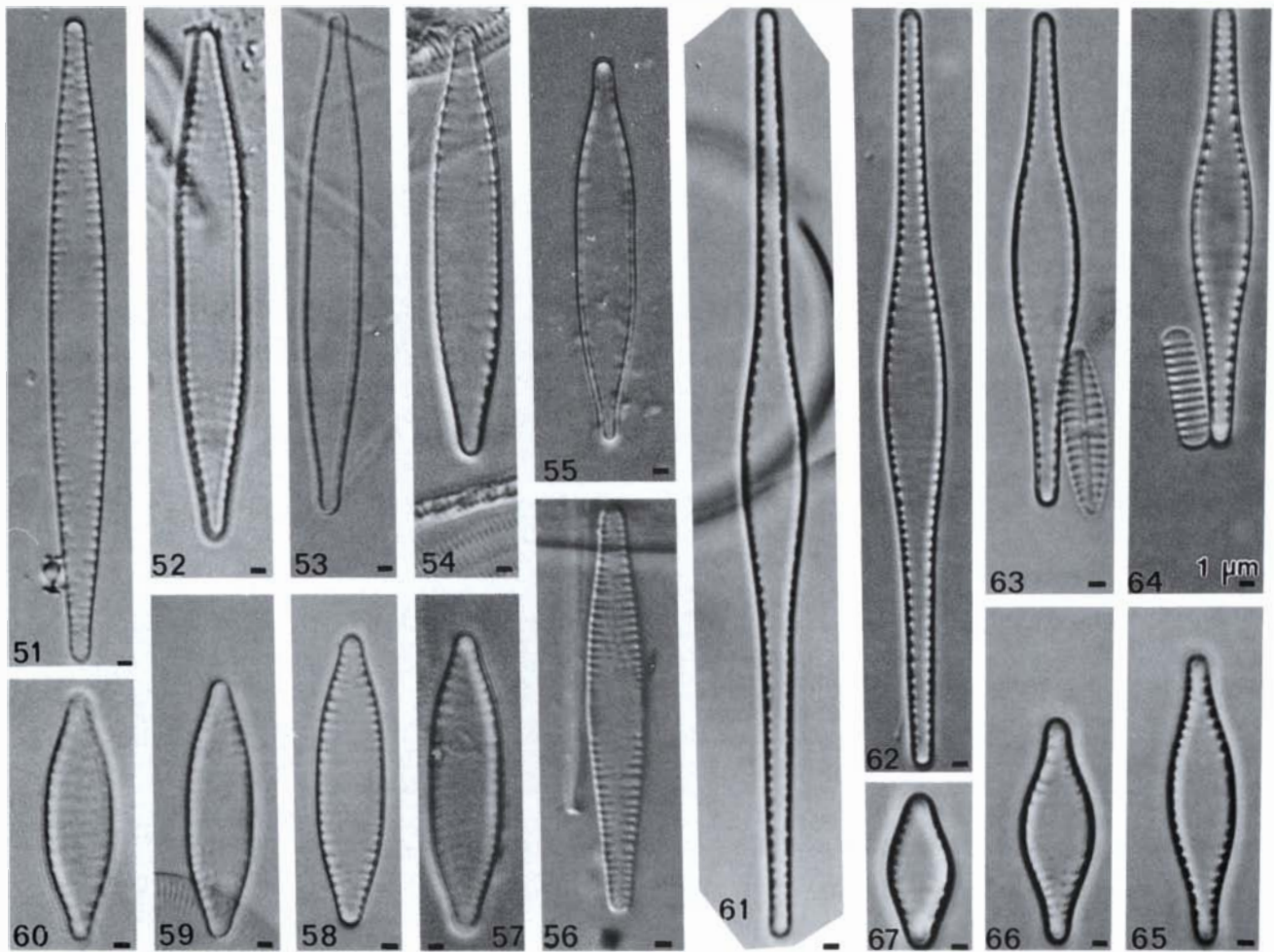
Figs 39–44. *S. hyperboreoides*.

Figs 39–42. Narrow valve projections, showing apical slit fields and labiate process.

Fig. 41. External view, the other internal views.

Fig. 43. Central part of valve in internal view.

Fig. 44a, b. Perforated, open bands, TEM.



Figs 51–67. *Synedropsis* spp. showing stadal variation of valve outline and *Fragilaria islandica* var. *adeliae*, LM. All at the same magnification.

Figs 51–55, 57–60. *S. recta*.

Figs 51, 52, 58, 59. Sea ice Quad 1–7.

Figs 53, 54, 55, 57, 60. Ice sample (IMBB Sample 2486).

Fig. 56. *F. islandica* var. *adeliae*, Cap Margerie, Terre Adélie, Manguin slide No. 1.

Figs 61–67. *S. laevis*, ice sample (IMBB Sample 1592).

interstriae) normally 12–16, sometimes 8 in 10 µm (Heiden & Kolbe 1928, p. 558; Simonsen 1992, p. 22). An examination of the lectotype of Heiden's species *Cymatosira laevis* (BRM slide 283/41) confirmed that we were dealing with the same taxon. Simonsen (1992, pl. 17) has documented the entire range of stadal variation of *C. laevis*. There is also good correspondence between the type locality of *C. laevis* and the localities from which we have observations.

The morphometric data of *N. aciculariformis* are: apical axis

49 µm, transapical axis 4 µm and 'keel puncta' c. 15 in 10 µm (Manguin 1957), which accord with those of *S. laevis*. Thus, this taxon could well represent part of the larger size fraction of *S. laevis*. Further reasons for synonymizing this diatom with *S. laevis* are the similar valve shape, the marginal areolae of *S. laevis*, which could easily be interpreted as 'keel puncta', and the fact that *S. laevis* was present on Manguin's slides (Nos 1 and 4) from the type locality of *N. aciculariformis*.

The morphometric data of *F. pseudoatomus* are: apical axis

Figs 68–78. *Synedropsis recta* and *Fragilaria islandica* var. *adeliae*, SEM. Scale bars equal 1 µm unless otherwise stated. Samples for *S. recta*: Figs 68–71, 74, 75. Ice sample (IMBB Sample 2486). Fig. 72. Ice sample (IMBB Sample 2596). Fig. 73. Ice sample (IMBB Sample 2590). Samples for *F. islandica* var. *adeliae*: Figs 77, 78. Rocky sea bottom (IMBB Sample 2588).

Figs 68–75. *S. recta*.

Figs 68, 69. Internal valve view, note central part with straight margins, deep areolate mantle and one labiate process (arrowhead).

Fig. 70. As above but external valve view.

