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Distribution of net phytoplankton in the sea-ice zone between Elephant Island and the South Orkney Islands (December 1988 – January 1989)

ABSTRACT: Altogether 105 algal taxa were identified including 101 diatom species. *Chaetoceros criophilus* was dominant in the western part of the study area influenced by waters from the Bellingshausen Sea. *Corethron criophilum* was abundant in the Weddell Sea water mass found to the east of 53.5°W meridian. *Nitzschia cylindrus* common in the ice-melt samples was dominant in only two net phytoplankton collections obtained at the ice-edge zone. Additional samples from Admiralty Bay, at King George Island revealed the dominance of *Chaetoceros socialis* and the presence of many tychoplankton species. Very few diatom cells were found in the open waters of the Bransfield Strait which combined with the presence of krill, suggested intensive grazing by herbivores. The unstable waters of the Weddell-Scotia Confluence area contained little phytoplankton except for a station dominated by *Phaeocystis pouchetii*. Greater cell densities were related to warm, lower salinity Weddell Sea water of summer modification found in the surface layer east from 49°W.

Key words: Antarctic, Weddell Sea, net phytoplankton, sea ice edge, diatoms.

Introduction

Two factors may affect phytoplankton development and distribution in the northern part of the Weddell Sea. The first is the cyclonic motion of the Weddell Sea waters causing continuous mixing with the waters of the Drake Passage and the Scotia Sea (Nelson *et al.* 1987). The second factor is the sea ice cover extending over 80% of the sea surface in September (Garrison, Sullivan and

Ackley 1986). Beginning in October, the annual ice cover recedes to a minimum coverage attained in February.

Phytoplankton of the Weddell-Scotia Confluence has often been investigated. Reports of increased algal blooms in this area are those of Kanaeva (1969), Sanina (1973), Nelson *et al.* (1987) and Smetacek and Veth (1989).

Every year about 7% of the world's ocean is periodically covered by sea ice (Niebauer and Smith 1989). The sea-ice edge zone is characterized by increased biological activity (Smith 1987). Phytoplankton blooms at ice edges may be caused by increased stability of the water column induced by meltwater, or, by the decrease of turbulence through the reduction of wind force. They may also be related to upwellings at ice edges, or may be caused by the seeding of waters with algae liberated from melting sea ice (Smith and Nelson 1986).

The effect of sea ice edge on phytoplankton development in the Weddell Sea has been observed both, in the close vicinity of the edge of ice (Bartsch 1989) and at various distances, up to several hundred km, from the ice edge (Nelson *et al.* 1987, Sullivan *et al.* 1988).

Net-collected phytoplankton at the ice edge is usually dominated by large-size diatoms, but small species are also present in significant quantities (Ligowski 1983, Fryxell 1989). Due to their relatively easy identification, diatom species might be good indicators of the water masses present in the upper surface layer of the sea. Net samples filter large volumes of water and allow to obtain dense collections of rare and large-size species (Fryxell 1989). Data based on such samples allow the distinction of species associations characteristic of different water masses.

The purpose of the present work was to determine net phytoplankton species composition and the density of cells (in 100 m water column, under 1 m^2 sea surface) in the sea-ice edge zone between Elephant Island and the South Orkney Islands.

The investigations reported here were conducted in the region of influence of two physical factors: the ice edge and the Weddell-Scotia Confluence. Other works carried out simultaneously off board of the r/v „Profesor Siedlecki" and related to primary producers included: algae in sea ice (Ligowski 1991), quantitative phytoplankton distribution (Kopczyńska 1991) and chlorophyll *a* determination (Lipski 1991).

Materials and methods

Phytoplankton samples were obtained between 26 December, 1988 and 8 January, 1989. 30 sampling stations were localized at the northern edge of pack ice between Elephant Island and the South Orkney Islands in the area inclosed within 54°08'W to 46°26'W and 61°43'S to 59°44'S (Fig. 1). Additional two samples were taken from Admiralty Bay and one from the Bransfield Strait. Detailed description of stations was done by Rakusa-Suszczewski (1991).

