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Distribution of net phytoplankton in the Scotia Front west of Elephant Island (BIOMASS III, October—November 1986)

ABSTRACT: Net phytoplankton was studied in 10 stations situated west of Elephant Island along three transects located in the Scotia Front zone and in 2 stations situated in the eastern Bransfield Strait. Altogether 70 algal taxa were identified. Phytoplankton density and seston biomass were the highest in stations neighbouring the Scotia Front from the south. In the Scotia Front region *Corethron criophilum* was a dominant species. Phytoplankton community of the region is rather uniform, however the closer comparison of the phytoplankton species composition allowed to distinguish 4 stations groups. This division is concordant with the hydrological one. A different phytoplankton community was recorded in the eastern part of the Bransfield Strait.

Key words: Antarctic, Scotia Front, distribution of diatoms, BIOMASS III.

1. Introduction

The northern border of the Weddell Sea Confluence (Scotia Front) is situated in the vicinity of the South Shetlands, west of Elephant Island (Patterson and Sievers 1980, Stein 1987). Water masses penetrating Scotia Sea from the Bellingshausen Sea are characterized by a low phytoplankton abundance (Hart 1934, Kanaeva 1969, Sanina 1973) whereas rather abundant phytoplankton occurs in the waters of the Weddell Sea (Vladimirskaja et al. 1976, Movčan 1982). Despite this, the confluence of Weddell Sea and Bellingshausen Sea waters in the region of Scotia Sea is characterized by an abundant phytoplankton (Hardy 1935, Kanaeva 1969, Sanina 1973). Hardy (1967) is of opinion that each of these water masses brings complementary substances lacking in the other one. In contrast, Witek, Pastuszek and Grelowski (1982) indicated that confluence regions at South Orkney Islands and South Georgia were areas of low phytoplankton biomass.

The Weddell Sea water masses differ in the composition of dominant phytoplankton species from the Bellingshausen Sea waters (Hart 1934) or the West Wind Drift waters (Sušin et al. 1985). At the northern limit of the Weddell-Scotia Confluence, water masses of various origin and hydrographical characteristics are inhabited by different phytoplankton species, which is to be observed in the vicinity of South Shetlands (Vladimirkaja et al. 1976; Priddle 1985, Bodungen et al. 1986; Gieskes and Elbrächter 1986; Nast and Gieskes 1986) and of South Georgia (Hart 1934; Hardy 1935; Theriot and Fryxell 1985; Priddle, Heywood and Theriot 1986).

In the investigated region 4 types of water masses were distinguished (Grelowski and Wojewódzki 1988; Rakusa-Suszczewski 1988b):

1. surface waters of winter modification down to the depth of about 100 m;
2. warm deep waters below 100 m to the north of the Scotia Front;
3. waters of the eastern part of the Bransfield Strait south of the Scotia Front;
4. Antarctic deep waters below 1000 m north of the Scotia Front.

Surface waters were affected by marine ice occurring in the northern part of the investigated area (Rakusa-Suszczewski 1988b). Data on the composition and density of algal assemblage, on the chlorophyll contents and on the density and bacteria in this ice are included in other papers in this volume (Ligowski, Lipski and Zieliński 1988; Zdanowski 1988).

Investigations of net phytoplankton were carried out as a part of interdisciplinary investigations in the course of the BIOMASS III expedition to the region of the Weddell-Scotia Confluence west of Elephant Island and aimed at evaluation and comparison of wet volume and dry weight of seston, density and biomass of phytoplankton and its species composition in stations situated along transects through the Scotia Front.

2. Material and methods

Samples of net phytoplankton were collected in a polygon comprising 10 stations west of Elephant Island (region of Scotia Front) and in two stations situated in the eastern part of the Bransfield Strait (Fig. 1). Transects I—III ran from the shelf across the continental slope to the zone of open ocean; transects I and II cut through the Scotia Front as indicated by Grelowski and Wojewódzki (1988) and Rakusa-Suszczewski (1988b). The other transects ran parallelly to Scotia Front, except transect IV which crosses Scotia Front between stations 39 and 44 running over the depth of more than 1500 m. Transect V ran over the continental slope over the depth of about 1000 m and transect VI ran above the shelf (Fig. 1).

Characteristics of the stations and their precise positions are given in Rakusa-Suszczewski (1988a).

