POLISH POLAR RESEARCH	19	3-4	187-204	1998

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Summer phytoplankton composition in transect from Weddell Sea to La Plata

ABSTRACT: A total of sixty five taxa of marine phytoplankton (diatoms, dinoflagellates, silicoflagellates and cyanoprokaryotes) were recorded in the transect from the cold region of the Antarctic (Weddell Sea) up to La Plata Bay, Argentine in the late austral summer (March 1989). Diatoms were the dominant group in a south-north transect from the Seal-Bay (Princess Martha Land, the Antarctic). Most of the phytoplankton species of the cold Antarctic region disappeared around 50°S where there is a steep water temperature gradient. The diatom flora declined in the regions of increasing temperature, *i.e.* between 60° and 50° S and was replaced by dinoflagellates of the genus *Ceratium*. Large centric diatom genera *Corethron, Rhizosolenia, Chaetoceros* and *Dactyliosolen* represented the most apparent phytoplankton part. The most common of the small centric diatom genera were *Thalassiosira, Asteromphalus, Actinocyclus* and *Coscinodiscus*, while several species of *Navicula* and *Nitzschia* were the most abundant pennate forms. The presence of a considerable number of freshwater pennate diatoms, characterized as indifferent in the halobion spectrum and mostly periphytic, might be attributed to survival strategies during their development on the floating coastal ice.

Key words: Antarctica, Weddell Sea, South Atlantic, phytoplankton, diatoms.

Introduction

Distinct diatom assemblages characterize the latitudial zones of the Antarctic Ocean and different types of Antarctic sea ice (Kopczyńska, Weber and El-Sayed 1986, Krebs, Lipps and Burckle 1987, Ligowski and Kopczyńska 1991, Ligowski 1991, Kang and Fryxell 1992). The ice edge in the Weddell Sea is thought to be the habitat substratum for different life stages with individual species showing markedly different growth habits in the different seasons (Ligowski, Lipski and Zieliński 1988, Fryxell 1989). Generally, a rich diatom flora has been found on floating ice in both polar regions (*e.g.* Meguro, Ito and Fukushima 1966, Meguro, Kuniyuki and Fukushima 1967, Smith, Clément and Head 1989, Okolodkov 1990).

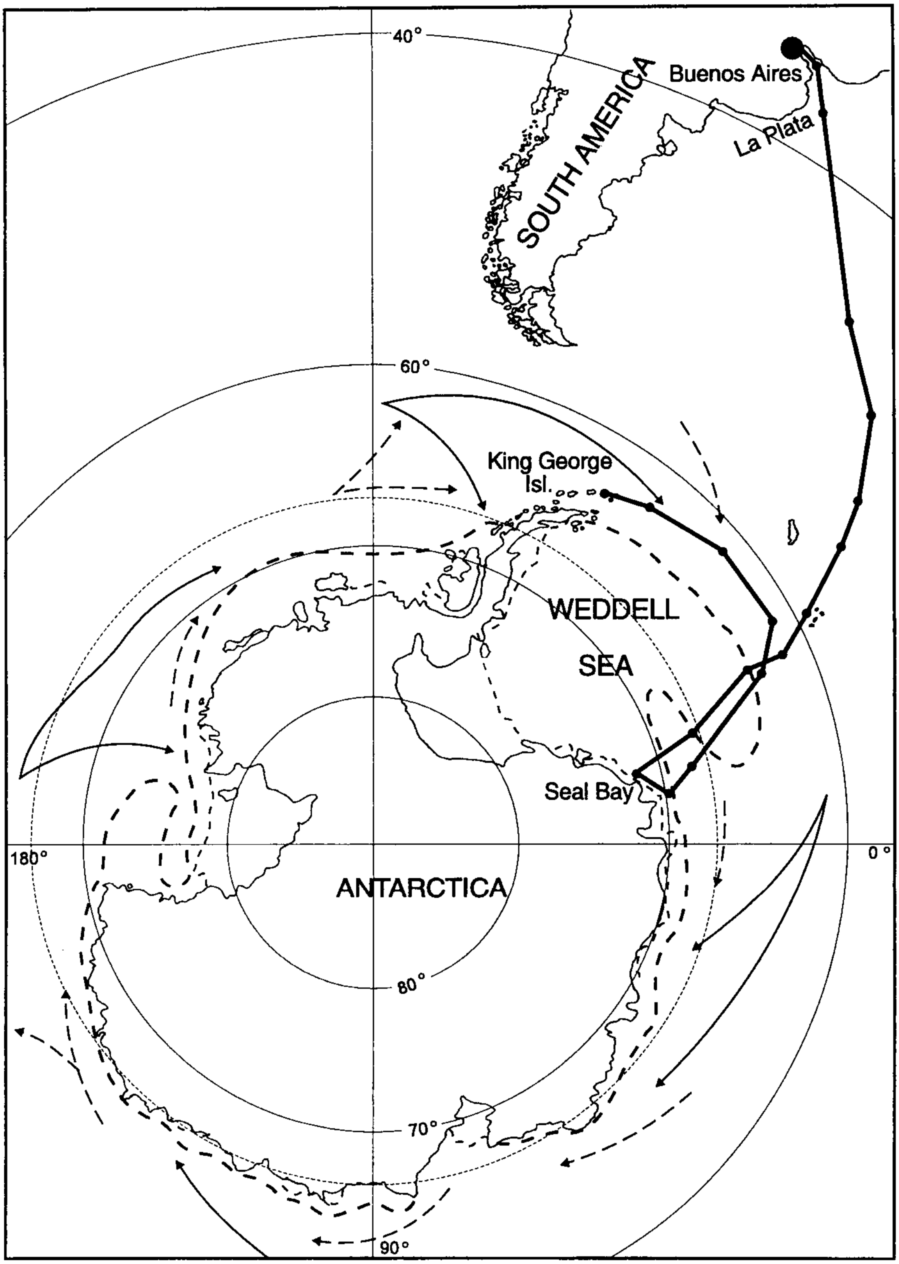
Phytoplankton communities may freeze during the winter season, or may remain associated with the walls of floating icebergs (*comp.* Smith *et al.* 1988, Smith, Clément and Head 1989). Some species sink down and do not participate in the further development of phytoplankton. Moreover, several freshwater and facultative cryophilic species are transported on floating icebergs far from the Antarctic coast (Palmisano and Sullivan 1985, Palmisano, Soohoo and Sullivan 1985). Freshwater Antarctic flora, transported into the ocean by melting icebergs can be present in great quantities during sampling, thus biasing the primary production measurements of the whole region. Comparison of algal assemblages in ice and water in the Weddell Sea provided evidence for seeding from sea ice of some species in Antarctica (Garrison, Buck and Fryxell 1987).

This floristic paper deals with dominant phytoplankton species and their distribution along a transect of King George Island–Seal Bay–La Plata during a cruise in March 1989.

Methods

Phytoplankton was sampled from the eastern part of the Weddell Sea and from the Southern Atlantic, along the south-north transect from King George Island (South Shetland Islands) – Seal Bay (Princess Martha Land) up to La Plata Bay (Map 1). Samples were collected from the surface (1–2 m of depth) by the collection vessel, mixed, preserved and sedimented from 2 liter volume. Samples were taken along the transect in approximately 24hrs intervals, always between 9.00 and 9.30 a.m. Sampling and temperature measurements were performed from March 6 to March 22, 1989. Samples of 50 ml were collected for identification and fixed in 4% formaldehyde.

Species identifications were made according to classical and modern monographs (Hustedt 1927–1966, 1930; Gemeinhardt 1930; Geitler 1932; Schiller 1937; Desikachary and Ranjitha Devi 1986; Krammer and Lange-Bertalot 1986, 1988, 1991; Desikachary and Prema 1987; Desikachary, Growthaman and Latha 1987; Desikachary *et al.* 1987; Desikachary 1988–1989; Makarova 1988) and were docummented by micrographs. Additional literature was used for providing data on the ecological requirements of the non-marine, exclusively pennate diatom species (*e.g.* Lowe 1974, Cholnoky 1968).



circumpolar winds, west-Australian oceanic currents,
route of ship navigation with sampling sites.

Map. 1. Cruise track and station positions.

Results

The dominant phytoplankton species and their distribution along the profile of Seal Bay–La Plata are presented in Tables 1–3. In the following annotated list of algae found, taxonomic remarks are given only for the taxa not completely coinciding with the types; also ecological preferences are presented only for the typical non-marine (exclusively pennate) diatom species. Photographs of the species found are shown in Figs 1–61.

Cyanoprocaryotes

Phormidium sp. Solitary trichomes without sheaths and always without gas vesicles. According to the morphological characteristics, they do not correspond with any known marine planktonic species (fragments of cryophilic freshwater species?).