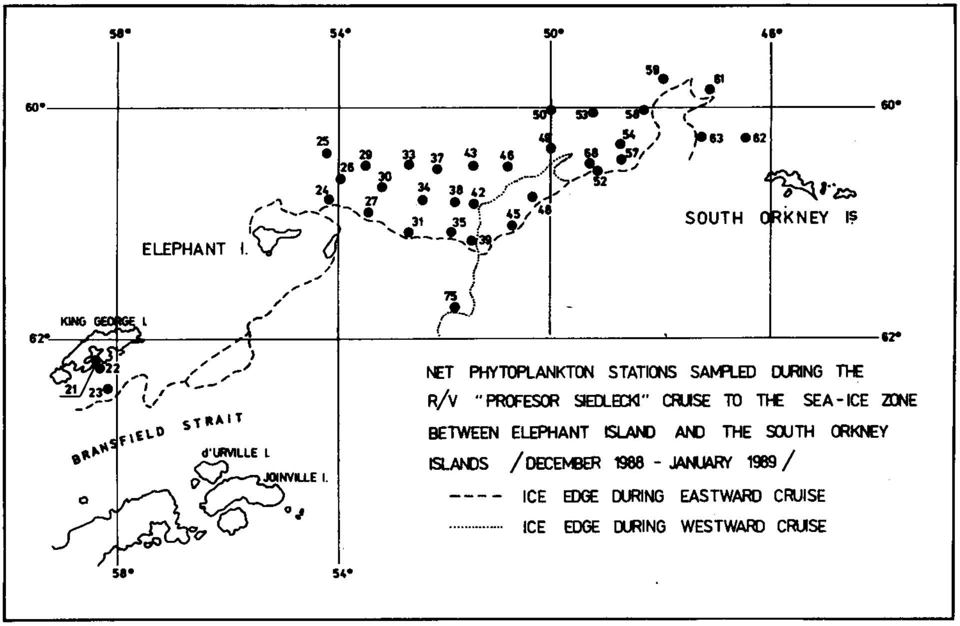

Fig. 1. Study area and net phytoplankton stations

Samples were obtained with a Copenhagen net of the mesh size ca. 55 µm from 100 m depth to the surface. Live samples and those fixed with 1% formaline were examined under Zeiss and Biolar PI microscopes at 500× magnification. At least 300 cells were counted in a water drop of known volume and related to cell densities in 100 m water column under 1 m^2 sea surface. For exact species identifications diatoms were cleaned with a chromic acid mixture, mounted in Pleurax and examined under Amplival (Zeiss) microscope with the use of Nomarski phase interference technique.

Results

Concentrations of algal cells in 100 m water column × 1 m^{-2} ranged 0.04×10^7 – 15.6×10^7 (Tab. 1, Fig. 2). Sample 23 in the north of the Bransfield Strait and sample 30 at the ice edge were nearly empty. The highest cell density was found in the eastern part of the study area between 49°30′W and the South Orkney Islands. The mean cell concentration was $3.39\pm4.4\times10^7\times m^{-2}$. Different water masses found in the area were characterized by different cell densities (Tab. 2).

105 algal taxa were identified (Tab. 3). Stations located in the Bransfield Strait shelf in Admiralty Bay differed from others by the presence of tychoplankton species. Only five algal species were dominant in the 33 samples: *Corethron*