Samples of net phytoplankton were taken from a water layer from the

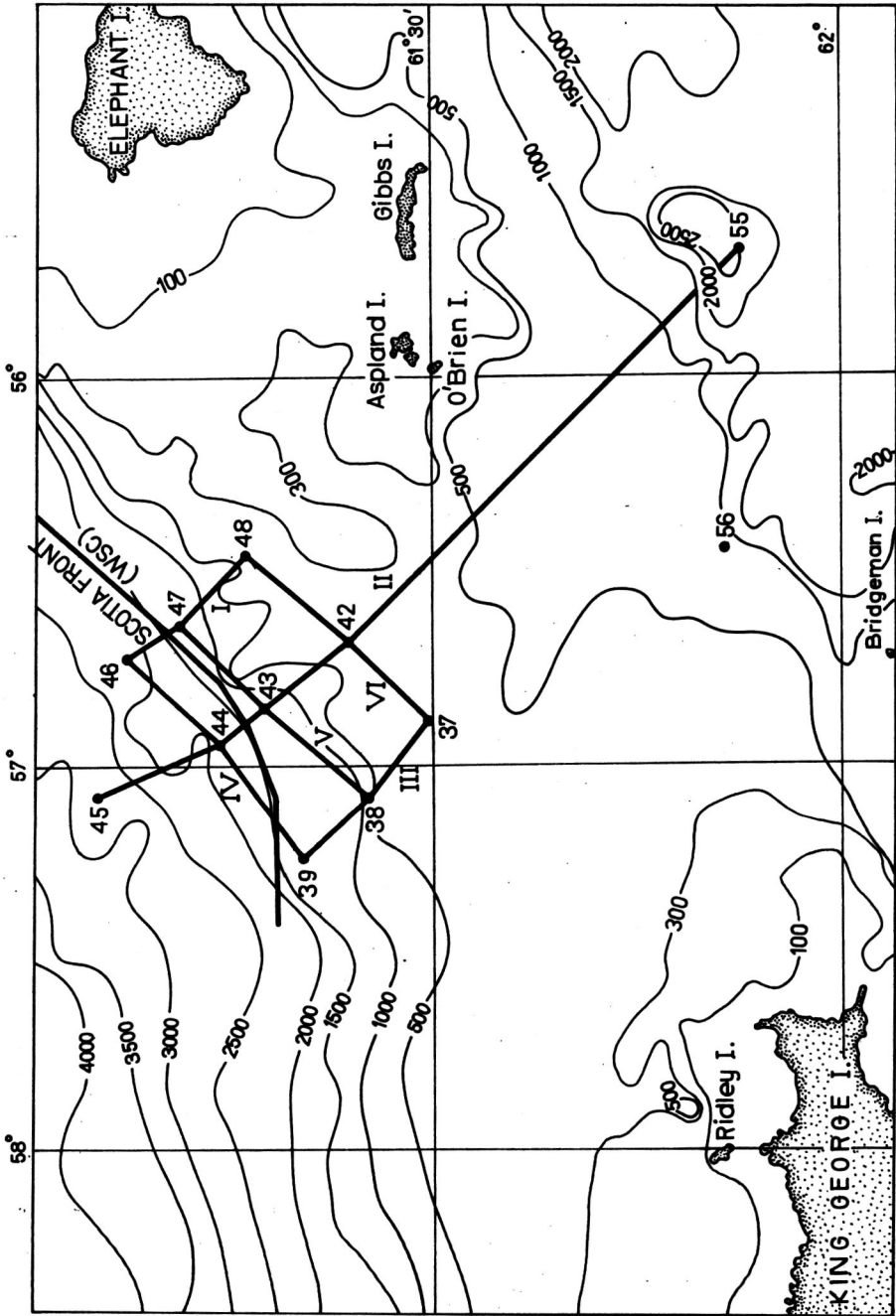


Fig. 1. Distribution of sampling stations. I—VI—transects.

depth of 100 m to the surface using a Copenhagen net of the opening of 0.196 m² and 55 µm mesh size. Definite, measured part of the sample was used to measure packed cells wet volume and dry weight of seston. Methods of measuring algal growth in cultures were used for this purpose (Sorokin 1979). Packed cells volume was calculated in cm³ after centrifuging the sample by 15 minutes at 1000 g. Dry weight (in grams) was obtained by drying the measured part of the sample on a membrane Millipore filter with 1.2 µm pores.

Second definite, measured part of the sample preserved in 1% formalin served for study of species composition and phytoplankton density. Diatoms were identified after removing organic parts with H₂O₂ and ultraviolet light (Swift 1967) and mounting frustules present in a 0.5 m³ of a sample in permanent microscopic slides in pleurax. In such a slide over 300 cells were also counted along a random transect for determining species domination. Species whose percentage share exceeded 5% were considered dominant. Swift's (1967) method allows to preserve fragile diatom frustules unspoiled in a permanent microscopic slide, and cenobia of the *Fragilariopsis* group do not fall into pieces. Hence, supplementary slides in pleurax were made of another part of each sample after removing organic parts with chromic acid clearing mixture (Siemińska 1964). Qualitative analysis of diatoms mounted in pleurax was carried out using immersion lens of Carl Zeiss microscope with Nomarski interference phase contrast accessories. Algal communities composition in particular stations were compared using the Jaccard's similarity coefficient (Romaniszyn 1972):

$$s = \frac{w}{a + b - w}$$

where: *s* — similarity of two compared stations, *w* — number of species common for both stations, *a* — number of species in the first stations, *b* — number of species in the second station and results were presented in a dendrogram. The density of algal cells was calculated in a chamber of the volume of 1 cm³ using an inverted microscope. On the basis of quantitative data the total volume of cells was estimated basing on the volumes of dominant taxa.

All values were calculated for a water column from 100 m to 0 m under surface of 1 m².

3. Results

3.1. Packed cells volume

Packed cells volume varied from 25 cm² to 151 cm² under 1 m² (Fig. 2). On average, in the stations at the Elephant Island this volume amounted to 97.0 ± 41.7 cm³ m⁻² and in stations in the eastern part of the Bransfield