Dinoflagellates

Ceratium bucephalum (Cleve) Cleve (Figs 59a–b). Marine species known from temperate and cold regions.

Ceratium fusus var. *seta* (Ehrenberg) Jørgensen. A cosmopolitan variety, mainly known from warm marine habitats.

Ceratium lineatum (Ehrenberg) Cleve (Fig. 60). Common in temperate and cold regions of the Atlantic, possibly in some areas of the Pacific.

Silicoflagellates

Distephanus speculum var. *pentagonus* Lemmermann (Fig. 61). A variety known from the Antarctic and the Atlantic Ocean.

Centric diatoms

Actinocyclus actinochilus (Ehrenberg) Simonsen (Figs 1a–c): Along with the valves, with taxonomic features coinciding with those of the type, populations with wide morphological variability were also found (see also comments in *A. octonarius* var. *sparsus*). It is noted that variable density of striation in material from the Antarctic was also mentioned by Simonsen (1982).

Actinocyclus octonarius Ehrenberg (Figs 2a–b): Valves were found with characters similar to the type species.

Actinocyclus octonarius var. *ralfsii* (W. Smith) Hendey (Fig. 4): Valves with striation similar to the typical variety.

Actinocyclus octonarius var. *sparsus* (Gregory) Hendey (Fig. 3): Not very common in our material. The valves identified as *A. octonarius* var. *ralfsii* and *A. octonarius* var. *sparsus* might be considered within the variability limits of *A. actinochilus*. However, their common presence with valves typical of *A. octonarius* in the same population was considered decisive element for the present identification.

Asteromphalus robustus Castracane (Figs 5a–c): Very common species with wide variability. Several valves are reminiscent of the structure of *A. antarcticus* Castracane or *A. reticulatus* Cleve.

Chaetoceros atlanticus Cleve (Figs 6a, b): Common in our material.

Chaetoceros atlanticus var. *skeleton* (Schutt) Hustedt (Figs 7a–d): Common, together with the type variety.

Chaetoceros borealis Bailey (Fig. 8): Common species, with valves similar to the type.

Chaetoceros bulbosum (Ehrenberg) Heiden (Figs 9a, b): Antarctic species. Among the typical specimens, several frustules deviate a little form both the type variety and *C. bulbosum* var. *schimperana* (Karsten) Heiden or *C. bulbosum* f. *cruciata* (Karsten) Heiden in length of the pervalvar axis.

Chaetoceros concavicornis Manguin (Figs 10a, b): With a wide variation in the length of setae.

Corethron hystrix Hensen (Figs 11a–d): Common in our samples. Some specimens with greater dimensions are reminiscent rather of *C. pelagicum* Brun.

Coscinodiscus curvatulus Grunow ex A. Schmidt (Figs 12a–b): Specimens with wide plasticity in valve structure (some of them differ slightly from the type, the other cannot be clearly distinguished from *C. subtilis* Ehrenberg).

Coscinodiscus cf. *nobilis* Grunow (Fig. 13): Several frustules reminiscent of *C. concinnus* W. Smith, but morphometric characteristics corresponds better to those of *C. nobilis.*

Coscinodiscus oculus-iridis Ehrenberg (Figs 15a–b): Specimens with wide plasticity in valve structure; atypical specimens occur together with the type.

Coscinodiscus oculus-iridis var. *borealis* (Bailey) Cleve (Figs 14a–b): Common in our samples with typical morphotypes.

Coscinodiscus cf. *perforatus* var. *cellulosa* Grunow (Figs 16a–b): Uncertain identification, since the central part of most valves was not very clear and the characteristic feature for this taxon (radial arrangement of areolae) was absent.

Coscinodiscus subtilis Ehrenberg (Figs 17a–b): Mixed with the typical specimens, there were commonly observed valves showing some similarities to *C. rothii* (Ehrenberg) Grunow or *Actinocyclus subtilis* (Gregory) Ralfs.

Dactyliosolen antarcticus Castracane (Figs 18a–c): Common in our samples, with valves similar to the type.

Eucampia balaustium Castracane (Figs 19a–b): Specimens with valves similar to the type.

Hemiaulus cf. *membranaceus* Cleve (Fig. 20): The individuals found do not correspond perfectly to the description of the type species.

Rhizosolenia alata Brightwell (Figs 21a–b): Common in our samples, with valves similar to the type.

Rhizosolenia hebetata f. *semispina* (Hensen) Gran (Figs 22a–c): Common in our samples; some valves transient to f. *bidens* (Hensen) Gran (Fig. 22c) also occur.

Rhizosolenia imbricata Brightwell (Figs 23a–c): Several specimens of the population observed are closer to the dimensions of var. *shrubsolei* (Cleve) Schröder, while few are reminiscent of *R. styliformis* Brightwell (Fig. 23b).

Thalassiosira anguste-lineata (A. Schmidt) Fryxell et Hasle (Fig. 24): Rarely occurring in our material.

Thalassiosira cf. *gracilis* (Karsten) Hustedt (Figs 26a–c): The presence of large central granules was considered a decisive feature for classifying the valves found as *T. gracilis;* however, they share certain common characteristics with *T. oestrupii* (Ostenfeld) Proškina-Lavrenko ex Hasle.

Thalassiosira lentiginosa (Janisch) Fryxell (Figs 27a–b): Not very common in our samples.

Thalassiosira sp. (Figs 25a–c): The populations studied show some similarities with *T. excentrica* (Ehrenberg) Cleve. Wide variation was observed in the density of striolation and the width of the marginal ring. The studied specimens are characterized by denser striolation and wider marginal area in the type of *T. excentrica*, while the structure of areolae is distant to that of the type.

Thalassiosira sp. (Fig. 28): It shows certain similarities with *T. bioculata* (Grunow) Ostenfeld but it lacks the prominent "two oculi" in the centre of the valve. Moreover, the structure of areolae is denser and more delicate in *T. bioculata.* Also, some valves are somewhat reminiscent of *Schimperiella oliverana* (O'Meara) Sournia.

Pennate diatoms

Achnanthes lanceolata var. *boyei* (Oestrup) Lange-Bertalot (Fig. 38): *A. lanceolata* (Brébisson) Grunow is a cosmopolitan species, slightly alkaliphilous (opt. pH = 7.2–7.5), indifferent in the halobion spectrum, oligosaprobic, periphytic, usually forming spring and autumn maxima (*).

Cocconeis pediculus Ehrenberg (Fig. 29): Cosmopolitan species, alkaliphilous (opt. pH = 7–9), indifferent in the halobion spectrum but apparently tolerating some salt, saproxenous to α-mesosaprobic, often epiphytic (*).

Cymatopleura solea (Brébisson) W. Smith (Fig. 30): Cosmopolitan species, alkaliphilous (opt. pH = > 8), indifferent in the halobion spectrum, oligosaprobic to β-mesosaprobic, oligothermal, usually metaphytic (*).

Cymbella aspera (Ehrenberg) Peragallo (Fig. 31): Cosmopolitan species, alkaliphilous (opt. pH = 7–8.5), indifferent in the halobion spectrum, oligosaprobic, mesothermal and metathermal, periphytic. Several specimens appear tran-

Note: Majority of pennate diatom species found are known as common freshwater cosmopolitan taxa (marked by *) sient characteristics (*e.g.* density of puncta) to *C. lanceolata* (Ehrenberg) Kirchner (*).

Cymbella cistula (Ehrenberg) Kirchner (Fig. 32): Cosmopolitan species, alkaliphilous (opt. pH = 8), indifferent in the halobion spectrum, oligosaprobic, periphytic and limnophilous (*).

Cymbella minuta Hilse ex Rabenhorst (Fig. 33): Some larger frustules are reminiscent of *C. silesiaca* Bleisch. Both species are cosmopolitan, indifferent in the halobion spectrum, with opt. pH 7.7–7.8, oligosaprobic to mesosaprobic, oligothermal (*).

Diploneis ovalis (Hilse) Cleve (Fig. 34): Cosmpolitan species, alkaliphilous (opt. pH over 8), probably indifferent in the halobion spectrum, saproxenous, periphytic and aerophilic (*).

Fragilaria vaucheriae (Kützing) Petersen (Fig. 36): Cosmopolitan freshwater species, mainly known from periphyton in cool waters, rather alkaliphilous (opt. pH = 6.5–9), indifferent in the halobion spectrum, β-mesosaprobic and oligothermal (*).

Gomphonema angustatum (Kützing) Rabenhorst (Fig. 37): Alkaliphilous species (opt. pH = 7.5–7.7), indifferent in the halobion spectrum, oligosaprobic, eurythermal and usually periphytic. Some of the valves found show intermediate characteristics to *G. angustatum* var. *productum* Grunow (*).