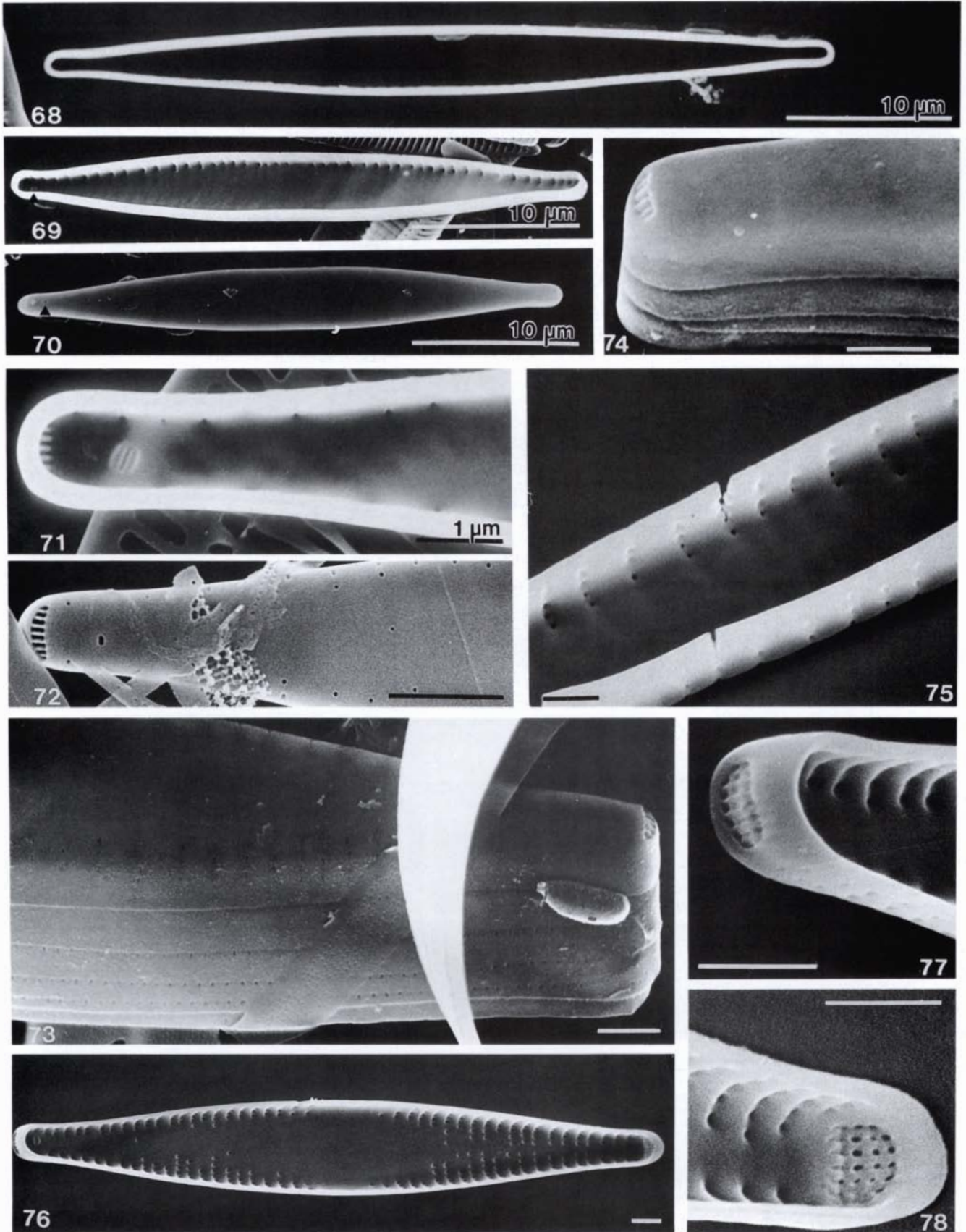
Fig. 71. Internal view of valve apices, note apical slit field, labiate process and areolate mantle.

Fig. 72. As above but external view.

Fig. 73. External view of epitheca with valvocopula, three perforate bands and hypovalve, note valve striae and apical slit field, tilt 50°.

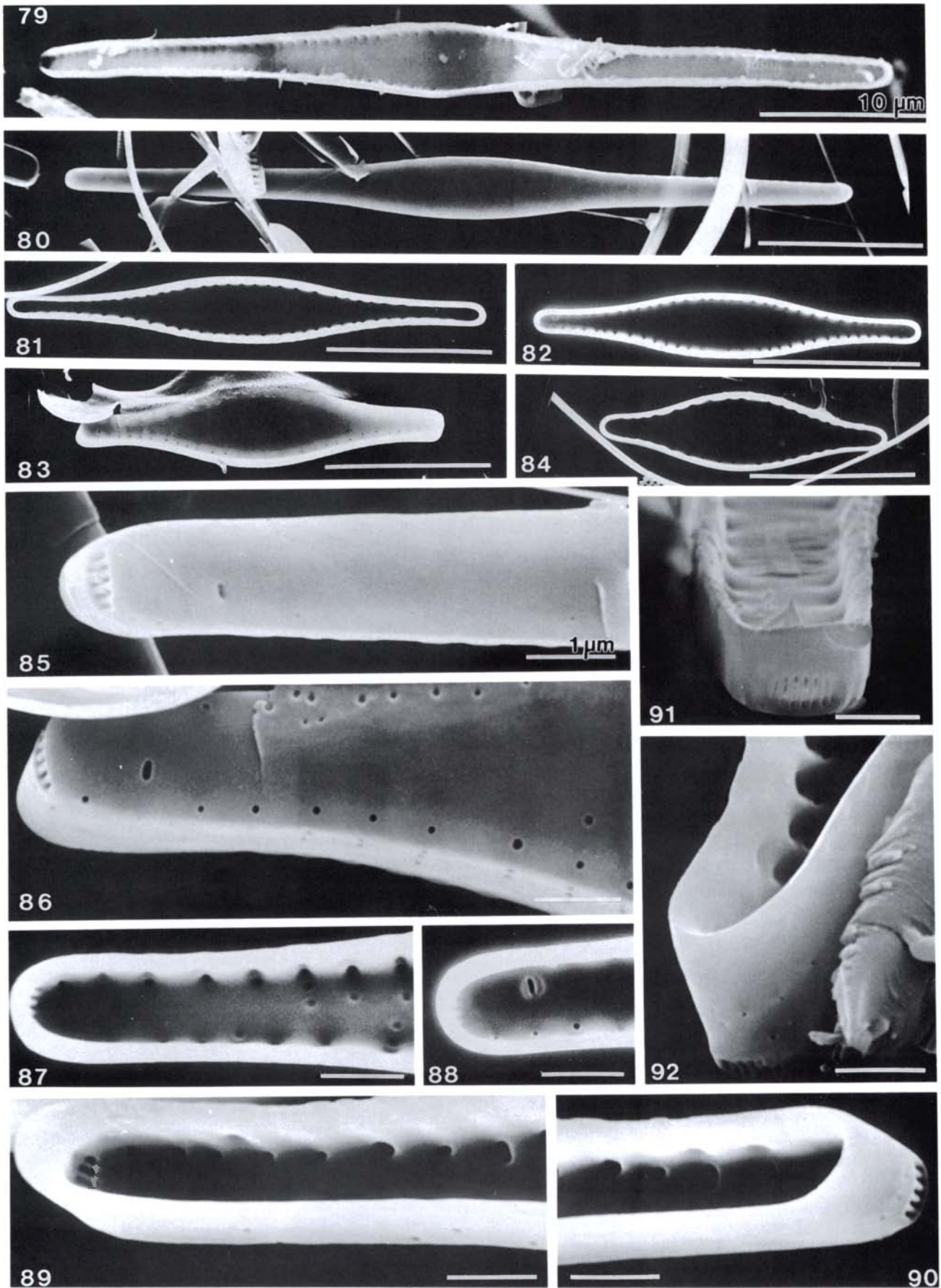
Fig. 74. External view of epitheca with three bands visible and apical slit field.

Fig. 75. Internal view of middle part of valve, note deep, areolate mantle.