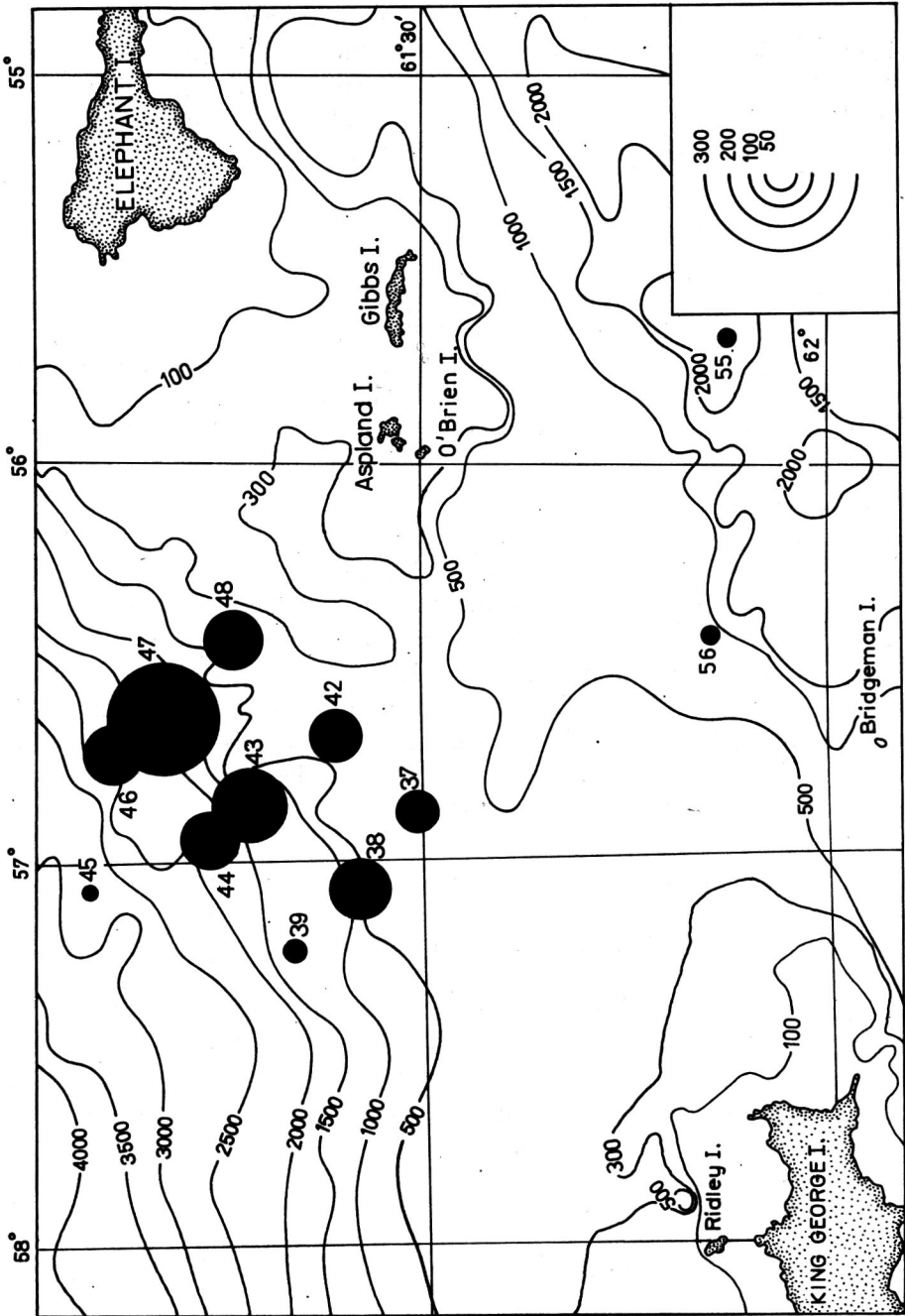


Fig. 2. Packed cells volume ($\text{cm}^3 \text{m}^{-2}$) in a 0—100 m water column

Strait — to $28.5 \pm 0.7 \text{ cm}^3 \text{ m}^{-2}$. The lowest values were recorded in stations 39 and 45 which were situated farthest north and west in the direction to the Drake Passage and in stations 55 and 56 which were situated south of Elephant Island, in the eastern part of the Bransfield Strait. The highest values were observed in stations 43 and 47, located close to the continental slope at the Scotia Front. An increase in the packed cells volume was observed towards the east, in the direction to the Elephant Island.

3.2. Dry seston weight

Dry seston weight ranged from 0.4 to 3.9 g under 1 m^2 (Fig. 3). In the region of the confluence at the Elephant Island dry seston weight was on average $2.54 \pm 0.94 \text{ g m}^{-2}$ and in the eastern part of the Bransfield Strait it amounted on average to $0.44 \pm 0.1 \text{ g m}^{-2}$. The distribution of dry seston weight was similar to that of the packed cells volume.

3.3. Phytoplankton density

Algal cells number in a water column 0—100 m under 1 m^2 area was from $19 \cdot 10^6$ to $141 \cdot 10^6$ (Fig. 4). West of Elephant Island there were on average $80,9 \cdot 10^6 \pm 42,9 \cdot 10^6$ cells and in the eastern part of the Bransfield Strait $37,5 \cdot 10^6 \pm 3,5 \cdot 10^6$ cells. In the Elephant Island region the lowest density occurred in stations situated farthest north and west in the direction of Drake Passage (stations 39 and 45). Number of algal cells increased to the east, towards Elephant Island and the highest density occurred above the slope of the continental shelf at the Scotia Front line.

3.4. Total volume of phytoplankton cells

Values of total calculated phytoplankton cells volume ranged in particular stations from $0.67 \text{ cm}^3 \text{ m}^{-2}$ to $9.0 \text{ cm}^3 \text{ m}^{-2}$ (Fig. 5) with the average value amounting to $5.3 \pm 2.7 \text{ cm}^3 \text{ m}^{-2}$ west of Elephant Island and to $1.0 \pm 0.5 \text{ cm}^3 \text{ m}^{-2}$ in the stations of the Bransfield Strait. Differences of the values of total calculated phytoplankton cells volume between stations are similar to the differences observed in the case of packed cells volume.

3.5. Species dominance structure

In all stations in the region of Scotia Front west of Elephant Island *Corethron criophilum* clearly dominated, and its share ranged between 70 and 90%, in the samples. The dominance values of species of the genus *Nitzschia*, of the group *Fragilariopsis* were much lower (Tab. 2).