Gyrosigma scalproides (Rabenhorst) Cleve (Fig. 39): Cosmopolitan freshwater species, alkaliphilous (opt. pH = 8.3–8.6), indifferent in the halobion spectrum, oligosaprobic and rheophilous (*).

Navicula agnita Hustend (Figs 43a–b): Marine species, known mainly from the western coast of the U.S.A. and the Indian Ocean, but probably more widely distributed.

Navicula capitatoradiata Germain (Fig. 40): Cosmopolitan species found mainly in freshwater habitats but also known from brackish waters, alkaliphilous (opt. pH = 8), usually β to α-mesosaprobic but tolerant to a broad saprobion spectrum, oligothermal to mesothermal (*).

Navicula cuspidata (Kützing) Kützing (Fig. 41): Cosmopolitan species found mainly in freshwater habitats but also known from brackish waters, alkaliphilous (opt. pH = 8.3–8.6), β-mesosaprobic (*).

Navicula lanceolata (Agardh) Ehrenberg (Figs 42a–c): Cosmopolitan species with wide ecological spectrum, occurring in freshwater habitats to brackish waters, oligo- up to β-mesosaprobic, oligothermal (*).

Navicula rhynchocephala Kützing (Fig. 44): Cosmopolitan species with wide ecological spectrum, alkalophilous (opt. pH = 7.3–7.6), indifferent to halophilous in the halobion spectrum, β-mesosaprobic (*).

Navicula slesvicensis Grunow in Van Heurck (Figs 45a, b): Cosmopolitan species occurring in electrolyte-rich freshwater habitats but also in inland salines (*).

Navicula cf. *vitrea* Grunow in Cleve et Möller (Figs 46a, b): *N. vitra* is a marine species known mainly from the Arctic Ocean. In our specimens some morphometric parameters of the frustules were not easy to be distinguished leading to the present uncertain identification.

Nitzschia acicularis (Kützing) W. Smith: Cosmopolitan species, alkalophilous (opt. pH = 8.3–8.5), indifferent in the halobion spectrum, β-mesosaprobic, limnophilous and euplanktic (*).

Nitzschia curta (Van Heurck) Hasle (Figs 47a–d): Marine species, in our samples common in colonial form. Similar type of colonies is common in other marine species of *Nitzschia* (i.e. *N. kerguelensis*), previously classified also as *Fragilaria* or *Fragilariopsis.*

Nitzschia kerguelensis (O'Meara) Hasle (Figs 50a–f): Marine species, common in our samples and variable in size.

Nitzschia linearis (Agardh) W. Smith (Figs 51a–b): Cosmopolitan species, alkaliphilous (opt. pH = 7.8), indifferent in the halobion spectrum, oligosaprobic, periphytic and crenophilous, oligothermal to mesothermal (*).

Nitzschia cf. *ritscheri* (Hustedt) Hasle (Figs 53a–c): Marine species, very common in our samples. Some individuals are hardly classified as *N. ritscheri* and need futher investigation.

Nitzschia separanda (Hustedt) Hasle (Figs 49a–c): Marine, psychrophilic species, common in our samples.

Nitzschia cf. *seriata* Cleve (Figs 52a–d): Marine species. The valves found do not correspond precisely to the description of the type (keelpuncta sometimes distinguished; striae very fine and not easily distint, 10 per 10 μm; cell dimensions 80 × 3.5 μm).

Pinnularia divergens W. Smith (Figs 48a–b): Cosmopolitan species prefering cool waters of low mineral content (*).

Pinnularia maior (Kützing) Rabenhorst (Fig. 54): Cosmopolitan species, occurring in dystrophic freshwaters of fairly low mineral content (*).

Stauroneis anceps Ehrenberg (Fig. 55): Cosmopolitan species, indifferent in pH (opt. 7) and in the halobion spectrum, β-mesosaprobic, often periphytic with spring and fall maxima (*).

Stauroneis phoenicenteron (Nitzsch) Ehrenberg (Fig. 56): Cosmopolitan species with a wide range of ecological tolerance, indifferent in the halobion spectrum, β-mesosaprobic, eurythermal (*).

Surirella brebissonii var. *kuetzingii* Krammer *et* Lange-Bertalot (Figs 57a–b): Cosmopolitan species, mesosaprobic, oligothermal to eurythermal (0–24°C), usually occurring in freshwater habitats but also in some brackish water of higher oxygen content, in Europe forming winter maxima. Rarely found in our samples (*).

Surirella linearis W. Smith (Fig. 58): Cosmopolitan freshwater species, rarely present in brackish water. It was found in our samples very rarely (*).

Synedra ulna (Nitzsch) Lange-Bertalot (Figs 35a–b): Common cosmopolitan freshwater species of great ecological valence, indifferent in the halobion spectrum, oligosaprobic to β-mesosaprobic, euplanktic, oligothermal to mesothermal. It was rarely found in our samples. Some deformed forms look similar to *Synedra nyansae* G. West, a species previously recorded from the tropics (*).

Tabularia fasciculata (Agardh) Williams et Round: Commonly occurring in brackish and inland salty waters, as well as in the sea.

Discussion

Phytoplankton occurring in the studied cold regions of the Antarctic Seas decreased in abundance at the sampling sites around 50°S. The same contrasting latitudinal distribution pattern of phytoplankton between a poor central and north region and the relatively rich southern shelf waters has already been pointed out (El-Sayed and Taguchi 1981, Hayes, Whiteker and Fogg 1984, Estrada and Delgado 1990). The diatom flora declined in the area with a water temperature over 5°C, *i.e.* between 60° and 50°S; in this area, diatoms were replaced by dinoflagellates.

Among dinoflagellates *Ceratium bucephalum, Ceratium lineatum* and *Ceratium fusus* var. *seta* occurred mainly in warmer sites of the ocean (over 13°C), although the first two are mainly known from colder regions of the Atlantic and probably the Pacific Oceans. Silicoflagellate *Distephanus speculum* var. *pentagonus* represents the most common motile species along the entire transect. The genus *Phaeocystis*, often cited from cold seas (Iverson, Whitledge and Goering 1979, El-Sayed, Biggs and Holm-Hansen 1983, Veldhuis, Admiraal and Colijn 1986, Estrada and Delgado 1990), was not encountered in our samples. Surprisingly, solitary trichomes of the cyanoprocaryots *Phormidium* sp. of unknown origin, were found in several samples between 60° and 58°S. They could be fragments of cryophilous freshwater or littoral *Phormidium*-species (from the cluster of *Ph. autumnale*), which grows or survives together with diatoms on the sides of floating icebergs.

Diatoms were the dominant group (60 identified diatom taxa out of 65 algal taxa) in our samples (Tables 2 and 3). Large centric diatoms (of more than 35 μm in diameter) were visually the most striking part of the phytoplankton. Members of the genera *Corethron, Rhizosolenia, Chaetoceros*, and *Dactyliosolen* were the most important representatives, whereas common small centric species belonged to the genera *Thalassiosira, Asteromphalus, Actinocyclus* and *Coscinodiscus*. Out of the pennate diatoms, frustules of several species of *Navicula* and *Nitzschia* were abundant in our samples.

Table 1

The review of main phytoplankton taxa (excl. diatoms); M – marine, F – freshwater.

Locality																		
	S	71°41'	71°41'	70°13'	70°00'	69°02'	67°41'	66°47'	65°09'	62°53'	61°12'	59°34'	58°58'	58°58'	58°19'	55°05'	50°31'	46°27'	
	W	12°09'	12°09'	07°41'	08°04'	07°18'	16°43'	09°26'	15°15'	22°00'	22°51'	40°29'	31°06'	25°30'	26°02'	33°27'	39°22'	44°45'	
Sampling date [1989]		15.03.	16.03.	14.03.	12.03.	13.03.	17.03.	11.03.	10.03.	18.03.	9.03.	6.03.	7.03.	8.03.	19.03.	20.03.	21.03.	22.03.	
Temperature [°C]		-1.6	-1.6	-0.9	-1.1	-0.5	0	0	0	-0.3	0	+1.6	0	+0.4	+0.3	+2.1	+5.5	+13.2	
Ceratium bucephalum																		+	M
Ceratium fusus var. *seta*																		+	M
Ceratium lineatum																		+	M
Distephanus speluculm var. *pentagonus*		+			+		+	+	+		+		+		+	+	+	+	M
Phormidium sp.												+	+	+					F?

Table 2

The review of the centric diatom taxa; M – marine, MP – marine/polar.