Figs 76–78. *F. islandica* var. *adeliae*.

Fig. 76. Internal view showing central part with curved margins and wide sternum extending to the margins, note one labiate process.
Figs 77, 78. Detail valve apices of specimen in Fig. 76 from external and internal views, note apical pore fields, tilt 60°.



12.5 μm , transapical axis 3–3.5 μm and transapical striae ‘réduites à l'état de points marginaux’ (Manguin 1957, p. 122) *c.* 12 in 10 μm . These data correspond fairly well with those of the smaller cells of *S. laevis*. On the other hand, Manguin's (1957) species has sub-rhomboid to lanceolate valves with no mention of valve projections or extremities and this excludes a synonymy with *S. laevis*.

The smallest specimens of *Synedropsis laevis* are slightly similar in valve shape to *S. recta* (Fig. 60 and Fig. 67) and the larger ones to *S. hyperboreoides* (Figs 14–16 and Figs 61, 62). The distinction between *S. laevis* and *S. recta* lies in the shape of the middle part of the valve, while that between *S. laevis* and *S. hyperboreoides* lies in length of the transapical axis and the density of striae, as well as the thickness of the valve wall.

DISTRIBUTION: *Synedropsis laevis* has the same distribution as *S. recta*, being present in a sample of broken shelf-ice (IMBB Sample 1592) and from the under-surface of pack-ice (IMBB Sample 2486); in samples from fast ice from the Ongul Islands area (IMBB Samples 2588–2591) and near the Russian Station, Molodezhnaya, *c.* 68°S, 45°E, Indian Ocean sector of the Antarctic (R. Ligowski, pers. comm.); and as *S. recta*, it was present in copepodite gut contents from Cap Margerie and in two sea-ice samples from west McMurdo Sound in the Ross Sea (IMBB Samples 2727–2729).

Synedropsis lata Hasle, Medlin et Syvertsen sp. nov.

Figs 93–110, 142e, Table 2

DESCRIPTION: Valvae minores anguste ellipticae apicibus late rotundatis; valvae majores portione centrali parum dilatata et stricturis exiguis ab apicibus distantibus instructae. Axis apicalis speciminum maximorum 17plo, speciminum minimorum 3plo, axi transapicali longior. Sternum variabile, interdum frontem totum occupans, interdum anguste elongatum nonnumquam centraliter expansum. Longitudo axis apicalis 77–16 μm , axis transapicalis 4–5.5 μm . Striae valvae 18–22, aliquando 14–16, in 10 μm , areolis 3–4 in 1 μm . Rimoportula, parva, labiis angustis. Agri rimorum apicales parum asymetrice positi. Ager apicalis prope rimoportulam 4–7, alter 5–8, rimis instructus.

Smaller valves narrowly elliptical with broad rounded apices; larger valves with slightly dilated central part and slight constrictions at some distance from valve apices. Ratio between apical and transapical axes 17 : 1 and 3 : 1 for large and smaller specimens, respectively. Sternum variable, sometimes occupying the entire valve face, sometimes only an elongate, narrow part with or without a central widening. Apical axis 77–16 μm , transapical axis 4–5.5 μm . Valve striae 18–22, occasionally 14–16, in 10 μm with 3–4 areolae in 1 μm . Labiate process small with narrow lips. The two apical slit fields of a

valve slightly asymmetrically located, apical field with labiate process with 4–7 slits, the other with 5–8 slits.

HOLOTYPE: IMBB 99.

ISOTYPES: BM 82215, BRM Zu 4/39, Zu 4/40, PH G.C. 91009.

TYPE LOCALITY: 60°42'S, 45°36'W [IMBB Sample 58(12)].

HABITAT: Antarctic sea-ice.

MORPHOLOGY: We have no information on possible colony formation or the shape of the frustule in girdle view. Only one valve with an attached valvocopula was found (Fig. 107). This band was open at one apex and had some scattered areolae in addition to one regular row of areolae.

Larger specimens of *S. lata* var. *lata* are, on average, narrower than the smaller ones. In some valves the striae are seen only along the margins (Figs 93, 94, 97, 98), while in others they are scattered (compare Figs 108, 110 and Figs 104, 107), and in still others the striae are well-developed almost to the central longitudinal part of the valve (Figs 95, 96, 99).

The labiate process lies close to one apical slit field, on the second or third stria from the valve apex. It is perpendicular (Figs 108, 110) or oblique to the apical axis (Fig. 109). One specimen had two processes, one larger than the other (Fig. 110). No external openings of the processes were observed in either TEM (Figs 98, 99) or SEM (Figs 100, 101, 103). The apical slit fields are large and visible in LM (Figs 94, 96) filling most of the broad valve ends (Figs 100, 108). The apical field associated with the labiate process has 1–3 fewer slits than the other (Figs 101–110); the one with fewer slits is located further down on the mantle than the larger one (Figs 99, 100). The mantle of the apex with the smaller apical slit field also appears steeper than the other (Figs 98, 104). *Synedropsis lata* is readily identified in LM by its characteristic valve shape and distinctive apical fields.

Synedropsis lata var. *angustata* Hasle, Medlin et Syvertsen var. nov.

Figs 111–123, Table 2

DESCRIPTION: Valvae angustae, elongatae, portione centrali parum dilatata et stricturis prope apices instructae. Axis apicalis speciminum maximorum 15plo, speciminum minimorum 10–12plo, axi transapicali longior. Longitudo axis apicalis 55–26 μm , axis transapicalis 2.5–3.5 μm . Striae valvae 10–20 in 10 μm , areolis 5 in 1 μm . Rimoportula labiis latis. Ager apicalis prope rimoportulam 2, aliquando 3, rimis, alter 4–6 rimis, instructus.

Valves narrow, elongate, slightly dilated in the central part and constricted close to the apices. Ratio between apical and transapical axes, 15 : 1 for the largest to 10–12 : 1 for the smallest specimens. Apical axis 55–26 μm , transapical axis 2.5–3.5

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Figs 79–92. *Synedropsis laevis*, SEM. Figs 79–84. All at the same magnification. Figs 85–92. All at the same magnification. Broken shelf ice sample (IMBB Sample 1592).

Figs 79, 81, 82, 84. Internal views of entire valves showing stadal variation of valve outline.

Figs 80, 83. As above but external views.

Fig. 85. External view of apex of long valve projection, note opening of labiate process and apical slit field, tilt 20°.