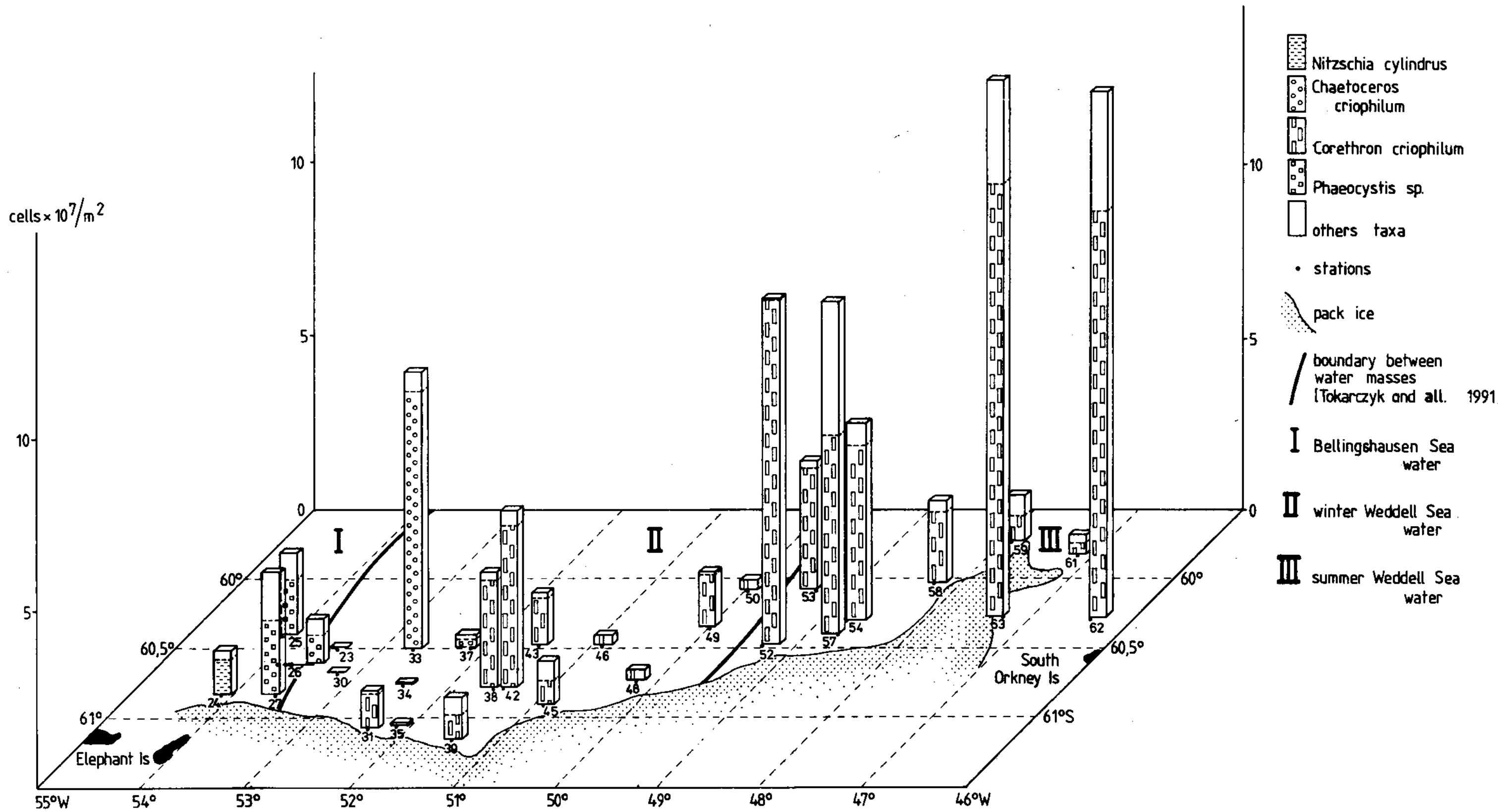

Fig. 2. Net phytoplankton cell number ($\times 10^7$) under 1 m^2 in 0–100 m water column.

Table 1

Percent composition of species in net phytoplankton

Date	26.12.88	26.12.88	26.12.88	29.12.88	29.12.88	30.12.88	30.12.88	30.12.88	31.12.88	31.12.88	31.12.88	1.01.89	1.01.89	1.01.89	2.01.89	2.01.89	2.01.89	3.01.89	4.01.89	4.01.89	5.01.89	5.01.89	5.01.89	6.01.89	6.01.89	6.01.89	7.01.89	7.01.89	7.01.89	8.01.89	8.01.89	8.01.89
Stations	21	22	23	24	25	26	27	29	30	31	33	34	35	37	38	39	42	43	45	46	48	49	50	52	53	54	57	58	59	61	62	63
No of cell $\times 10^7$ under 1 m^2 in 100 m water column	1.65	1.88	0.0	1.24	2.28	1.23	3.52	0.04	0.0	0.99	8.06	0.05	0.5	0.37	3.29	1.16	5.1	1.48	1.23	0.33	0.03	1.57	0.28	10.9	3.7	5.7	9.6	2.4	1.4	0.63	15.3	15.6
Actinocyclus actinochilus																											0.25	0.5				
Chaetoceros bulbosus						1.8	4.1																									
Ch. criophilus	1.0			9.1	69.4	60.4	60.3			3.4			5.2	88.9	3.2		6.2	6.5			5.3	2.8		0.5	2.7	5.3	0.8	17.8	24.4	6.0	3.1	6.1
Ch. dichaeta																		3.5									0.8			3.0		
Ch. neglectus	13.7					7.2												1.8								3.1	1.0	4.8	2.9		0.9	7.2
Ch. socialis	67.0	95.8																														
Ch. tortissimus	6.3	3.2																														
Chaetoceros sp.													1.7																	2.0		
Corethron criophilum	3.5			4.5	6.7	3.6	11.8			93.2		99.0	67.2	4.5	93.0	50.5	90.1	88.2	50.0	99.0	93.0	93.8	21.3	99.0	86.8	91.6	60.5	54.3	54.6	51.0	77.0	84.4
Coscinodiscus sp.	1.8																		0.5													
Odontella weissflogii										1.7																	0.3					
Porosira pseudodenticulata																			0.5									0.5				
P. glacialis				4.5						1.7						1.8																
Proboscia alata	0.3				0.5	0.9	0.6																									
Rhizosolenia inermis	0.3				1.9	3.6									0.6				0.5									0.5				0.2
Rh. hebetata f. semispina	1.0				21.5	20.7	10.6						1.7	2.2			1.9		2.5						0.5		0.3	0.5	5.9	2.0		
Rh. simplex																														1.0		
Thalassiosira spp.	0.7														1.3	1.8	0.3		1.5									0.5			1.9	0.4
Thalassiothrix antarctica	0.7														0.6	0.9	0.7		0.5						1.6		0.5	0.5	1.5			
Licmophora sp.	0.7																															
Navicula sp.																4.6			0.4									0.5				
Nitzschia curta														2.2														0.5				
N. cylindrus				80.3									12.1			9.2			3.6			1.4										1.4
N. heimii																5.5																
N. „nana”				1.5			0.6																									
N. subcurvata							1.2	25.0					3.4			6.4			1.0		1.3						30.0	1.4				0.2
N. turgiduloides/lineola	1.7															5.5												1.4		10.0		0.2
Nitzschia spp. (Fragilariopsis)							5.9				1.9			2.2		1.8			39.0				8.5				5.8	12.0				0.2
Cryptomonas							2.4	75.0														2.0	46.8		8.4				10.2	2.0	0.4	1.3
Phaeocystis											97.8					9.2														23.0	16.6	
	1.0						0.6				0.3		8.6		1.3								23.4					4.3	0.5			
Tintinidae	com.	few						v. com.									few															
Krill or krill pelets											few												few		com.			few				
Salpae			v. com.								v. com.																					