Locality																		
	S	71°41'	71°41'	70°13'	70°00'	69°02'	67°41'	66°47'	65°09'	62°53'	61°12'	59°34'	58°58'	58°58'	58°19'	55°05'	50°31'	46°27'	
	W	12°09'	12°09'	07°41'	08°04'	07°18'	16°43'	09°26'	15°15'	22°00'	22°51'	40°29'	31°06'	25°30'	26°02'	33°27'	39°22'	44°45'	
Sampling date [1989]		15.03.	16.03.	14.03.	12.03.	13.03.	17.03.	11.03.	10.03.	18.03.	9.03.	6.03.	7.03.	8.03.	19.03.	20.03.	21.03.	22.03.	
Temperature [°C]		-1.6	-1.6	-0.9	-1.1	-0.5	0	0	0	-0.3	0	+1.6	0	+0.4	+0.3	+2.1	+5.5	+13.2	
Actinocyclus actinochilus					+		+	+							+				M
A. octonarius		+					+	+											M
A. octonarius var. *ralfsii*								+											M
A. octonarius var. *sparsus*		+					+												M
Asteromphalus robustus		+	+	+	+		+	+	+	+	+		+	+	+	+	+		MP
Chaetoceros atlanticus								+	+	+									MP

Table 2 – *continued.*

Ch. atlanticus var. *skeleton*				+		+	+	+				+		+	+	+		MP
Ch. borealis						+	+											M
Ch. bulbosum						+												M
Ch. concavicornis	+	+	+	+	+	+	+	+		+		+	+	+	+	+		MP
Corethron hystrix	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		MP
Coscinodiscus curvatulus	+																	M
C. cf. *nobilis*							+											MP
C. oculus-iridis				+				+		+								MP
C. oculus-iridis var. *borealis*	+					+												M
C. cf. *perforatus* cf. var. *cellulosa*					+			+										MP
C. subtilis										+								M
Dactyliosolen antarcticus		+					+	+						+	+	+		MP
Eucampia balaustium	+						+		+									M
Hemiaulus cf. *membranaceus*							+											M
Rhizosolenia alata				+			+	+		+		+						M
R. hebetata f. semispina	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		M
R. imbricata							+	+										MP
Thalassiosira anguste-lineata										+								M
T. cf. *gracilis*	+	+		+		+	+	+		+		+		+	+	+		M
T. lentiginosa	+			+			+											M
Thalassiosira sp.														+				MP
Thalassiosira sp.						+	+	+										M

Table 3

The review of pennate diatom taxa; M – marine, MP – marine/polar, BR – brackish, F – freshwater.

Locality																		
	S	71°41'	71°41'	70°13'	70°00'	69°02'	67°41'	66°47'	65°09'	62°53'	61°12'	59°34'	58°58'	58°58'	58°19'	55°05'	50°31'	46°27'	
	W	12°09'	12°09'	07°41'	08°04'	07°18'	16°43'	09°26'	15°15'	22°00'	22°51'	40°29'	31°06'	25°30'	26°02'	33°27'	39°22'	44°45'	
Sampling date [1989]		15.03.	16.03.	14.03.	12.03.	13.03.	17.03.	11.03.	10.03.	18.03.	9.03.	6.03.	7.03.	8.03.	19.03.	20.03.	21.03.	22.03.	
Temperature [°C]		-1.6	-1.6	-0.9	-1.1	-0.5	0	0	0	-0.3	0	+1.6	0	+0.4	+0.3	+2.1	+5.5	+13.2	
Achnanthes lanceolata var. *boyei*								+	+										F
Cocconeis pediculus													+						F
Cymatopleura solea								+			+								F
Cymbela aspera									+										F
Cymbela cistula					+														F
Cymbela minuta								+	+										F
Diploneis ovalis													+						F
Fragilaria vaucheriae					+			+	+		+		+						F
Gomphonema angustatum					+			+	+		+		+						F
Gyrosigma scalproides											+								F
Navicula agnita																+	+		M
N. capitatoradiata													+						BR
N. cuspidata					+			+	+		+		+			+	+		BR
N. lanceolata					+			+	+		+		+						F
N. rhynchocephala					+			+			+		+						F
N. slesvicensis					+			+	+		+		+						F
N. cf. *vitrea*									+		+		+						MP

Table 3 – *continued.*

Nitzschia acicularis								+		+								F
Nitzschia curta				+		+	+	+		+		+		+				M
Nitzschia kerguelensis				+		+	+	+		+		+		+	+			M
Nitzschia linearis				+			+			+		+				+		F
Nitzschia cf. *ritscheri*				+		+	+	+		+		+		+	+		+	M
Nitzschia separanda				+		+	+	+		+		+		+	+	+		MP
Nitzschia cf. *seriata*							+	+		+		+				+		M
Pinnularia divergens	+					+	+	+				+						F
Pinnularia maior										+								F
Stauroneis anceps				+			+			+								BR
S. phoenicenteron				+														F
Surirella brebissonii var. kuetzingii				+			+			+		+						F
Surirella linearis								+										F
Surirella ulna				+			+			+								M
Tabelaria fasciculata						+	+	+		+								BR

The composition of marine microalgal assemblages showed great similarities with the findings of Estrada and Delgado (1990) from a transect between the southern coast of the Weddell Sea and the Antarctic Peninsula. However, it differed from the two types of ice algal assemblages ("surface type" and "bottom type") described by Meguro, Fukushima and Matsuda (1992) from the Antarctic sector around Lützow-Holm Bay. The typical circumpolar phytoplankton species *Nitzschia seriata* Cleve (Baker 1954) was found in our samples. It is a typical representative of the "surface type" and the most abundant diatom in water column assemblages of marginal ice-edge zones of the Weddell Sea (Kang and Fryxell 1992, see also Moisan and Fryxell 1993).

Along with the typical marine diatom representatives (all the centrics, *i.e.* 28 taxa in total; and 7 pennates i.e. *Navicula agnita, N.* cf. *vitrea, Nitzschia curta, N. kerguelensis, N. ritscheri, N. separanda, N.* cf. *seriata*), two typical freshwater species (*Pinnularia divergens, P. maior*) and three salinity tolerant to halophilous species (*Navicula rhynchocephala, N. slesvicensis, Tabellaria fasciculata*) were also found. The remaining pennates (20 taxa in total) are freshwater species classified as indifferent in the halobion spectrum, apparently capable of tolerating low salinities, whereas most of them rank at the lower levels of the saprobic systems (oligosaprobic, β-mesosaprobic); with the exception of *N. acicularis*, their great majority were characterized as periphytic. From the periphytic genus *Cocconeis* only one species was found in our samples; however, on subtidal sediments of the Kerguelen Islands under the *Macrocystis* canopy, this genus is particularly well represented (Riaux-Gobin 1994).

The common presence of these freshwater species in the Antarctic Seas was surprising, and might be attributed to their development on the floating coastal ice. They seem to enter the marine environment through ice thawing, later sinking down quickly. This interpretation is indirectly supported by the absence of freshwater species in samples collected far from floating icebergs or in areas without melting ice (*comp.* Table 3). Previous work in shallow water systems showed a predominance of benthic or periphytic species associated with deep-water pack ice and planktic assemblages (Bunt and Wood 1963, Krebs 1977, Grossi and Sullivan 1985). Studies on ice populations and planktic populations in the Weddell Sea showed a high index of similarity providing evidence for seeding from sea ice of some species in Antarctica (Garrison, Ackley and Buck 1983; Garrison and Buck 1985, 1986; Garrison, Buck and Fryxell 1987). However, the occurrence of freshwater diatom species in oceanic samples (Table 3) is the most notable observation in contrast to the previous investigations.

Acknowledgements. — This research was funded by the Grant Agency of the Czech Republic (Grant No. 05/94/0156). The authors thank particularly to Dr. Borislav A. Levenko (Moscow State University, Russia) for algae samples and to Dana Švehlová for technical assistance.