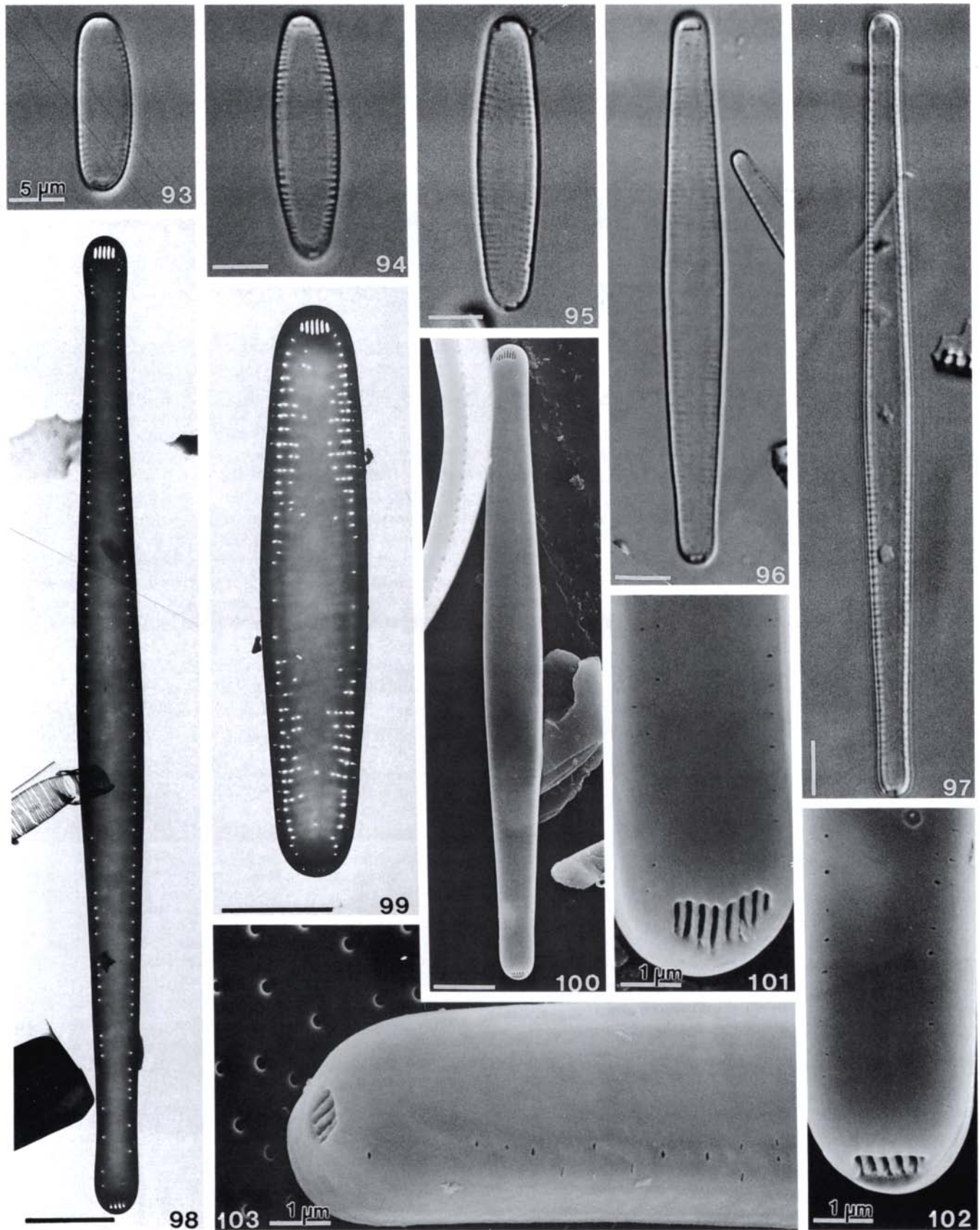
Fig. 86. External view of apex of shorter projection of less rostrate valve, note opening of labiate process, apical slit field and striation on mantle and part of valve face, tilt 20°.

Figs 87, 88. Apices of specimen in Fig. 82.

Figs 89, 90. Apices of specimen in Fig. 81, tilt 50°.

Fig. 91. External view of apical slit field, deep mantle, tilt 16°.

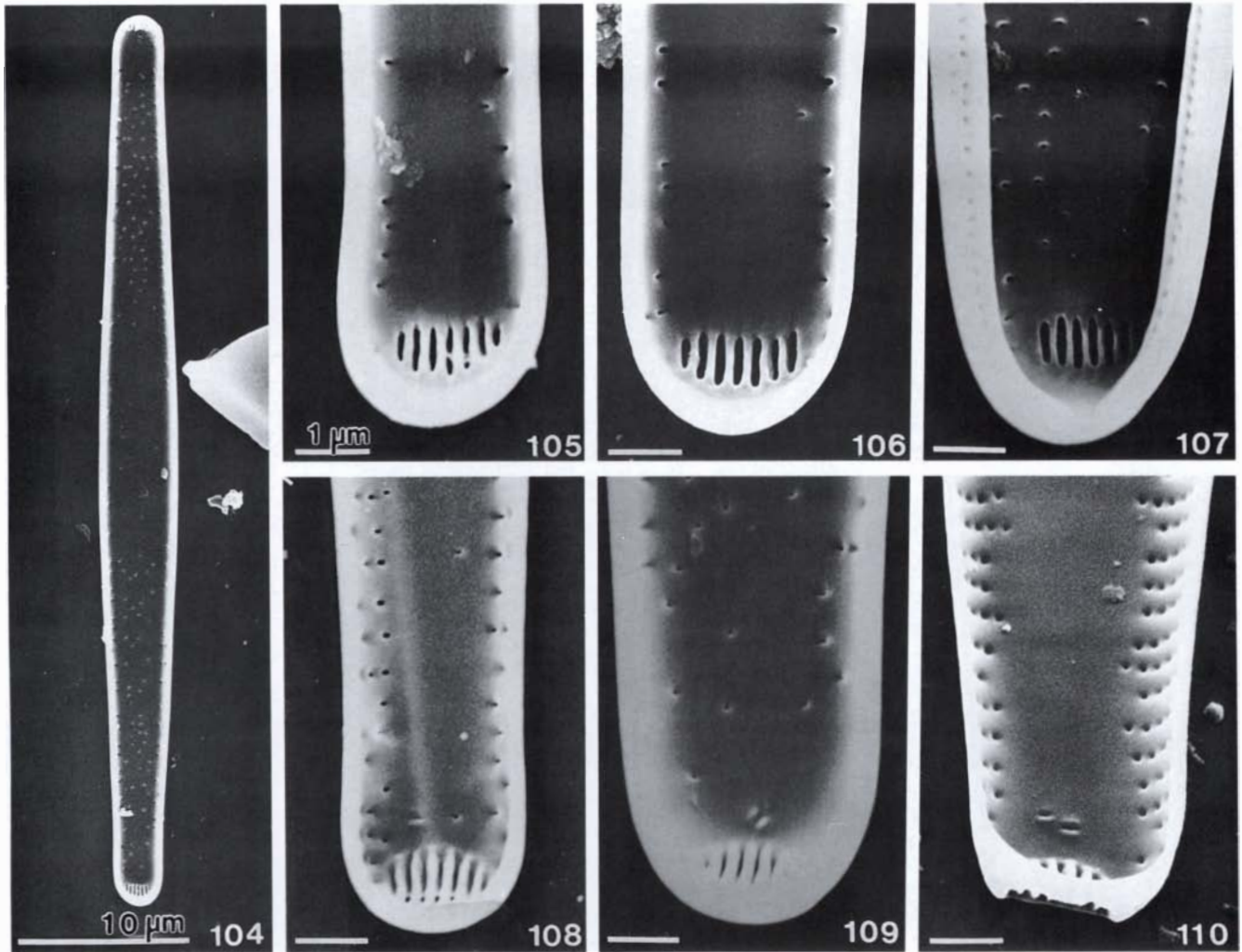
Fig. 92. Deep mantle with apical slit field and small areolae, tilt 50°.



Figs 93–103. *Synedropsis lata* var. *lata*, Figs 93–97. LM. Figs 98, 99. TEM. Figs 100–103. SEM. Scale bars equal 5 μm unless otherwise stated. Iceberg shelf sample [IMBB Sample 58(12)].