criophilum dominated in 24 samples, *Chaetoceros criophilus* in 4 samples, *Ch. socialis* and *Nitzschia cylindrus* in 2 samples, and *Phaeocystis pouchetii* in one sample (Fig. 2). *Chaetoceros socialis* was dominant in Admiralty Bay and *Nitzschia cylindrus* in a sample from the western part of the ice edge zone. *Chaetoceros criophilus* was dominant in the western part of the study area, while *Corethron criophilum* prevailed in the east. The intermediate region between west and east was characterized by small cell densities and variable domination of species. *Phaeocystis pouchetii* dominated only one collection (Fig. 2). Empty or broken diatom frustules were often found in excess of live cells in this area.

Discussion

Net phytoplankton cell concentrations found in the sea-ice edge zone can be compared with our previous results obtained by the same methods during earlier BIOMASS expeditions. In the South Shetland Islands area in February–March 1981 during FIBEX (Kopczyńska and Ligowski 1982) and in December 1983 – January 1984 during SIBEX (Kopczyńska and Ligowski 1985) cell densities were two orders of magnitude greater than presently. In October–November 1986 (Ligowski 1988) cell densities in the region of the Weddell-Scotia Confluence near an ice field west from Elephant Island were similar to those recorded now.

All stations in the area of pack ice showed high nutrient content (Tokarczyk *et al.* 1991, Lipski 1991) not likely to limit phytoplankton growth. Low concentrations of cells may reflect a winter stage of phytoplankton development. Greatest abundance of net retained cells occurred to the east of 49°W in warm surface waters of lowered salinity identified as the Weddell Sea waters of summer modification (Tokarczyk *et al.* 1991). According to these authors this thin (45 m) layer of warmed water was probably a fragment of a larger lens of modified water, formed as a result of local heating and ice melting. Similar results of higher cell concentrations in water of increased stability were obtained by Vladimirskaya *et al.* (1976).

Net phytoplankton in Admiralty Bay contained many tychoplanktonic species (Tab. 3). Benthic and periphyton species have been previously recorded in the plankton of bays in the West Antarctic (Mangin 1915, 1922, Hart 1934, Hendey 1937, Frenquelli and Orlando 1958, Kopczyńska 1981, Ligowski 1986). They seem to be a permanent component of the flora of small bays in West Antarctic.

Only five algal species were clearly dominant in at least one net collection: *Chaetoceros socialis, C. criophilus, Corethron criophilum, Nitzschia cylindrus* and *Phaeocystis pouchetti*. Among them *C. socialis* was dominant in Admiralty Bay (Fig. 2). The Bellingshausen Sea water masses are usually encountered there (Grelowski and Tokarczyk 1985, Lipski 1987). It is a cosmopolitan (Semina

Species composition of net phytoplankton collected in the Bransfield
(December 1988 –