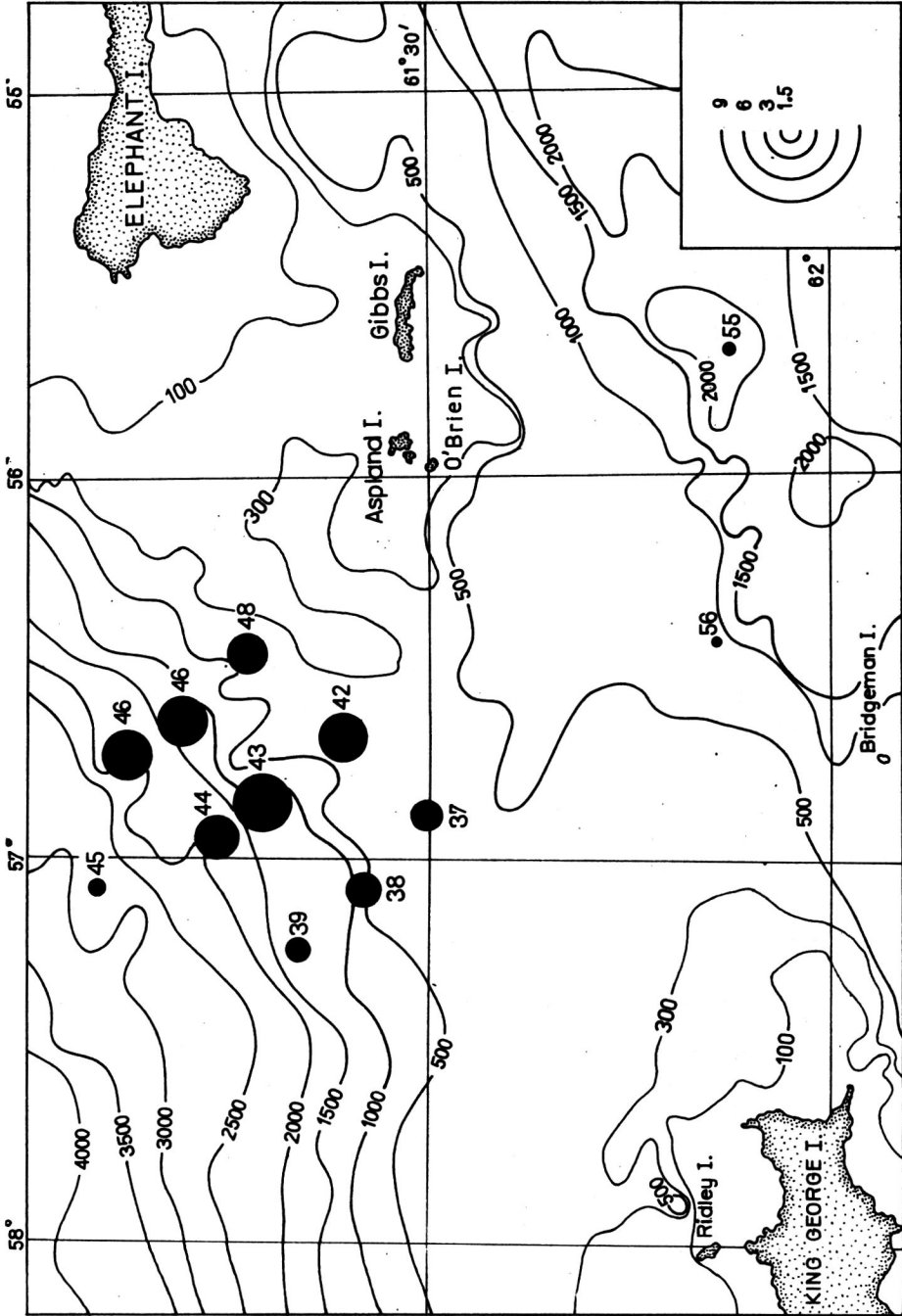


Fig. 3. Dry seston weight (g m⁻²) in a 0-100 m water column

Table 1

Species composition of net phytoplankton at BIOMASS III stations,
31 October — 5 November 1986. Percentage share in number of cells of only dominant species in
particular station is given

Taxa	Stations											
	West of the Elephant Island										Bransfield Strait	
	37	38	39	42	43	44	45	46	47	48	55	56
<i>Actinocyclus actinochilus</i> (Ehrenberg)												
Simonsen	+	+	+	+	+	+	+	+	+	+	+	+
<i>Amphiprora kjelmanii</i> Cleve							+	+	+	+		
<i>A. oestrupii</i> Van Heurck				+			+	+	+	+		
<i>Amphora antarctica</i> Hustedt	+			+								
<i>Asteromphalus hookerii</i> Ehrenberg	+	+					+			+	+	
<i>A. parvulus</i> Karsten				+			+					
<i>Chaetoceros atlanticus</i> Cleve	+	+	+	+	+	+	+	+	+	+	8	5
<i>Ch. atlanticus</i> var. <i>skeleton</i> (Schütt)												
Hustedt												+
<i>Ch. concavicornis</i> Manguin							+	+			+	+
<i>Ch. criophilum</i> Castracane	+	+	+	+	+	+	+	+	+	+	+	+
<i>Ch. dictyota</i> Ehrenberg	+	+		+	+	+	+	+	+	+	+	+
<i>Ch. flexuosum</i> Manguin	+			+			+				+	+
<i>Ch. neglectum</i> Karsten	+	+	+	+	+	+	+	+	+	+	12	10
<i>Ch. tortissimus</i> Gran				+	+	+			+	+	+	10
<i>Cocconeis costata</i> Gregory				+								
<i>Corethron criophilum</i> Castracane	70	89	87	87	82	76	80	83	74	85	32	16
<i>Coscinodiscus bouvet</i> Karsten	+	+	+	+	+	+	+	+	+			+
<i>C. oculoides</i> Karsten	+	+	+	+	+	+	+	+	+	+	+	+
<i>C. oculus-iridis</i> Ehrenb.		+	+	+			+		+	+	+	+
<i>Dactyliosolen antarcticus</i> Castracane							+	+				+
<i>D. tenuijunctus</i> (Manguin) Hasle							+		+			
<i>Eucampia balaustium</i> Castracane	+	+	+	+	+	+		+	+	+	+	+
<i>Leptocylindrus mediterraneus</i> (Pergallo)								+				
Hasle												
<i>Navicula criophila</i> Manguin				+			+		+		+	+
<i>N. directa</i> W. Schmidt								+				
<i>N. glaciei</i> Van Heurck	+	+	+	+		+	+	+	+	+	+	+
<i>Nitzschia</i> spp. (Fragilariopsis gr.)	21	5	10	11	13	17	10	11	16	9	+	16
<i>N. angulata</i> Hasle	+	+	+	+	+	+	+	+	+	+	+	+
<i>N. curta</i> (Van Heurck) Hasle	+	+	+		+	+	+		+		+	+
<i>N. cylindrus</i> (Grunow) Hasle	+			+	+	+	+	+	+	+	+	+
<i>N. kerguelensis</i> (O'Meara) Hasle	+	+	+	+	+	+	+	+	+	+	+	+
<i>N. lineata</i> Hasle												+
<i>N. obliquecostata</i> (Van Heurck) Hasle	+	+	+	+	+	+	+	+	+	+		
<i>N. peragalli</i> Hasle								+				+
<i>N. ritscherii</i> (Hustedt) Hasle	+	+	+	+		+	+		+	+	+	+
<i>N. separanda</i> (Hustedt) Hasle											+	
<i>N. sublineata</i> Hasle	+	+	+	+	+	+	+	+	+	+		+
<i>N. vanheurckii</i> (M. Paragallo) Hasle	+	+	+	+	+	+		+	+	+	+	+
<i>Nitzschia</i> spp. (<i>Nitzschia</i> gr.)		+		+	+	+	+	+	+	+	13	8
<i>N. bicapitata</i> Cleve							+					