Figs 93–100. Stadal variation of valve outline, showing variation in size of sternum and development of striation and dissimilar apical slit fields at the two poles.

Figs 101–103. External view of apices at higher magnification. Fig. 103, tilt 30°.



Figs 104–110. *Synedropsis lata* var. *lata*, SEM.

Figs 105–110. At the same magnification. Internal views. Figs 105, 108, tilt c. 10°, Figs 107, 110, tilt 40°. Iceberg shelf sample [IMBB Sample 58(12)].

Fig. 104. Whole valve, scattered areolae on valve face.

Figs 104, 106, 107. Apices, no labiate process, wide apical slit fields.

Figs 108, 109, 110. Apices, labiate processes, narrow apical slit fields. **Fig. 110.** Two processes and well developed striation.

µm. Valve striae 18–20 in 10 µm with 5 areolae in 1 µm. Labiate process with broad lips. Apical fields with 2, occasionally 3 slits, and 4–6 slits, at apices with and without labiate process, respectively.

HOLOTYPE: IMBB 100.

ISOTYPES: BM 82214, BRM Zu 4/38, PH G.C. 91010.

TYPE LOCALITY: 60°42.5'S, 45°36'W [IMBB Sample 58(12)].

HABITAT: Antarctic sea-ice.

MORPHOLOGY: Both large and small valves are narrowly linear-oblong (Figs 111–116). The valves appear almost structureless in LM. The sternum exhibits the wide variation in shape and extension of the nominate variety (Figs 118, 119). With the light microscope a faint striation is visible along the margins of the smaller specimens (Figs 111–113); in the larger specimens the marginal structures are most distinct (Figs 114–116).

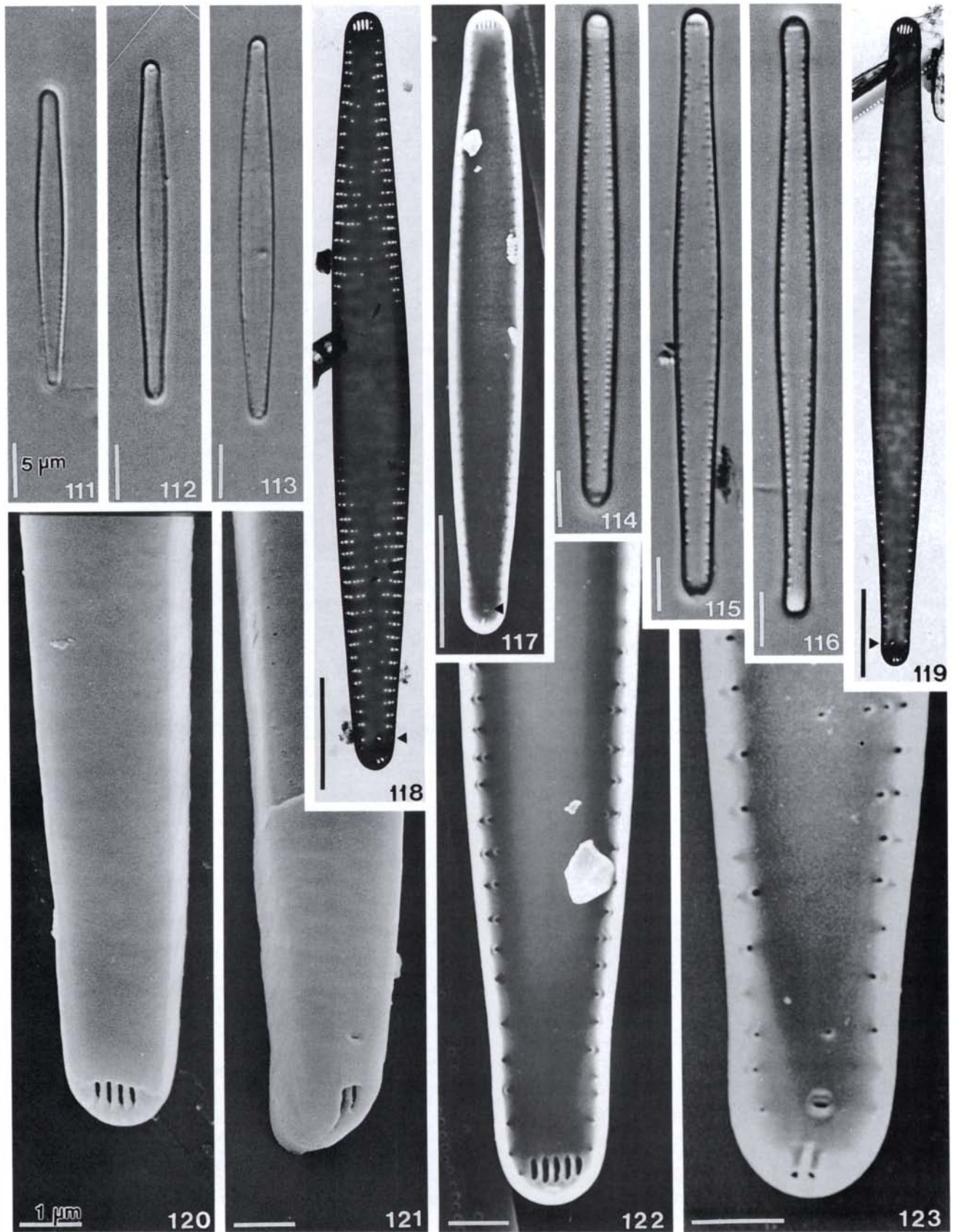
The labiate process is comparatively small and shallow, characterized by the broad lips (Figs 123) and an external opening (Fig. 121) discerned with EM (Figs 118, 119).

Both taxa can be recognized in LM by the shape of the valve, the short marginal striae and the unequal, distinctive, apical slit fields.

TAXONOMY: *Synedropsis lata* differs from the other species of the genus by (i) valve outline, (ii) size and shape of the labiate process and (iii) the apical fields with an unequal number of slits at each apex.

The larger specimens of *S. lata* (Figs 97, 98) are superficially similar to *Synedra adeliae* Manguin (Manguin 1957, p. 123, pl. 5, fig. 21, apical axis 73 µm), to the more coarsely structured *Thalassionema gelida* Peragallo (Peragallo 1921, p. 69, pl. 3, fig. 10, 10 marginal areolae in 10 µm) as well as to the larger *Fragilaria islandica* var. *producta* and var. *stricta* (see comparison with *S. recta*). However, the lack of information on a possible stadial variation and the lack of type material for EM examination preclude further comparisons.

The smaller *S. lata* var. *lata* specimens (Figs 93–95, 99) differ notably from the smaller *S. lata* var. *angustata* (Figs 111–113, 117–119) in the shape of the valve. The distinction



Figs 111–123. *Synedropsis lata* var. *angustata*. Figs 111–116. LM. Fig. 117. 120–123. SEM. Figs 118, 119. TEM. Figs 111–119. Scale bars equal 5 μm . Figs 120–123. Scale bars equal 1 μm . Iceberg shelf sample [IMBB Sample 58(12)].
Figs 111–116. Stadal variation of valve outline, note apical slit fields and marginal structure.

between the two taxa is also manifest by the external openings of the labiate processes and the fewer apical field slits at the labiate process apices in var. *angustata*. The identification of specimens c. 50–70 μm long and 3.5–4 μm wide (Figs 97, 98 and Figs 114–116) is more problematic. These cells are similar to the smaller specimens of var. *angustata* in shape but could also belong to the upper size range in var. *lata* since Figs 96 and 100 may be regarded as transition forms to the longer and more slender Figs 97 and 98. Alternatively, Figs 97, 98, 114, 115 and 116 may belong to a third variety of *S. lata*. As long as information on the stadal variation from clonal cultures is missing, this question has to be left unanswered.