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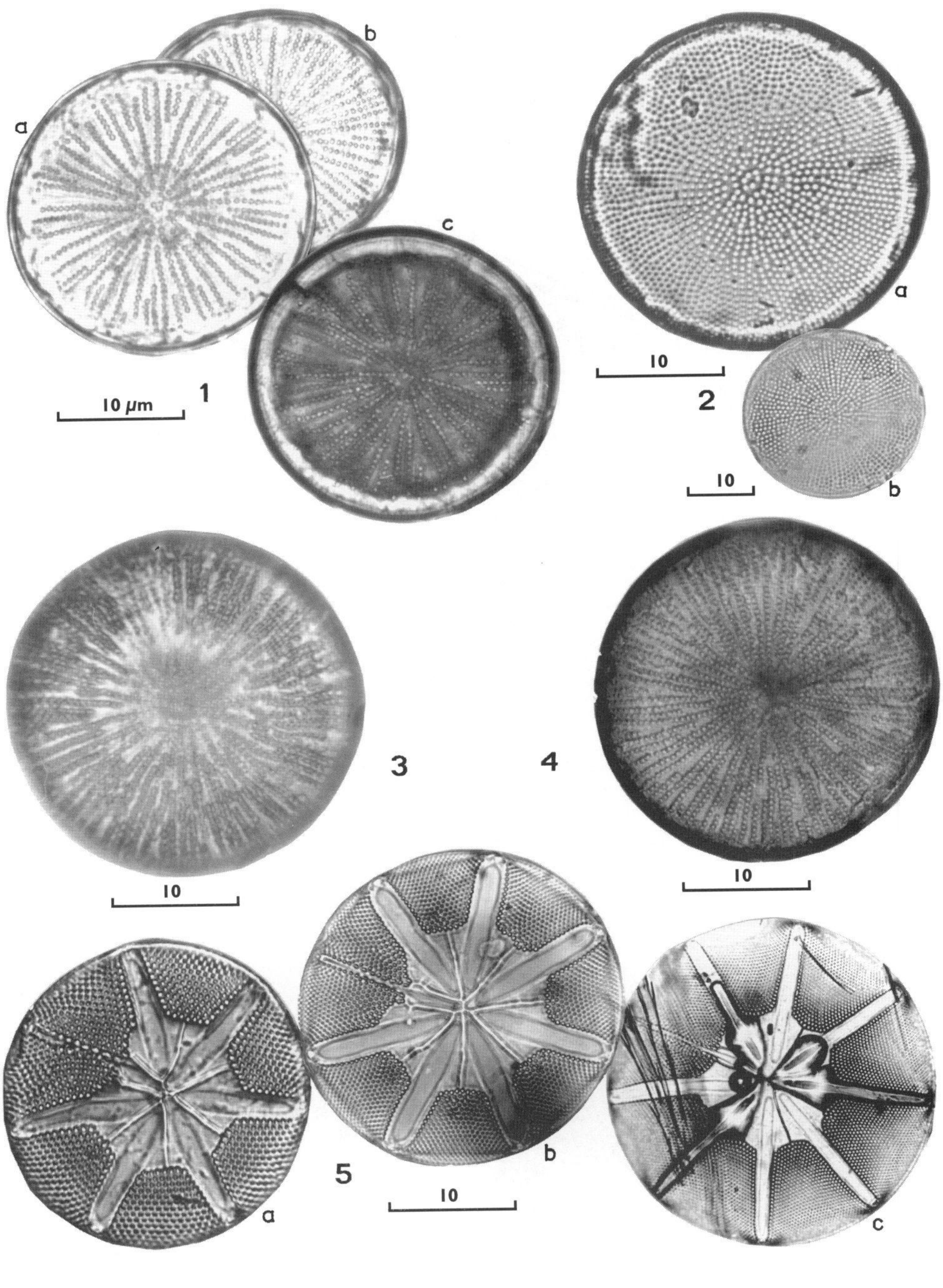
Received April 28, 1997
Accepted June 30, 1997

Streszczenie

W fitoplanktonie powierzchniowym zebranym w transekcie od Morza Weddella (Antarktyka) do Zatoki La Plata (Argentyna) w marcu 1989 r. zidentyfikowano 56 taksonów należących do okrzemek, bruzdnic, tobołków i złotowiciowców (figs 1–61). Okrzemki dominowały w południowo-północnym transekcie od Zatoki Seal. Większość gatunków fitoplanktonu występujących w zimnych rejonach Antarktyki zanika około 50°S, gdzie wzrasta nagle temperatura. Flora okrzemkowa w rejonie wzrastającej temperatury między 60° a 50°S była zastąpiona przez bruzdnice z rodzaju *Ceratium.* Duże promieniste okrzemki należące do rodzajów *Corethron, Rhizosolenia, Chaetoceros* i *Dactyliosolen* stanowiły najbardziej znaczącą część fitoplanktonu. Najpospolitszymi rodzajami małych okrzemek promienistych były *Thalassiosira, Asteromphalus, Actinocyclus* i *Coscinodiscus,* a spośród okrzemek pierzastych najliczniej występowały rodzaje *Navicula* i *Nitzschia.* Obecność znaczącej ilości pierzastych okrzemek słodkowodnych, określonych jako obojętnych na zasolenie i głównie peryfitonowych, świadczyłaby o ich strategii przetrwania w czasie ich rozwoju w dryfującym lodzie przybrzeżnym.

Figure captions [All metric indications are in micrometers].