table 2 continued

Taxa	Stations											
	West of the Elephant Island										Bransfield Strait	
	37	38	39	42	43	44	45	46	47	48	55	56
<i>N. decipiens</i> Hustedt											+	
<i>N. heimii</i> Manguin												+ +
<i>N. lecointei</i> Van Heurck		+		+		+	+	+				+ +
<i>N. turgiduloides</i> Hasle					+	+	+	+	+	+		+ +
<i>Odontella litigosa</i> (Van Heurck) Hoban										+		
<i>O. weissflogii</i> (Janisch) Grunow	+											
<i>Pleurosigma antarcticum</i> Heiden et Kolbe										+		
<i>P. directum</i> Grunow		+							+			
<i>Porosira antarctica</i> Koslova												+
<i>P. glacialis</i> (Grunow) Jørgensen	+	+		+	+	+	+	+	+	+		+ +
<i>P. pseudodenticulata</i> (Hustedt) Jouse		+	+	+	+		+	+	+	+		+
<i>Rhizosolenia alata</i> Brightwell	+	+	+	+	+	+	+	+	+	+		13 15
<i>R. hebetata f.semispina</i> (Hensen) Gran	+	+			+				+	+		+
<i>R. sima</i> Castracane				+								
<i>Synedra reinboldii</i> Van Heurck												+
<i>Stellarima microtrias</i> (Ehrenb.) Hasle et Sims	+	+	+	+	+	+	+	+	+	+		+ +
<i>Thalassionema nitzchioides</i> Grunow	+					+						
<i>Thalassiosira antarctica</i> Comber	+	+	+	+	+	+	+	+	+	+		+ +
<i>T. gracilis</i> (Karsten) Hustedt		+										
<i>T. gracilis</i> var. <i>expecta</i> (V. Land.) Fryxeil et Hasle												+
<i>T. gravis</i> Cleve										+		
<i>T. lentiginosa</i> (Janisch) G. Fryxell		+			+		+	+				+ +
<i>T. oliveriana</i> (O'Meara) Makarova et Nikolaev								+				
<i>T. maculata</i> Fryxell et Johansen								+	+			
<i>T. ritscherii</i> (Hustedt) Hasle	+	+			+		+		+	+		+
<i>T. tumida</i> (Janisch) Hasle		+	+	+	+		+		+	+		
<i>Thalassiothrix antarctica</i> Schimper ex Karsten	+	+	+	+	+	+	+	+	+	+		6 8
<i>Tropidoneis fusiformis</i> Manguin										+		
<i>T. glacialis</i> Heiden								+				
<i>Dictyocha speculum</i> Ehrenberg	+					+	+	+				+
<i>Protoperdinium antarcticum</i> (Schimper) Balech	+	+				+	+					+
Flagellates												+

In stations situated in the eastern Bransfield Strait, south of Elephant Island, another net phytoplankton assemblage was recorded. *Corethron criophilum* also dominated in these stations but to a lesser degree. Other dominants were *Rhizosolenia alata*, *Chaetoceros neglectum*, *Ch. atlanticus*, *Thalassiothrix antarctica* and *Nitzschia* species of the group *Nitzschia* (Fig. 4).

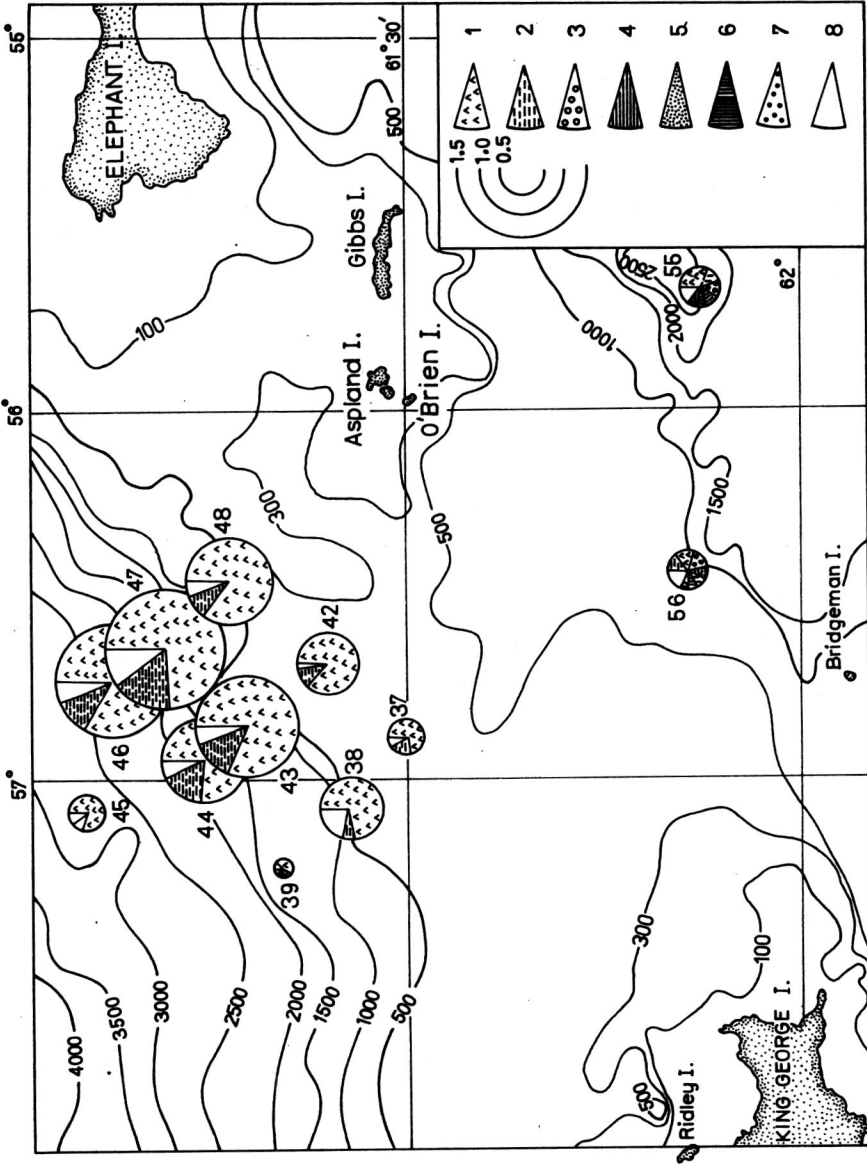


Fig. 4. Net phytoplankton cell number ($\times 10^8$) under 1 m² in a 0–100 m water column

1 — *Corethron criophilum*, 2 — *Nitzschia* sp. (*Fragilariopsis* group), 3 — *Chaetoceros atlanticus*, 4 — *Thalassiothrix antarctica*, 5 — *Chaetoceros neglectum*, 6 — *Nitzschia* sp. (*Nitzschia* group), 7 — *Rhizosolenia alata*, 8 — others.