DISTRIBUTION: *Synedropsis lata* was common in the type material from an iceberg shelf [IMBB Sample 58(12)]. A single specimen was observed from one of the Ongul Islands samples (IMBB Sample 2588).

***Synedropsis fragilis* (Manguin) Hasle,
Syvertsen et Medlin comb. nov.**

Figs 124–141, 142f, Table 2

BASIONYM: *Synedra fragilis* Manguin 1957, p. 123, pl. 5, fig. 22 (see also Manguin 1960, p. 301, pl. 13, fig. 141).

NEOTYPE: IMBB 103.

NEOISOTYPES: BM 82317, BRM Zu 4/34, Zu 4/35, PH G.C. 91008.

TYPE LOCALITY: Cap Margerie, Terre Adélie, 66°50'S, 141°25'E.

NEOTYPE LOCALITY: Kita-no-seto Strait, East Antarctica (IMBB Sample 2591).

MORPHOLOGY: *Synedropsis fragilis* forms stellate or pin-cushion-shaped colonies (Figs 124, 134) attached to large benthic diatoms (Manguin 1957). There are probably two elongate or plate-like chloroplasts per cell (Fig. 124). In girdle view cells are slightly asymmetrical along the apical axis, one valve being straight, the other convex in the middle and somewhat concave near the apices (Fig. 124). Information on the structure of the girdle is fragmentary. The valvocopula appears unperforated and open at one apex; the next abvalvar band is broader with

one row of rectangular areolae, 5–6 in 1 μm , close to the pars interior (Fig. 141).

Valves are lanceolate with gradually prolonged obtuse projections (Figs 125, 127–130, 135), tapering to small rhomboid valves with obtuse apices (Figs 126, 131, 132, 134, 138).

The sternum is highly variable, in some specimens manifest as a longitudinal rib with a central widening, in others occupying most of the valve face (Figs 129–133). The areolae have vela of the rota type, lying flush with the external valve surface (Figs 139, 140).

The labiate process has broad lips and occupies about half the width of the valve apex. It is located on the second, occasionally third stria from apex and is perpendicular or slightly oblique to the apical axis (Fig. 136). The external rectangular opening is about twice the size of an areola (Fig. 139). The apical fields, located midway down on the slanting mantle, have 6–7 slits at both ends (Figs 136–139).

The parallel striae are distinctive in LM, probably because of the broad interstriae, but neither the labiate process nor the apical slit fields are discernible without the use of EM.

TAXONOMY: Although we were able to identify *Fragilaria islandica* var. *adeliae* and probably also *Synedra tabulata* var. *australis* Manguin and *Synedra adeliae* Manguin on Manguin's slides, we did not find any diatom corresponding to *Synedropsis fragilis*. Nevertheless, Manguin (1957, 1960) illustrated two valves of the same size and rhomboid outline and described his species as rhomboid-lanceolate with an apical axis of 53–31 μm , a transapical axis of 3–4 μm and 23–26 striae in 10 μm . Thus the valve outline, the morphometric data and the habitat of Manguin's species agree with the diatom examined by us from East Antarctica. We therefore assume that we are dealing with the same taxon and, lacking material to be used for a lectotype, we designate a neotype from a habitat similar to Manguin's locality.

The smaller specimens of *S. fragilis* are distinguished by their rhomboid shape. Larger specimens show superficial similarity to *S. hyperborea* but *S. fragilis* has a more robust appearance. It does not taper so much towards the apices and thus has broader cell ends than *S. hyperborea*. *Synedropsis fragilis*

→
Figs 124–133. *Synedropsis fragilis*, LM and TEM. Figs 124–128. All at the same magnification. Figs 129–133. All at the same magnification. Figs 124, 126, 129–133. Ice sample (IMBB Sample 2591). Figs 125, 127, 128. Rocky sea bottom (IMBB Sample 2588).

Fig. 124. LM. Colony attached to a diatom, one cell in girdle view, chloroplasts, *Pseudonitzschia* sp. at the bottom.

Figs 125–128. LM. Stadal variation of valve outline, variation of sternum and development of striation.

Figs 129–133. TEM. Stadal variation of valve outline, variation of sternum and development of striation, note apical slit fields and labiate process (arrowheads).

Figs 134–141. *Synedropsis fragilis*, SEM. Scale bars equal 1 μm unless otherwise stated. Ice sample (IMBB Sample 2591).

Fig. 134. Cells in stellate colony, valve view.

Figs 135, 136, 137. Valve in internal view, with detail of labiate process, apical slit fields and areolae at higher magnifications.

Figs 138, 139. External view of lightly silicified valve showing valve striation and sternum, with detail of apical slit fields and labiate process (arrowheads) at higher magnification.

Fig. 140. Internal view of areolae with vela.

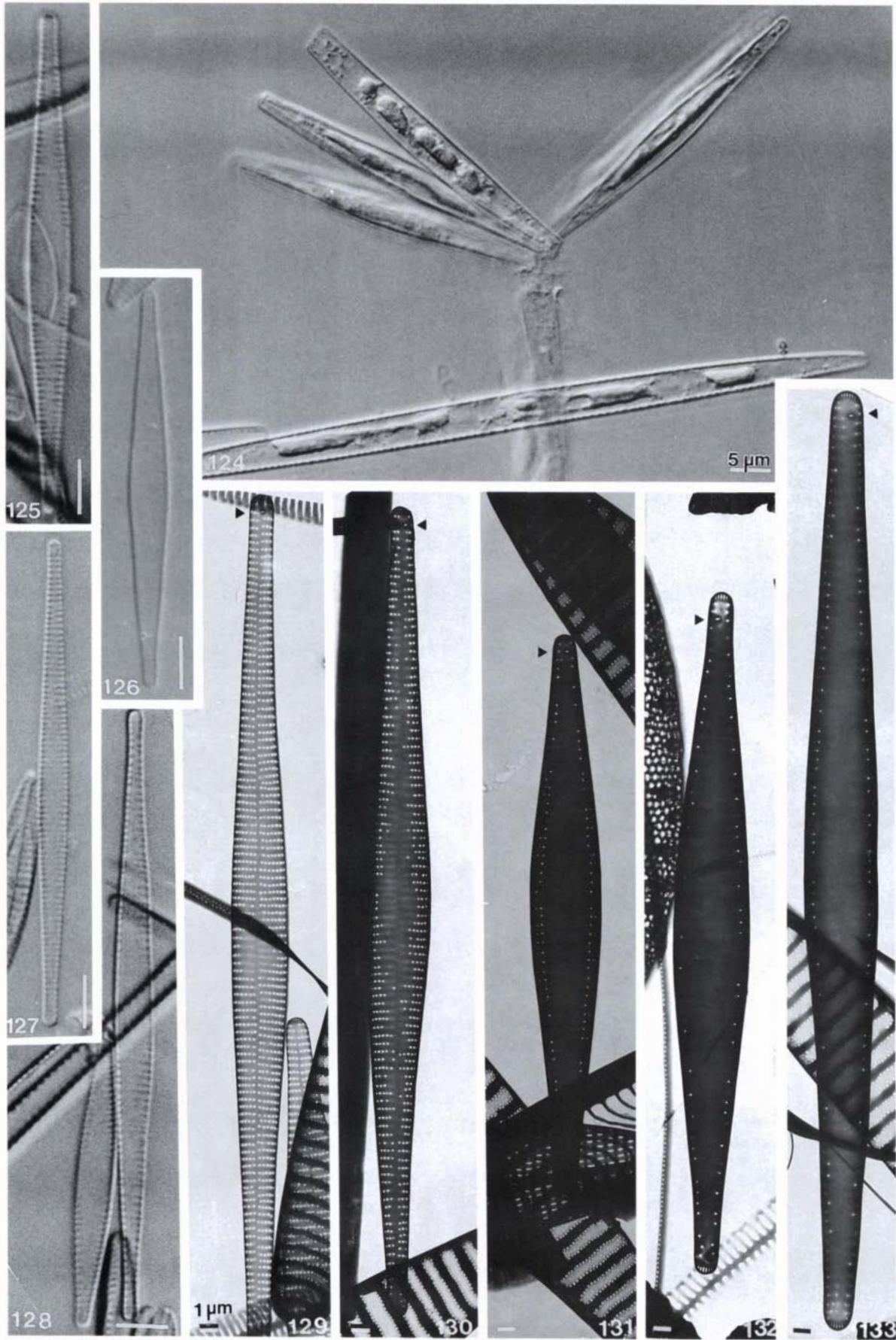
Fig. 141. Two cells, note apical slit fields, unperforate valvocopula and two bands, each with one row of large areolae close to pars interior, tilt 60°.