Fig. 1a–c. *Actinocyclus actinochilus* (Ehrenberg) Simonsen.
Fig. 2a–b. *Actinocyclus octonarius* Ehrenberg.
Fig. 3. *Actinocyclus octonarius* var. *sparsus* (Gregory) Hendey.
Fig. 4. *Actinocyclus octonarius* var. *ralfsii* (W. Smith) Hendey.
Fig. 5a–c. *Asteromphalus robustus* Castracane.
Fig. 6a–b. *Chaetoceros atlanticus* Cleve.
Fig. 7a–d. *Chaetoceros atlanticus* var. *skeleton* (Schutt) Hustedt.
Fig. 8. *Chaetoceros borealis* Bailey.
Fig. 9a–b. *Chaetoceros bulbosum* (Ehrenberg) Heiden.
Fig. 10a–b. *Chaetoceros concavicornis* Manguin.
Fig. 11a–d. *Corethron hystrix* Hensen.
Fig. 12a–b. *Coscinodiscus curvatulus* Brunow ex A. Schmidt.
Fig. 13. *Coscinodiscus* cf. *nobilis* Grunow.
Fig. 14a–b. *Coscinodiscus oculus-iridis* var. *borealis* (Bailey) Cleve.
Fig. 15a–b. *Coscinodiscus oculus-iridis* Ehrenberg.
Fig. 16a–b. *Coscinodiscus* cf. *perforatus* var. *cellulosa* Grunow.
Fig. 17a–b. *Coscinodiscus subtilis* Ehrenberg.
Fig. 18a–c. *Dactyliosolen antarcticus* Castracane.
Fig. 19a–b. *Eucampia balaustium* Castracane.
Fig. 20. *Hemiaulus* cf. *membranaceus* Cleve.
Fig. 21a–b. *Rhizosolenia alata* Brightwell.
Fig. 22a–c. *Rhizosolenia hebetata* f. *semispina* (Hensen) Gran.
Fig. 23a–c. *Rhizosolenia imbricata* Brightwell.
Fig. 24. *Thalassiosira anguste-lineata* (A. Schmidt) Fryxell *et* Hasle.
Fig. 25a–c. *Thalassiosira* sp.
Fig. 26a–c. *Thalassiosira* cf. *gracilis* (Karsten) Hustedt.
Fig. 27a–b. *Thalassiosira lentiginosa* (Janisch) Fryxell.
Fig. 28. *Thalassiosira* sp.
Fig. 29. *Cocconeis pediculus* Ehrenberg.
Fig. 30. *Cymatopleura solea* (Brébison) W. Smith.
Fig. 31. *Cymbella aspera* (Ehrenberg) Peragallo.
Fig. 32. *Cymbella cistula* (Ehrenberg) Kirchner.
Fig. 33. *Cymbella minuta* Hilse ex Rabenhorst.
Fig. 34. *Diploneis ovalis* (Hilse) Cleve.
Fig. 35a–b. *Synedra ulna* (Nitzsch) Lange-Bartalot.
Fig. 36. *Fragilaria vaucheriae* (Kützing) Petersen.
Fig. 37. *Gomphonema angustatum* (Kützing) Rabenhorst.
Fig. 38. *Achnanthes lanceolata* var. *boyei* Lange-Bertalot.
Fig. 39. *Gyrosigma scalproides* (Rabenhorst) Cleve.
Fig. 40. *Navicula capitatoradiata* Germain.
Fig. 41. *Navicula cuspidata* (Kützing) Kützing
Fig. 42a–c. *Navicula lanceolata* (Agardh) Ehrenberg.
Fig. 43a–b. *Navicula agnita* Hustedt.
Fig. 44. *Navicula rhynchocephala* Kützing.
Fig. 45. *Navicula slesvicensis* Grunow in Van Heurck.
Fig. 46a–b. *Navicula* cf. *vitrea* Grunow in Cleve *et* Möller.
Fig. 47a–d. *Nitzschia curta* (Van Heurck) Hasle.
Fig. 48a–b. *Pinnularia divergens* W. Smith.
Fig. 49a–c. *Nitzschia separanda* (Hustedt) Hasle.
Fig. 50a–f. *Nitzschia kerguelensis* (O'Meara) Hasle.
Fig. 51a–b. *Nitzschia linearis* (Agardh) W. Smith.
Fig. 52a–d. *Nitzschia* cf. *seriata* Cleve.
Fig. 53a–c. *Nitzschia* cf. *ritscheri* (Hustedt) Hasle.
Fig. 54. *Pinnularia maior* (Kützing) Rabenhorst.
Fig. 55. *Stauroneis anceps* Ehrenberg.
Fig. 56. *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg.
Fig. 57a–b. *Surirella brebissonii* var. *kuetzingi* Krammer *et* Lange-Bertalot.
Fig. 58. *Surirella linearis* W.Smith.
Fig. 59a–b. *Ceratium bucephalum* (Cleve) Cleve.
Fig. 60. *Ceratium lineatum* (Ehrenberg) Cleve.
Fig. 61. *Distephanus speculum* var. *pentagonus* Lemmermann.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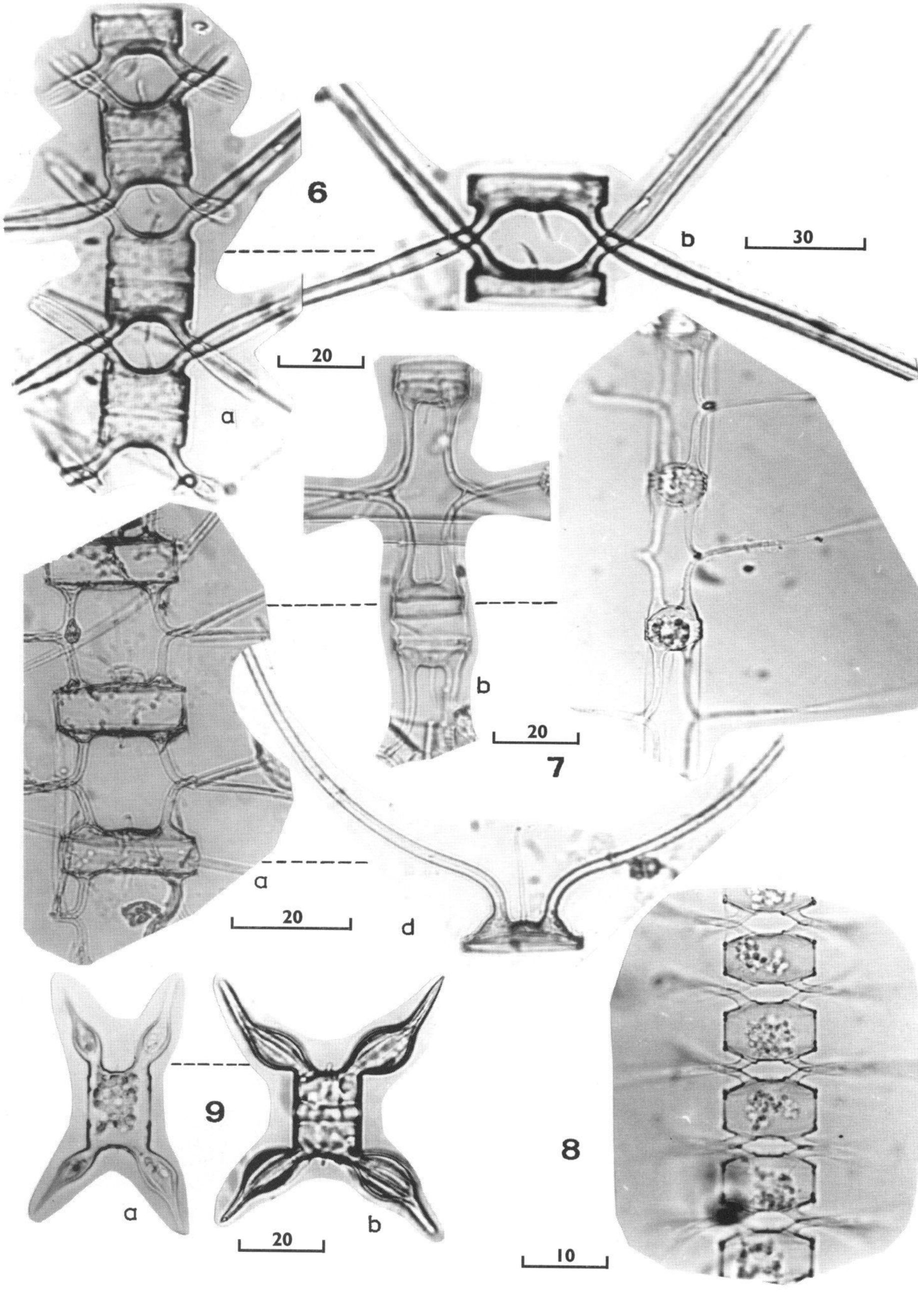
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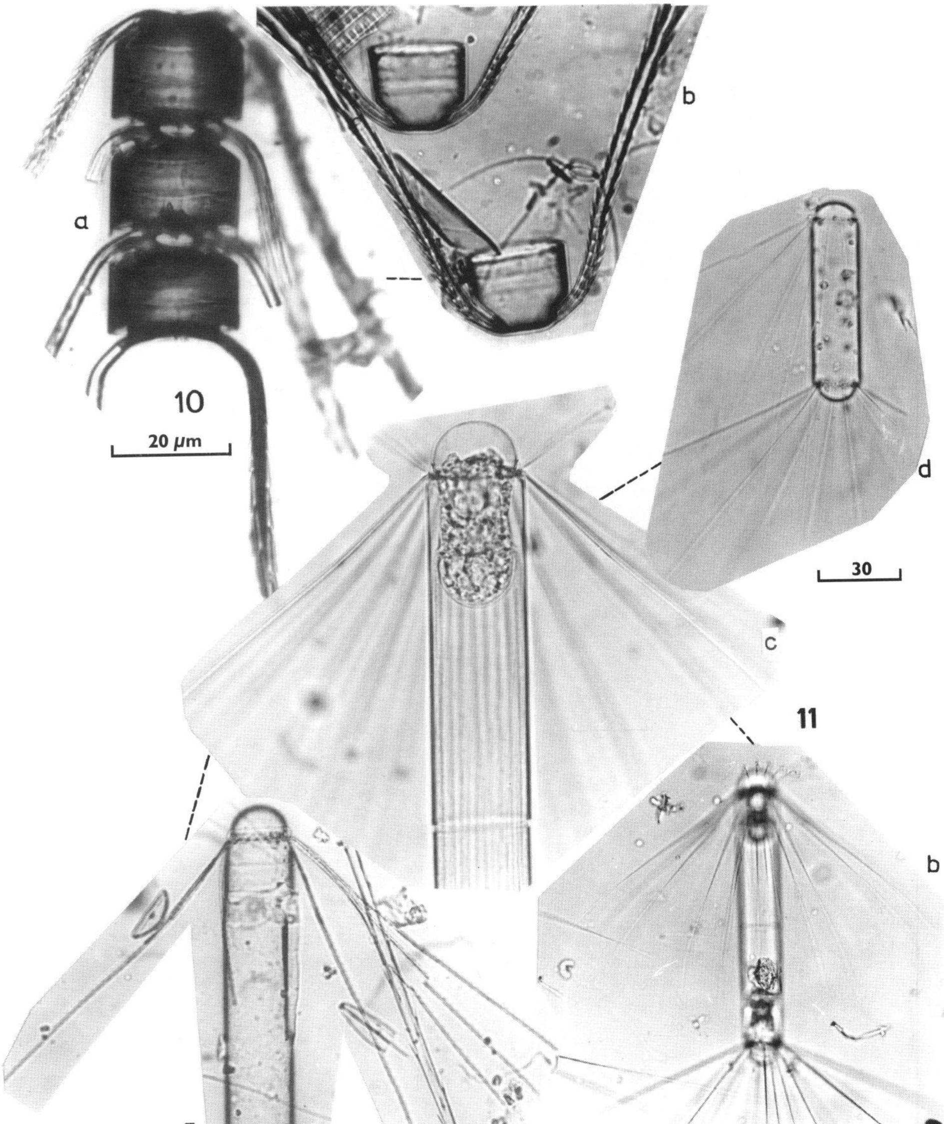