Taxa	Sta													
	Bransfield Strait			sea ice edge zone between										
	21	22	23	24	25	26	27	29	30	31	33	34	35	37
Achnanthes sp.	+	+												
Actinocyclus actinochilus (Ehrenberg) Simonsen	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Amphiprora kjellmanii Cleve		+		+										
A. oestrupii Van Heurck	+			+							+			
Amphora barrei Manguin		+		+										
Amphora sp. 1	+													
Amphora sp. 2		+												
Asteromphalus hookerii Ehrenberg						+								
Azpeitia tabularis (Grunow) Fryxell et Sims		+												
Banquisia belgicae (Van Heurck) Paddock														
Chaetoceros atlanticus Cleve						+	+							
Ch. convolutus Castracane														
Ch. criophilus Castracane	+	+		+	+	+	+	+	+	+	+	+	+	+
Ch. dichaeta Ehrenberg														
Ch. flexuosus Manguin														
Ch. neglectus Karsten	+					+					+			
Ch. neogracile Van Landingham		+												
Ch. socialis Lauder	+	+												
Ch. tortissimus Gran	+	+												
Chaetoceros sp.													+	
Cocconeis antiqua var. *tenuistriata* Van Heurck		+		+										
C. balatonsis Pantoseck	+	+												
C. costata Gregory	+	+		+		+		+						
C. costata var. *hexagona* Grunow	+	+												
C. infirmata Manguin	+	+												
C. gautieri Van Heurck		+												
C. illustris Schmidt	+	+			+				+					
C. litigiosa Van Heurck		+												
C. melchiori Frenguelli	+	+			+									
C. orbicularis Frenguelli	+	+												+
Cocconeis sp. 1		+												
Cocconeis sp. 2		+												
Corethron criophilum Castracane	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Coscinodiscus bouvet Karsten	+	+		+						+				
C. oculoides Karsten														
C. oculus-iridis Ehrenberg	+	+	+	+	+		+		+	+		+	+	+

Table 2

Strait and between Elephant Island and South Orkney Islands
– January 1989)

tions																		
Elephant Island and South Orkney Islands																		
38	39	42	43	45	46	48	49	50	52	53	54	57	58	59	61	62	63	75
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
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													+					
+	+	+	+	+		+			+			+	+			+	+	+

	21	22	23	24	25	26	27	29	30	31	33	34	35	37
Dactyliosolen tenuijunctus (Manguin) Hasle		+				+	+							
Entopyla sp.		+												
Eucampia antarctica Castracane	+	+	+				+			+			+	+
Fragilaria striatula Lyngbye	+	+												
Gomphonema sp. 1		+												
Gomphonema sp. 2	+	+												
Gomphonema sp. 3	+	+												
Haslea trompii (Cleve) Simonsen				+										
Licmophora abbreviata Agardh		+												
Licmophora sp. 1		+												
Licmophora sp. 2	+	+												
Navicula directa (W.Sm.) Ralfs											+			
N. glaciei Van Heurck	+													
N. grevillei Agardh		+												
N. jejunoides Van Heurck				+										
Navicula sp.	+													
Nitzschia angulata Hasle		+	+	+	+	+	+	+			+		+	
N. barbieri M. Peragallo														
N. curta (Van Heurck) Hasle	+	+	+	+	+	+	+	+	+	+	+	+	+	+
N. cylindrus (Grunow) Hasle	+	+		+	+	+	+	+	+	+	+	+	+	
N. decipiensis Hustedt														
N. kerguelensis (O'Meara) Hasle	+	+			+	+	+	+	+		+			
N. lecointei Van Heurck													+	
N. medioconstricta Hustedt		+												
N. neglecta Hustedt		+				+								
N. obliquecostata (Van Heurck) Hasle	+	+			+					+		+	+	+
N. ritscherii (Hustedt) Hasle	+	+	+		+	+	+		+			+		
N. separanda (Hustedt) Hasle	+													
N. sublineata Hasle	+	+		+	+	+	+		+	+		+	+	+
N. turgiduloides Hasle	+	+		+		+	+							
N. vanheurckii (M. Peragallo) Hasle			+				+							
Odontella litigiosa (Van Heurck) Hoban	+										+			
O. weissflogii (Janisch) Grunow	+	+					+			+		+	+	+
Paralia sol (Ehrenberg) Crawford	+	+												
Pinnularia quadratarea (W. Smith) Cleve		+												
Pleurosigma antarcticum Heiden et Kolbe														
P. directum Grunow		+												

Table 2 cont.