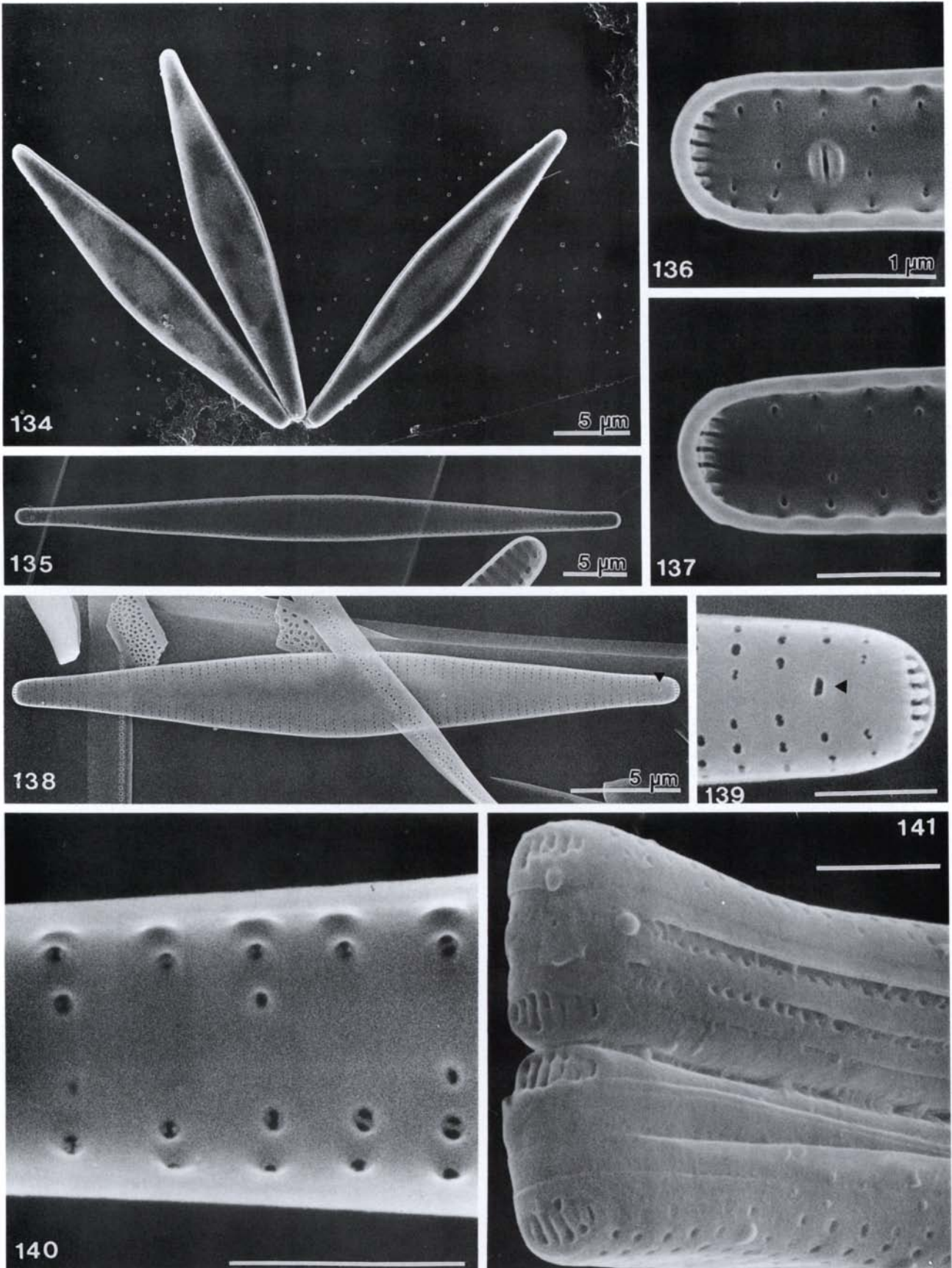
←
Fig. 117. Internal valve view, note apical slit fields and labiate process (arrowhead).

Figs 118, 119. Variation of sternum and development of valve striation, note apical slit fields and labiate process (arrowheads).

Figs 120, 121. External views of valve apices, without and with labiate process respectively, tilt 30°.

Figs 122, 123. Internal views of valve apices, without and with labiate process respectively, tilt 10°.





differs from *S. recta* by its more lanceolate shape of the central part of the valve and finer striation.

DISTRIBUTION: Our records of *S. fragilis* are from rocky sea bottom under fast ice by Kita-no-ura Cove (IMBB Sample 2588) and from the bottom of sea ice in Kita-no-seto Strait near Syowa Station (IMBB Sample 2591), both in East Antarctica.

DISCUSSION

Fragilaria, *Synedra* and genera consisting of species previously referred to these two (Williams 1986; Williams & Round 1986, 1988a, 1988b) have in the past been fairly poorly defined, usually in terms of negative characters. They lack a raphe or slit in the cell wall but usually possess labiate processes, the proposed precursor of the raphe (Hasle 1973). The basic architecture of the valve consists of a central, regular rib (sternum) extending between the two poles from which lateral ribs or interstriae emanate. The space between the interstriae may be partly perforated by areolae forming the striae. In these genera the lack of areolae is restricted to the central part of the valve (the central area). The size and the development of the central area may vary considerably, e.g. in *Fragilaria striatula* Lyngbye (Hasle & Syvertsen 1981).