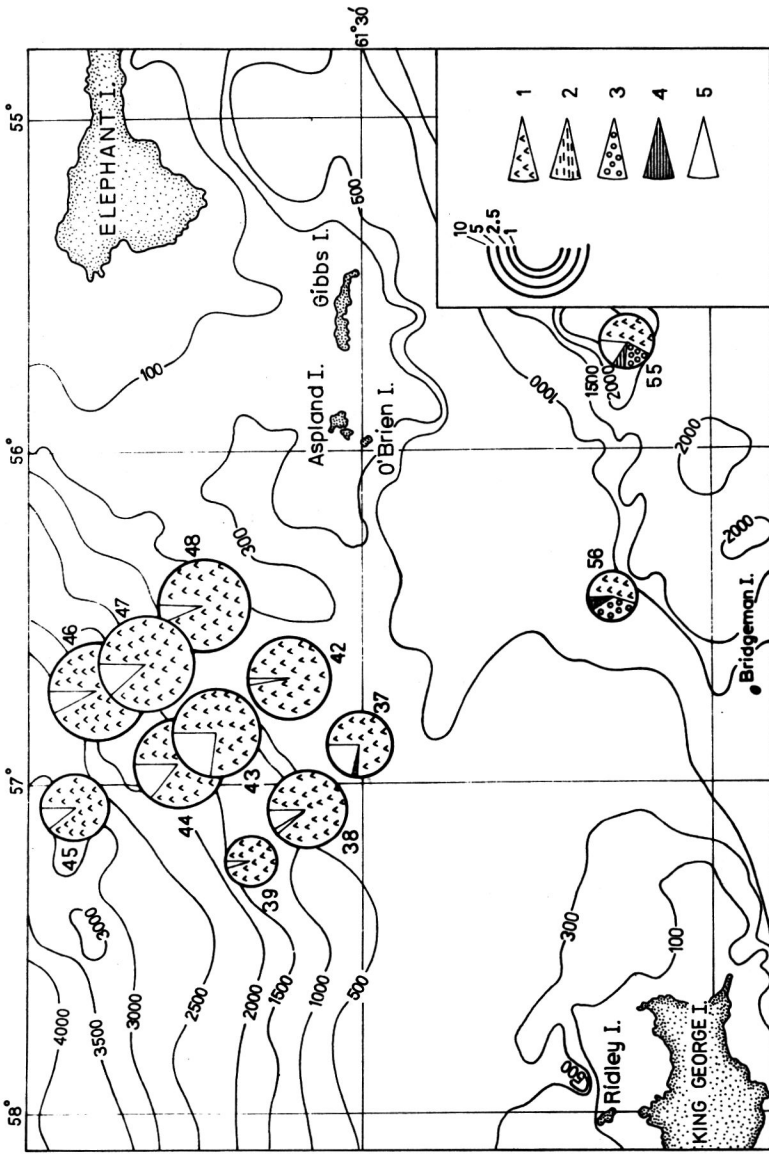


Fig. 5. Net phytoplankton cell volume ($\text{cm}^3 \text{m}^{-2}$) in a 0–100 m water column
 1 — *Corethron criophilum*, 2 — *Nitzschia* sp. (*Fragilariopsis* group), 3 — *Chaetoceros atlanticus*, 4 — *Thalassiothrix antarctica*, 5 — others.

In station 56 *Nitzschia* species of the *Fragilariopsis* group belonged also to the dominants.

3.6. Seston biomass, algal density and dominance along transects

Transect I ran closest to the Elephant Island and crossed the Scotia Front (Fig. 1). This transect was characterized by a high biomass (Figs. 2 and 3) and density values (Fig. 4). In this transect highest values occurred over the continental slope, mainly south of the Scotia Front.

Transect II, an intermediate one, also crossed the Scotia Front and was the longest one (Fig. 1). Its terminal stations 45 and 55 were situated over similar depths (about 2500 m) and had similar seston biomass and phytoplankton density values, being the lowest values in this transect (Figs. 2, 3 and 4). However, station 55 differed from station 45 and from all other stations near Elephant Island by its different composition of dominant species (Fig. 4).

Transect III was the westernmost one and did not cross Scotia Front line (Fig. 1). Seston biomass and phytoplankton density values were the lowest in station 39, situated in the deep water zone and farthest in the direction to the Drake Passage; highest values were noted in station 38, situated over the continental slope (Figs. 2, 3 and 4).

Along transects IV, V and VI seston biomass and phytoplankton density values increased towards Elephant Island (Figs. 2, 3 and 4).

3.7. Species composition

A total of 70 algal taxa were identified in the investigated samples (Tab. 1). In 10 net phytoplankton samples from the vicinity of Elephant Island 67 algal taxa were identified, 64 of which were diatoms; three remaining taxa were *Protoperdinium antarcticum*, *Dictyocha speculum* and unidentified flagellates. In stations situated in the Elephant Island region the number of taxa ranged from 24 to 44, with a mean species number in a sample amounting to 32.0 ± 5.16 . Twelve diatom species occurred in all samples; they were: *Actinocyclus actinochilus*, *Chaetoceros atlanticus*, *Ch. criophilum*, *Ch. neglectum*, *Corethron criophilum*, *Coscinodiscus oculoides*, *Nitzschia angulata*, *N. obliquecostata*, *Rhizosolenia alata*, *Stellarima microtrias*, *Thalassiosira antarctica* and *Thalassiothrix antarctica*.

Species constancy curve for the stations of the Elephant Island region is approximatively an U-shaped one (Fig. 6).