38	39	42	43	45	46	48	49	50	52	53	54	57	58	59	61	62	63	75
	+			+									+	+	+			
+	+			+		+						+	+				+	
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+			+	+								+	+					
	+																	

	21	22	23	24	25	26	27	29	30	31	33	34	35	37
Porosira glacialis (Grunow) Jørgensen	+	+		+						+		+		
P. pseudodenticulata (Hustedt) Jousé	+	+		+	+		+		+	+		+	+	+
Proboscia alata (Brightwell) Sundström	+	+		+	+	+	+						+	+
Proboscia inermis (Castracane) Jordan et Ligowski	+	+			+	+	+	+						
Rh. hebetata f. *semispina* (Hensen) Grall	+	+		+	+	+	+	+	+		+	+	+	+
Rh. sima Castracane				+										
Rh. simplex Karsten														
Rhoicosphenia sp.	+	+												
Stellarima microtrias (Ehrenberg) Hasle et Sims	+	+	+	+	+	+	+	+	+	+		+	+	+
Thalassionema elegans Hustedt														
T. nitzschioides Grunow	+	+					+					+		
Thalassiosira antarctica Comber	+	+		+										
T. australis Peragallo				+										
T. dichotomica (Kozlova) Fryxell et Hasle														
T. frenguelliopsis Fryxell et Johansen														
T. gracilis (Karsten) Hustedt	+	+		+	+	+	+				+			
T. gracilis var. *expecta* (Van Land.) Fryxell et Hasle	+										+			
T. lentiginosa (Janisch) Fryxell	+	+			+	+		+						+
T. maculata Fryxell et Johansen				+										+
T. perpusilla Kozlova														
T. ritscherii (Hustedt) Hasle	+	+			+						+			
T. tumida (Janisch) Hasle				+			+			+	+	+	+	+
Thalassiothrix antarctica Schimper et Karsten	+	+	+	+	+	+	+	+	+	+	+			
Trachyneis aspera (Ehrenberg) Cleve		+												
Trigonum sp.		+												
Trichotoxon reinboldii (Van Heurck) Reid et Round							+			+	+	+	+	+
Tropidoneis sp.														
Phaeocystis pouchetii (Hariot) Lagerheim											+			
Dictyocha speculum Ehrenberg					+	+								
Siliceous cysts 1	+			+			+				+		+	
Siliceous cysts 2														

Table 2 cont.

38	39	42	43	45	46	48	49	50	52	53	54	57	58	59	61	62	63	75
	+					+							+			+		+
+	+	+	+	+		+	+		+	+		+	+	+	+	+		
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1974) and neritic species (Hendey 1937, Cupp 1943, Drebes 1974, Theriot and Fryxell 1985). It was found in the Bransfield Strait previously (Uribe 1982, Kopczyńska and Ligowski 1985) but according to the latter authors lives only in waters of low temperature and high salinity characteristic for the Weddell Sea. Near South Georgia *C. socialis* occured in abundance above shelf, in mixed water masses not related to the Weddell Sea (Priddle, Heywood and Theriot 1986). On the other hand, Hart (1934) observed a rich bloom of *C. socialis* at South Georgia in waters of Weddell Sea origin containing an admixture of the Bellingshausen Sea water. It is probable that such mixed water masses were present in Admiralty Bay during our studies, however, no hydrography measurements were made at the time of phytoplankton sampling. *Chaetoceros socialis* occurs sporadically, but when present, it usually dominates in numbers which soon decline following the bloom (Hart 1934).

Table 3

Net phyloplankton density and species domination in different water masses

Water masses	No of samples	Average No of cells/m^2 × 10^7	Net phytoplankton dominants
Drake Passage origin (I)	4	2.07 ± 0.94	*Chaetoceros criophilus* *Nitzschia cylindrus* (once)
Mixed Drake/ Weddell (I/II)	5	0.1 ± 0.14 (diatoms only) 0.91 ± 2.4 (all taxa)	*Corethron criophilum* (twice) *Ch. criophilius* (once) *Phaeocystis pouchetii* (once) one sample empty
Weddell Sea winter origin (II)	10	1.5 ± 1.4	*C. criophilum* *N. cylindrus* (once)
Weddell Sea summer origin (III)	9	7.3 ± 5.5	*C. criophilum*

Lack of algal cells in a sample taken to the south of entrance to the Admiralty Bay is in accordance with other observations of summer phytoplankton poverty in the central part of the Bransfield Strait (Fukase and El-Sayed 1965, Kopczyńska and Ligowski 1982, 1985, Lipski 1982, 1985, Uribe 1982, 1985). At times, however, the Bransfield Strait was included into the Antarctic areas having rich phytoplankton (El-Sayed 1985). Brandini and Kutner (1986) found small quantities of phytoplankton in the mixed water masses to south-east of the Bransfield Strait and a higher abundance in the central part of the Strait where the phytoplankton consisted mailny of small algal cells < 10 μm. Witek, Pastuszak and Grelowski (1982) reported low net phytoplankton abundance in the Bransfield Strait during several seasons. This poverty of net phytoplankton especially in the central Bransfield Strait may be due to grazing by phytophagous organisms such as krill or salps (Uribe 1985) or to low stability of the mixed water masses of the Bellingshausen and the Weddell seas (Kopczyńska and Ligowski 1985).