These araphid genera are further characterized by having apical pore fields. *Synedra* and most genera previously included in this genus (Williams & Round 1986) and *Fragilaria sensu stricto* (Williams & Round 1988a) have an ocellulimbus at each apex. An ocellulimbus is described as 'a pore plate set into the polar valve mantle', the pore plate having a mesh of 'closely packed porelli in regular, linear rows' (Williams 1986, p. 146). Other genera, e.g. *Fragilariforma* Williams et Round and *Staurosira* Williams et Round, previously included in *Fragilaria* (Williams & Round 1988a, 1988b), have simple apical pore fields usually consisting of a few pores or poroids lying flush with the valve surface.

The specimens examined by us are sufficiently different from the genera mentioned above to warrant the erection of the new genus, *Synedropsis*. This genus is mainly characterized by the structure of its apical fields, which are slits rather than pores. Each species assigned to this new genus, except *S. hyperboreoides*, exhibits extreme stadal variation in its valve outline (Fig. 142). There is also great variability in the shape and the size of the non-areolated part of the valve face (sternum) in longitudinal as well as transverse directions in all *Synedropsis* species so far examined. This lack of perforation often leaves the sternum very heavily silicified and the areolation restricted to the margins of the valve face and/or the mantle. This feature is absent from *Synedra*, *Fragilaria* and the other newly described genera mentioned above.

On the other hand, *Synedropsis* shares some features with several other araphid genera. Uniseriate striae with circular poroids, a single labiate process per valve and open bands with one row of poroids are characters shared with *Fragilaria* and *Fragilariforma* (Hasle & Syvertsen 1981; Williams & Round 1988a). In these respects *Synedropsis* differs from *Synedra*, which has uniseriate or biseriate striae, closed bands and a single labiate process at each pole (Williams 1986).

Apical fields similar to those of *Synedropsis* have been observed in *Asterionellopsis* Round, *Falcula* Voigt, *Hustedtiella*

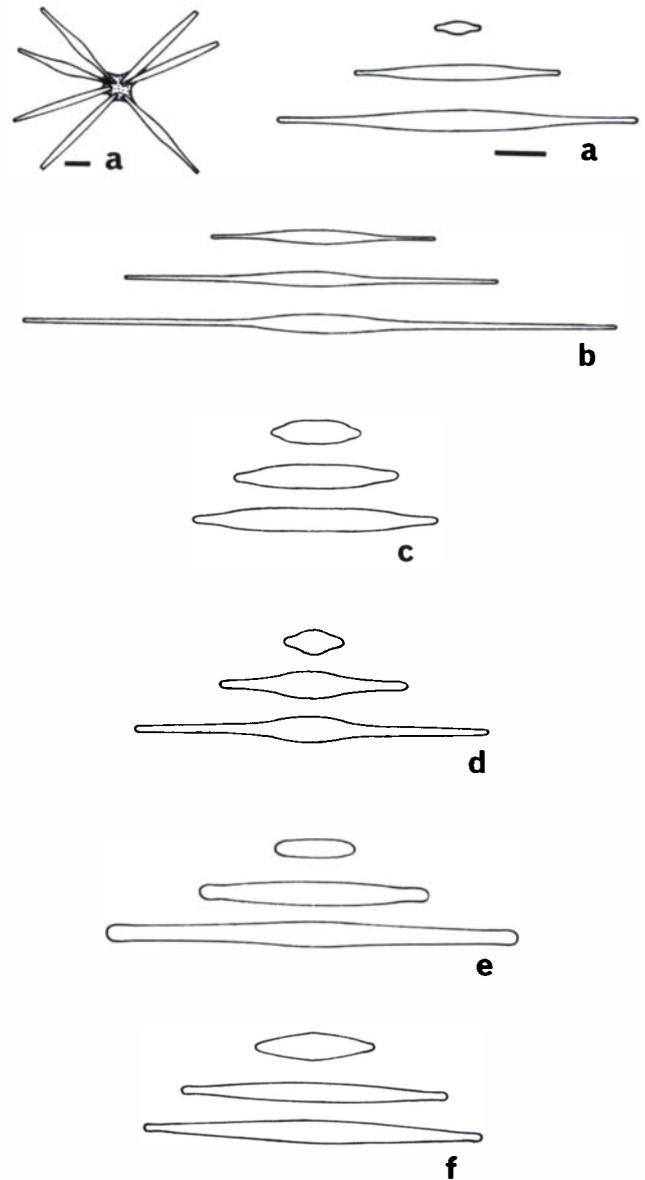


Fig. 142. Schematic drawings illustrating colony formation and stadal variation of valve outline. a. *S. hyperborea*, b. *S. hyperboreoides*, c. *S. recta*, d. *S. lata* var. *lata*, e. *S. lata* var. *lata*, f. *S. fragilis*. All valves at the same magnification.

Simonsen, *Sceptronema* Takano and *Psammosynedra* Round (Körner 1970; Hasle 1973; Takano 1983; Round *et al.* 1990; Crawford *et al.* 1993; Round 1993). These genera may form a natural grouping in the araphid diatoms.

The apical field of *Neosynedra* Williams et Round occupies both the valve mantle and part of the valve face. It consists of long bars and apertures occasionally interrupted by shorter cross-members (Williams & Round 1986). However, it is not recessed into the valve mantle and is therefore only superficially similar to that of *Synedropsis*.

Thus, based on the structure of the valve wall, the apical fields, the bands and the number of labiate processes, *Synedropsis* is a well-defined genus, closer to *Fragilaria* than to *Synedra*. The historical records of *Synedropsis* species may be very difficult to interpret. In all likelihood these species have

been recorded as either *Fragilaria* or *Synedra* spp. or have been entirely overlooked. There is a striking difference between the number of *Fragilaria* and *Synedra* taxa in arctic as compared to antarctic sea-ice communities. For example, *Fragilaria striatula*, *F. islandica* Grunow, *Synedra camtschatica* Grunow and *S. tabulata* (Agardh) Kützing are the only taxa besides *Synedropsis hyperborea* recorded from the Arctic (Hsiao 1983; Horner 1985, Appendix). In the Antarctic, Peragallo (1921), Heiden in Heiden & Kolbe (1928) and Manguin (1957, 1960) described a total of eight taxa belonging to *Fragilaria* and seven to *Synedra*. This number was drastically reduced when Simonsen (1992, p. 21) synonymized four of them with *F. striatula*.

The arctic *Fragilaria* and *Synedra* species associated with sea ice are morphologically different from *Synedropsis* spp. (Hasle & Syvertsen 1981; Williams & Round 1986). Except for those araphid taxa placed in *Synedropsis*, the true taxonomic affinity of many antarctic *Fragilaria* and *Synedra* species is less well known. Thus we are left with one *Synedropsis* species from the Arctic and five from the Antarctic.

Garrison (1991) and Horner *et al.* (1992) have differentiated a series of different sea-ice communities. The sea-ice material from which *Synedropsis* spp. have been recorded originates primarily from bottom and sub-ice samples (Table 1). A more precise characterization of the relevant sea-ice community, *sensu* Horner *et al.* (1992), to which *Synedropsis* species belong, will require further studies with a detailed sampling programme. The paucity of plankton records of *Synedropsis* spp. gives sufficient evidence, however, to conclude that the genus, in general, belongs to bottom sea-ice communities, either directly attached to the sea ice or epiphytic on larger diatoms attached to the ice.

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