In 2 samples from the eastern part of the Bransfield Strait 47 algal taxa were recorded (Tab. 1). In the dendrogram of similarities of net phytoplankton species composition the following station groups can be distinguished (Figs. 7 and 8):

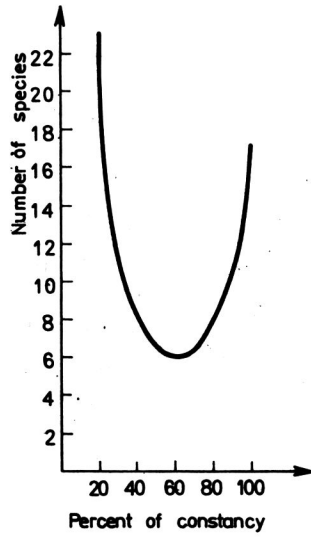


Fig. 6. Net phytoplankton species constancy curve for the community with the dominance of *Corethron criophilum*

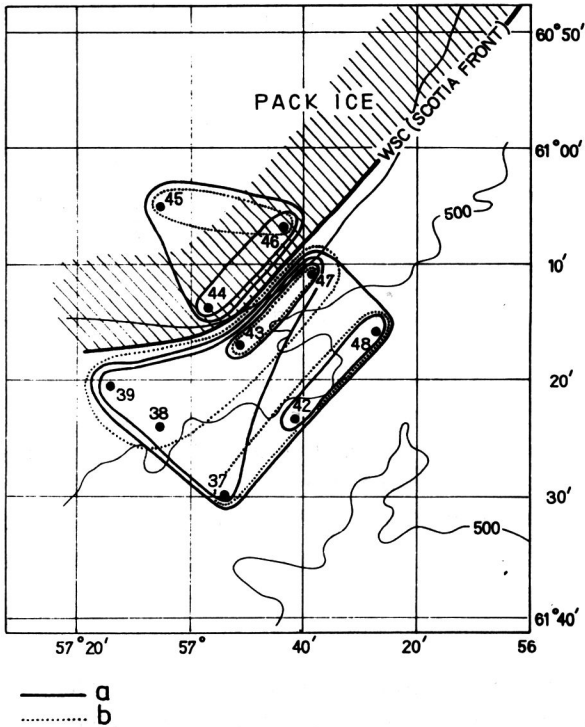


Fig. 7. Stations of the investigated polygon grouped according to their hydrological similarity (a — Rakusa-Suszczewski 1988b) and the similarity of net phytoplankton species composition (b)

- 1) stations adjoining Scotia Front from the south (st. 43, 47, 38, 39), stations 43 and 47 displaying the highest similarity in net phytoplankton composition;
- 2) stations situated over the shelf (st. 48, 42, 37) of intermediate similarity of species composition;
- 3) stations 55 and 56 of low similarity of species composition, situated in the eastern part of the Bransfield Strait;
- 4) stations 46 and 45 of lowest similarity of species composition which were situated farthest north of Scotia Front.

Station 44 is left apart since it is located north of the Scotia Front (Rakusa-Suszczewski 1988b) but at the same time its species composition is very similar to that of the station 37 situated south of the Scotia Front.

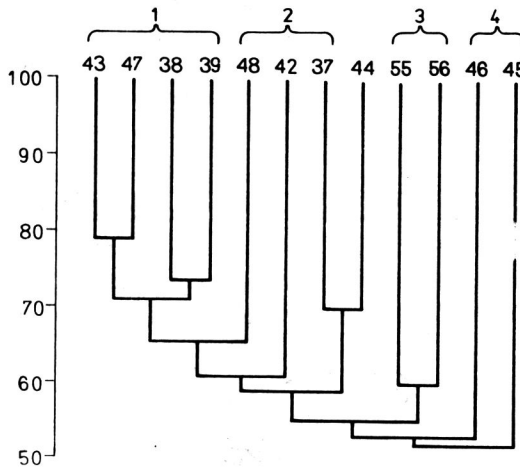


Fig. 8. Dendrogram of similarities of stations in the net phytoplankton

The values of similarity coefficient of species composition between particular stations were usually higher than 0.5. Only the station 45 had similarity coefficient values lower than 0.5 in the case of as much as 6 other stations; this fact proves the separateness of this most northern station (Fig. 8).

4. Discussion

In November 1986 seston biomass values recorded west of Elephant Island were much higher than respective values from this area given for January 1984 (Kopczyńska and Ligowski 1985), higher than the values for the turn of February and March 1977 and the values observed in February

1979 (Witek, Pastuszak and Grelowski 1982). These last authors gave similar values of seston biomass for the beginning of February 1976. Remarkably lower phytoplankton biomass values in stations far in the Drake Passage and in eastern Bransfield Strait evidence for the tendency observed in the course of earlier Polish BIOMASS investigations in the same region: at the beginning of the growing season more abundant development of net phytoplankton begins earlier over the shelf than in open ocean (Kopczyńska and Ligowski 1985). In the second part of the growing season net phytoplankton was more abundant in regions of open ocean than in coastal waters (Kopczyńska and Ligowski 1982), although Witek, Pastuszak and Grelowski (1982) are of the opinion that in the oceanic zone relatively high net phytoplankton biomass occurs throughout the whole growing season. Hart (1942) observed that spring net phytoplankton growth maxima occurred earlier off South Georgia than in the adjacent regions of open ocean. A decrease in net phytoplankton biomass in the second part of the growing season was recorded at South Georgia (Hardy 1935; Witek, Pastuszak and Grelowski 1982) and in the Admiralty Bay of King George Island (Ligowski 1986).

The highest net phytoplankton biomass and density values and very similar species composition occurred in stations 43 and 47. Hydrological characteristics of these two stations clearly distinguished them from the all other stations. High net phytoplankton density values were also recorded in stations 44 and 46. Between stations 46 and 47 and between stations 43 and 44 a zone of intensive mixing occurred and surface waters are affected by the Warm Deep Water which caused a slight increase in temperature and probably brought nutrients into surface water (Rakusa-Suszczewski 1988b).

The species composition of net phytoplankton in the Elephant Island region was relatively not much diversified. Only 67 taxa were found whereas about 120 taxa were recorded in samples collected in the Bransfield Strait in the second part of the BIOMASS III project in November 1986 (Ligowski, unpubl.). Species constancy curve was approximatively U-shaped and the high number of species (12) occurring in all samples indicate a high homogeneity of this community. Similarity coefficients of species composition between stations were almost always higher than 0.5 (except for station 45). Using this same coefficient for comparing stations situated along the transect in the Australian region of Southern Ocean, Ratkova (1978) has recorded a high similarity only between stations in the Antarctic part of this transect. The division of our stations into groups based on the net phytoplankton species composition in general is in agreement with the hydrological division made by Rakusa-Suszczewski (1988b). An exception was high similarity of species composition between stations 37 and 44, situated on the opposite sides of Scotia Front. This similarity could be the result of anticyclonal whirl in Scotia Front causing the downwelling of surface waters in north-eastern part of the studied polygon and its upwelling in its south-western part

(Grelowski and Wojewódzki 1988). Station 45 was the northern most one in the transects cutting the Scotia Front zone and differed from the others by its lowest temperature (about -1.8 C) and salinity (about $33.98^{0/00}$) in the 100—0 m layer (Grelowski and Wojewódzki 1988). This was caused by the pack-ice occurring in the northern part of the polygon (Rakusa-Suszczewski 1988b). Station 45 differed from other stations in its net phytoplankton species composition and its highest number of taxa (as much as 44). Another distribution of stations similarly populated by phytoplankton was observed by Priddle (1985) in summer 1982. Out of 4 compared stations situated along the transect cutting the Weddell-Scotia Confluence north-east of Elephant Island the station situated farthest south contained the most different net phytoplankton community.