Only one net sample taken at the ice edge was dominated by *Nitzschia cylindrus*, a diatom abundant at the same time in melted ice samples (Ligowski 1991). This species was also dominant in the most south located station 75. *N. cylindrus* is characteristic for the ice edge (Nöthig 1988). Fryxell (1989) noted that *N. cylindrus* contained in faecal pellets can be retained in large quantities by a plankton net and thus may appear in high numbers in cleaned diatom mounts. Our material was examined under microscope before and after chemical cleaning, and *N. cylindrus* dominated in both, water and Pleurax mounts. In net samples from Olaf Prydz Bay, small species such as *Nitzschia* of the *Fragilariopsis* group were also present in large densities (Ligowski 1983). Therefore, we think that the lack of high numbers of small species – such as *Nitzschia* – in other ice edge stations reflects the true situation in the plankton. This is corroborated by the results from quantitative, whole water samples examined at the same time (Kopczyńska 1991). German studies from November–December the same year did not report either any accumulation of phytoplankton biomass in melted sea ice from the marginal ice zone in the Weddell Sea (Smetacek and Veth 1989). On the other hand, in the Scotia Sea, along 49°W meridian and in the area of the Weddell-Scotia Confluence, large diatoms were dominant in the plankton (Buma *et al.* 1989).

Distinct domination of *Chaetoceros criophilus* and the co-occurrence of *Corethron criophilum* were characteristic of waters inflowing from the Drake Passage, while domination of *Corethron criophilum* was linked to the Weddell Sea waters containing also some (<10%) *Chaetoceros criophilus* (Fig. 2). Hart (1942) included *Chaetoceros criophilus* to oceanic species co-occuring with *Corethron criophilum*. The two species have been observed as co-dominant in the western Weddell Sea (Hart 1934), in the far South (Hendey 1937) and in the northern population of the Weddell Sea (Estrada and Delgado 1990). Theriot and Fryxell (1985) and Priddle, Heywood and Theriot (1986) reported co-dominance of *Corethron criophilum* and *Chaetoceros criophilus* to the east of South Georgia in waters of the Pacific and the Bellingshausen Sea origin.

The inflowing Drake Passage waters with a distinct domination of *Ch. criophilus* differed from other sampling areas by relatively high temperature (above 0°C) and low silicate content (Tokarczyk *et al.* 1991). Sushin *et al.* (1985) indicated in their studies of the Bouvet Island area, that *Ch. criophilus* is a major species of the Circumpolar Current. According to Hustedt (1958) and Kozlova (1962) *Ch. criophilus* is a typical Antarctic species. Kopczyńska, Weber and El-Sayed (1986) found it present both south and north of the Polar Front in the Indian Ocean sector of the Antartic. Rat'kova (1978) stated that this species develops late in the summer season and occurs in the warmest Antarctic waters.

Distribution of *Corethron criophilum* in the Antarctic Peninsula region is usually linked with the Bellingshausen Sea and the Bransfield Strait (see Ligowski 1988). The present studies point out to domination of *C. criophilum* in the Weddell Sea waters. Among the rather rare cases reporting such distribution, Fryxell and Hasle (1972) showed quantitative dominance of this species in only one station of the Weddell Sea, while at other stations it generally reached only 2.5% of the numbers. In a period preceding our studies, Buma *et al.* (1989) observed a regular occurrence of *C. criophilum* in the Weddell Sea. High cell numbers of this species were noted in the Weddell Sea in December–January (Vladimirskaya *et al.* 1976).

The confluence area of the Drake Passage and the Weddell Sea is characterized by poverty of diatom species and numbers. Many frustules of *Corethron criophilum* are empty or broken. One station is dominated by *Phaeocystis pouchetii.* Species composition in stations such as 37, 29, 30, 33, 34 reflect the mixing of the water masses. Based on hydrography data (temperature, oxygen, nitrate content, water density) this area of confluence is especially noticeable along 53°5′W meridian (Tokarczyk *et al.* 1991).

Poverty of net phytoplankton in the confluence area can be explained by low stability of the waters and/or grazing by herbivores. Krill swarms were observed at the same time (Godlewska and Klusek 1991, Kittel, Siciński and Żmijewska 1991) and our net phytoplankton collections contained large quantities of krill and salps. Empty or broken frustules of *Corethron criophilum* often found in excess of live cells suggested feeding by zooplankton, including herbivorous dinoflagellates (Jacobson and Anderson 1986). In laboratory conditions, krill is reported to feed preferably on particles exceeding 20 μm (Meyer and El-Sayed 1983, Quetin and Ross 1985). Finely broken frustules of the large-size diatom *Corethron criophilum* were found in the alimentary tract of krill (Ligowski 1982) and in krill faecal pellets (Bodungen *et al.* 1987).