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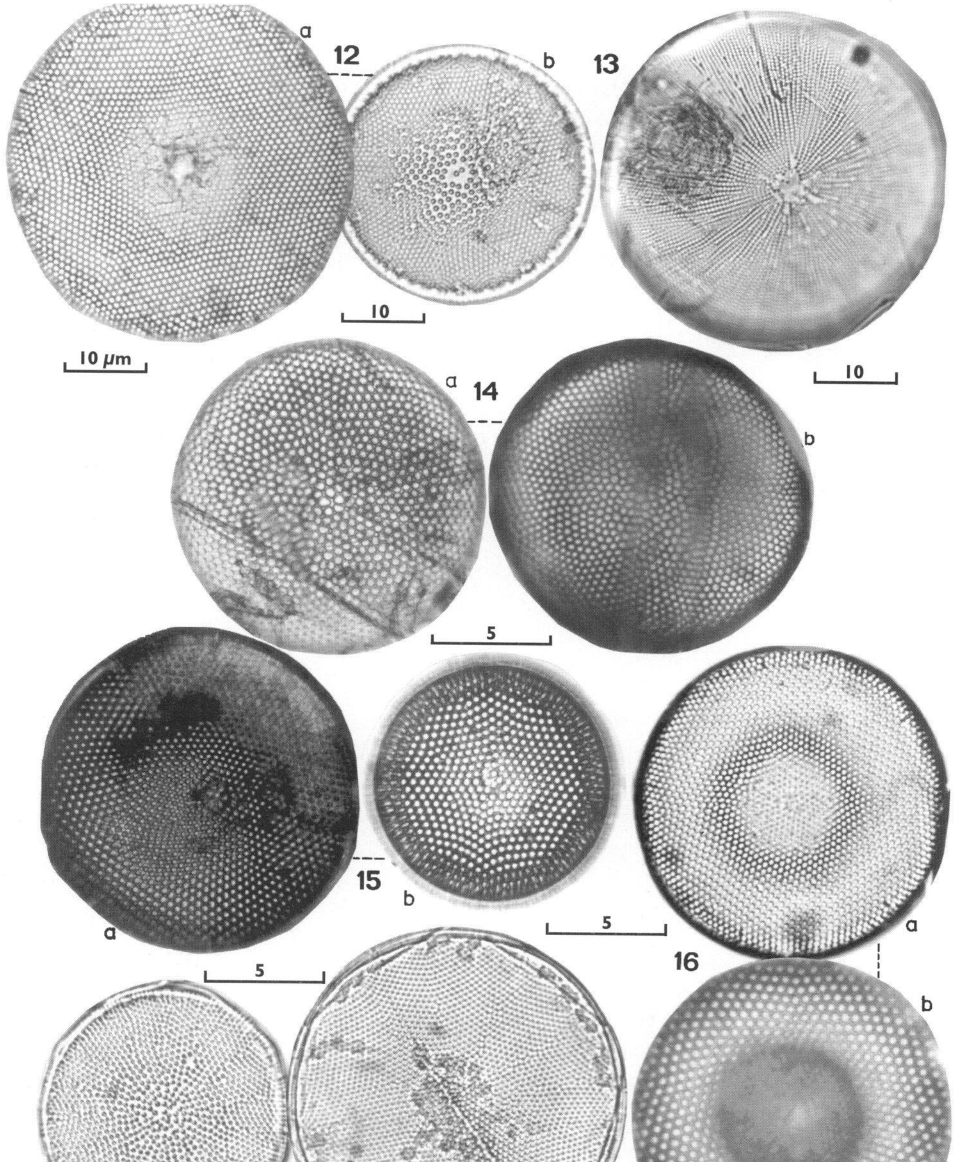
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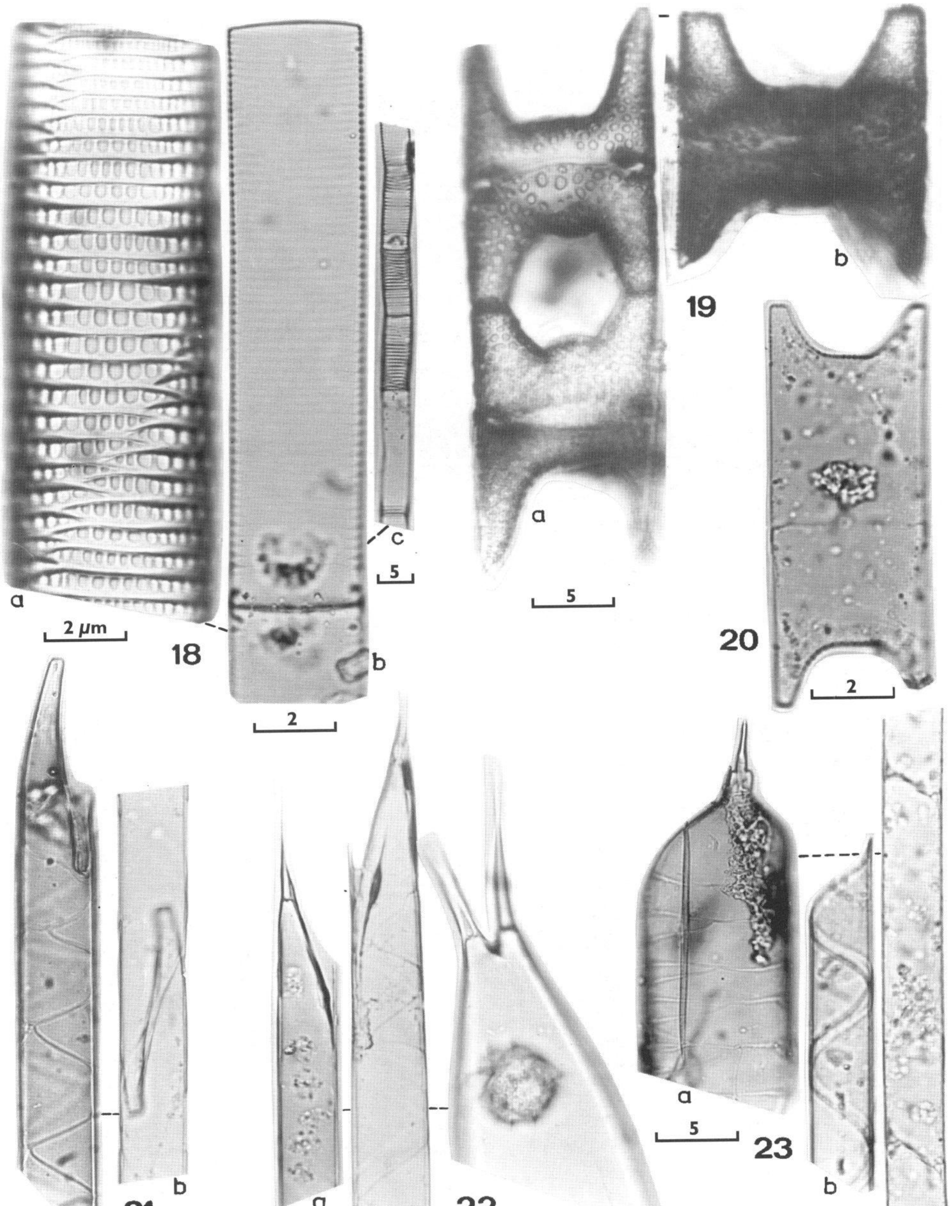

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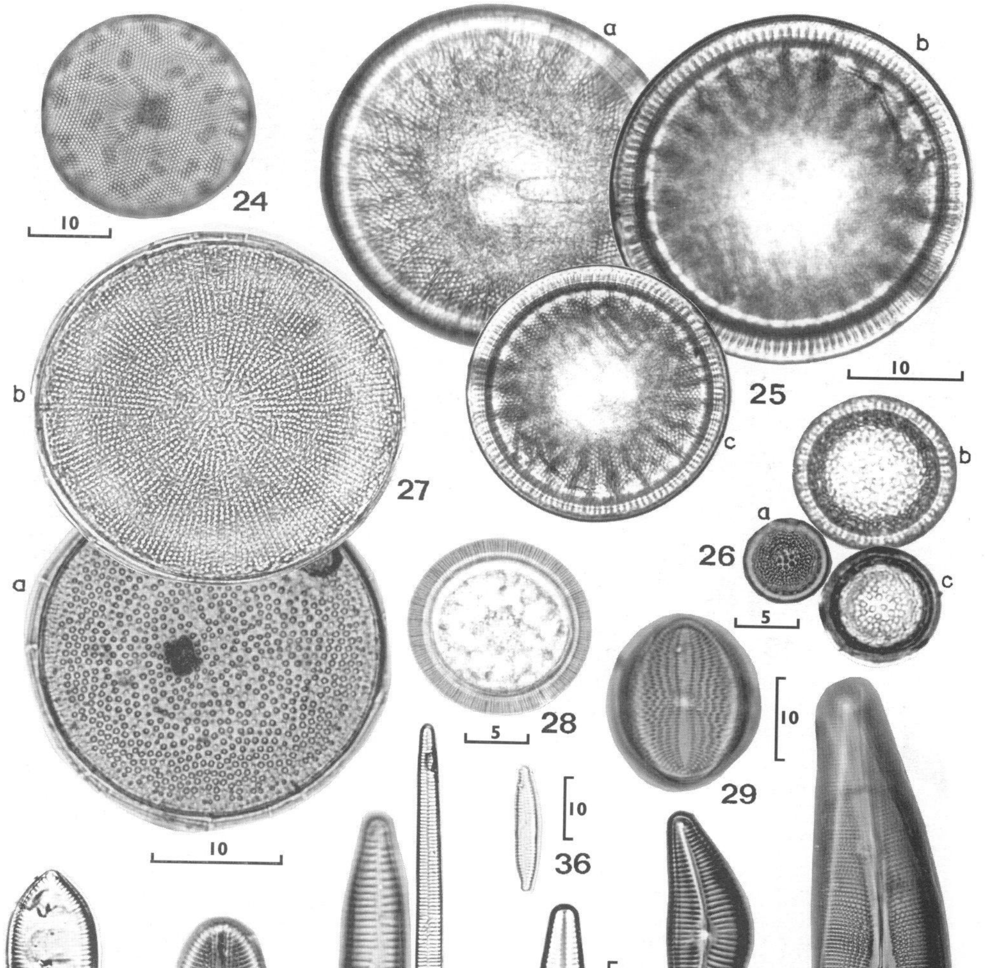
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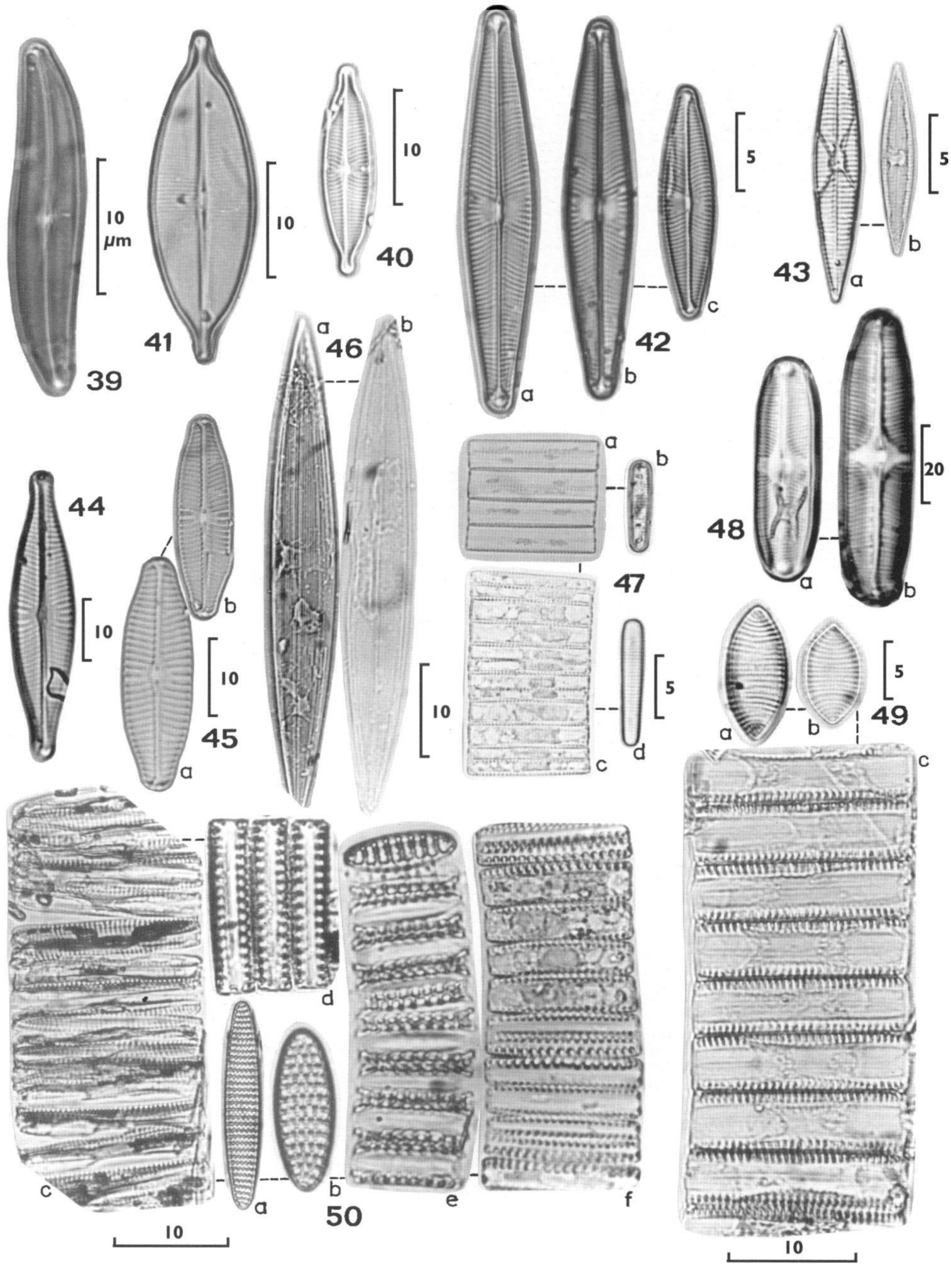
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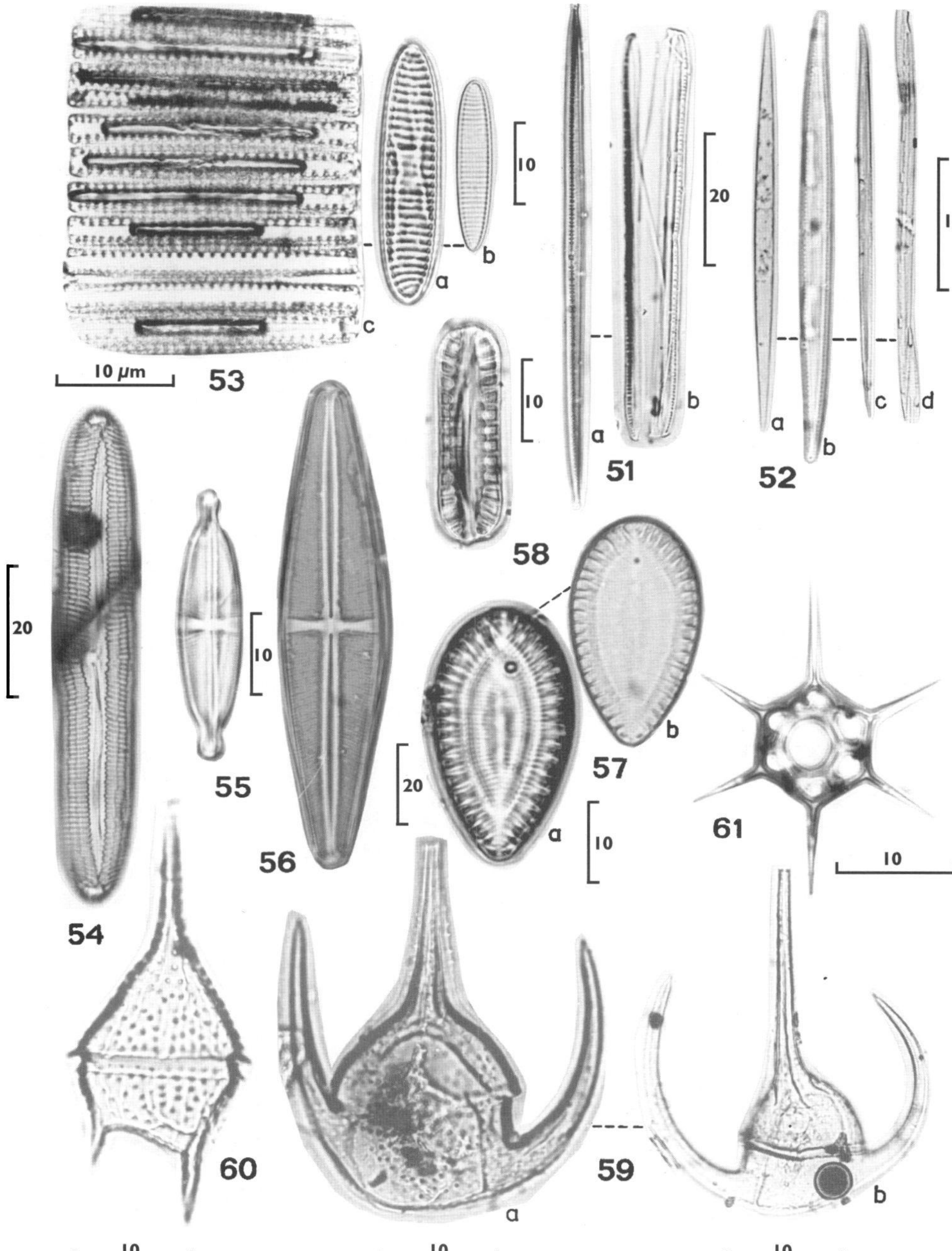

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