Little is known about the ecology and distribution of *Phaeocystis pouchetii* (Fryxell and Kendrick 1988). In our samples this species dominated only once in the frontal region, similar to the observation made by Estrada and Delgado (1990) in the Weddell Sea.

In the rather small area of our studies extending 30 nM north from the Weddell Sea ice edge, we have not observed a distinct effect of the edge of the ice either on the net phytoplankton species composition, or on cell densities. However, increased cell concentrations were noted at a few stations located in the eastern part of the study area and were related to the Weddell Sea warm and low salinity waters of summer modification. This lens of more stabilized water could have been a fragment of a larger lens formed as a result of local heating and ice melting (Tokarczyk *et al.* 1991). German studies conducted between November 1988 and January 1989 along 47°W and 49°W did not report net phytoplankton accumulation in melt water lenses (Smetacek and Veth 1989).

Only two net phytoplankton stations were dominated by *Nitzschia cylindrus*, a diatom common at the same time in ice samples. In quantitative phytoplankton samples examined at the ice edge, Kopczyńska (1991) found only small concentrations of *N. cylindrus* and *N. curta* diatoms dominant in ice; their numbers drastically decreased towards the open waters, showing that these ice species were not very viable in the plankton. In other studies, Garrison, Buck and Fryxell (1987) reported the seeding of phytoplankton with cells originated in sea ice. Jacques and Panouse (1989) stated that diatom blooms occur only at the beginning of spring following the ice break up. Diatoms of the genus *Nitzschia* liberated from melted sea ice in our studies did not show any photosynthetic activity (Ligowski, Godlewski and Łukowski, 1990).

The observed differences in net phytoplankton distribution were both qualitative and quantitative. Qualitative variations were related to water masses. West of ca. 53.5°W meridian, *Chaetoceros criophilus* was dominant in waters inflowing from the Bellingshausen Sea and Drake Passage. The Weddell Sea water mass identified east from 53.5°W was dominated by *Corethron criophilum.*

Variability in cell densities was related to low stability waters in the western part of the study area characterized by poverty of phytoplakton, and on the other hand, to more stabilized, warm and low salinity waters in the east characterized by increased concentrations of phytoplankton cells.

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Streszczenie

Badania fitoplanktonu sieciowego w szerokiej do 30 nM strefie przy krawędzi paku lodowego prowadzone były na 30 stanowiskach w rejonie Konfluencji Weddel-Scotia między Wyspą Elephant a Południowymi Orkadami od 26 grudnia 1988 do 8 stycznia 1989. Dodatkowe próby pobrano w Zatoce Admiralicji i w Cieśninie Bransfielda.

Zidentyfikowano 105 gatunków glonów, z czego 101 należało do okrzemek. Szereg gatunków tychoplanktonowych stwierdzono tylko nad szelfem w Zatoce Admiralicji.

W strefie przylodowej tylko w 2 próbach stwierdzono dominację pochodzącej z lodu okrzemki *Nitzschia cylindrus*. Dominacja poszczególnych gatunków glonów wiązała się z różnymi masami wodnymi. *Chaetoceros criophilus* dominował w zachodniej części badanego rejonu w wodach pochodzących z Morza Bellingshausena. We wschodniej części w wodach Morza Weddella dominował *Corethron criophilum*. Akwen, w którym następowało mieszanie wód różnego pochodzenia, charakteryzowało bardzo małe zagęszczenie komórek okrzemek przy różnej dominacji oraz dość znaczny rozwój *Phaeocystis pouchetii* na jednej stacji. *Chaetoceros socialis* dominował w Zatoce Admiralicji, gdzie najprawdopodobniej występowały wody z Morza Weddella z domieszką wód z Morza Bellingshausena. Próba z centralnej części Cieśniny Bransfielda była niemal pusta.

Małe zagęszczenie komórek w strefie mieszania występowało w rejonie mieszania się wód różnego pochodzenia i licznego występowania kryla i salp. Największe zagęszczenie fitoplanktonu sieciowego występowało na zachód od Orkadów Południowych i było spowodowane warstwą wód z Morza Weddella o letniej modyfikacji.

Nie stwierdzono w badanym akwenie znaczniejszego wpływu krawędzi lodu na fitoplankton sieciowy. Różnice jakościowe w dominacji spowodowane były przez odmienne masy wodne, a różnice ilościowe w zagęszczeniu komórek — przez masy głównie z letnią modyfikacją wód.