The dominance of *Corethron criophilum* was very high in all stations of the Scotia Front region. It is a cosmopolitan species (Semina and Zernova 1986), with richest development in Antarctic coastal waters (Hasle 1969) and it is regarded as a most important component of net phytoplankton in the Southern Ocean (Hendey 1937).

When studying the Atlantic sector of Antarctica Priddle (1985) observed that the *Corethron criophilum* dominance was accompanied by the occurrence of only few other species and sometimes *C. criophilum* was the only species in the sample. Similar data on the lack of other net phytoplankton species in samples with *C. criophilum* dominance can be also found in other studies of this region (Manguin 1915; Frenquelli and Orlando 1958; Brandini and Kutner 1986). This phenomenon was not observed in our study in the Elephant Island area in November 1986. Along with the presented above homogeneity of the diatom community an average number of species in our samples was 32, and the lowest number of taxa recorded at *C. criophilum* dominance was 24.

Corethron criophilum dominance is a very distinct feature of the investigated area. At the beginning of the growing season such a high dominance of *C. criophilum* was not recorded in this region; this dominance was usually observed only in summer. In November 1929 Hart (1934) has found the dominance of *Rhizosolenia alata* and *Nitzschia seriata* and low abundance of *C. criophilum* in the station situated in the northern border of our study area ($61^{\circ}03'S$, $56^{\circ}42'W$); *C. criophilum* clearly dominated between Elephant and Clarence Islands and in stations situated farther south in December 1930. In 1974—1975 *C. criophilum* dominated in Elephant Island region in net phytoplankton samples south of the Weddell-Scotia Confluence and *Rhizosolenia alata* dominated in samples collected north of WSC (Vladimirskaia et al. 1976).

In November 1980 in the region of our research polygon flagellates dominated in the phytoplankton, whereas among not abundant diatoms, most numerous were *C. criophilum* and small Pennatae (Bodungen et al. 1986).

In austral summer 1982 (February—March) Priddle (1985) observed the dominance of *Corethron criophilum* both to the north and to the south of the Weddell-Scotia Confluence. Similarly, in summer of 1982/83, in the station situated west of Elephant Island Brandini and Kutner (1986) recorded *C. criophilum* as the only diatom species of surface phytoplankton.

In November 1983, in the surface phytoplankton (5 m) of the same area at Elephant Island, north of the Weddell-Scotia Confluence, Gieskes and Elbrächter (1986) have found the dominance of *Nitzschia*, *Rhizosolenia*, *Thalassiosira* and *Chaetoceros*; south of the WSC they have found the dominance of *Corethron criophilum*. *Thalassiothrix longissima* dominated somewhat closer to Elephant Island at the depth of 5 m north of the WSC, whereas south of the WSC other diatom species dominated — mainly *Thalassiosira* (Gieskes and Elbrächter 1986; Nast and Gieskes 1986). In January 1984, in the area of the present study, dominance of *C. criophilum* and *Rhizosolenia alata* in net phytoplankton was found by Kopczyńska and Ligowski (1985). At the beginning of December 1984, in surface samples from the Drake Passage between 59°S and 62°S, Sommer and Stabel (1986) recorded a high share of *C. criophilum*. In December 1985 *C. criophilum* was the main net phytoplankton component around Elephant Island (Drits, Semenova and Toth 1986).

Also in samples collected in January 1987 the present author recorded the *Corethron criophilum* dominance similar to that of November 1986 in a position corresponding to station 44 over the depth of 1700 m, whereas in the position 61°19'S and 57°40'W, i.e. close to station 42 over the depth of about 1000 m besides *C. criophilum* and *Nitzschia* sp. (*Fragilariopsis* group) also *Chaetoceros tortissimus*, *Ch. neglectum* and *Rhizosolenia alata* dominated. Two months earlier the same composition of dominant species occurred to the south, in the eastern part of the Bransfield Strait, which suggests the possibility that upper water masses moved to the north.

In the region of Weddell-Scotia Confluence, off South Georgia, where temperature and salinity values are typical of the Scotia Sea (Priddle, Heywood and Theriot 1986) *Chaetoceros criophilum* and *Corethron criophilum* usually dominated (Theriot and Fryxell 1985). A similar dominant species distribution was recorded in this area by Hart (1934) and Hardy (1935). In the Scotia Sea Movčan (1973) observed that *Corethron criophilum* occurred in large quantities in the waters of the West Wind Drift, but in other parts of this region, including the Weddell Sea waters, the share of this species was low. In the study of net phytoplankton of the Weddell Sea (Fryxell and Hasle 1971) *C. criophilum* dominated in only one station, the average share of this species being 2.5%. While mentioning species dominating in the Weddell Sea, Hart (1934) evaluated *Corethron criophilum* as a species less important than *Chaetoceros criophilum*, *Rhizosolenia styliformis* and *Nitzschia seriata*. Sušin et al. (1985) did not include *C. criophilum* among

dominant species of the Weddell Sea. However Vladimirskaia et al. (1976) have mentioned that in the Scotia Sea *C. criophilum* was a distinct indicator of the Weddell Sea waters.

In the Bellingshausen Sea, Hart (1934) has found large amounts of *C. criophilum* and considered it the most important dominant of this sea phytoplankton. *C. criophilum* occurred abundantly in stations at Graham Land, in the generally poor phytoplankton (Hasle 1969). The dominance of *C. criophilum* at high net phytoplankton biomass was recorded in this area in 1983 (Kopczyńska and Ligowski 1985). In transects through the Bransfield Strait in waters originating from the north-eastern Bellingshausen Sea *C. criophilum* was a distinct dominant, whereas in stations with water originating from the Weddell its share was comparatively low (Hart 1934).

In the Admiralty Bay (King George Island), whose waters mix quickly with waters of the northern Bransfield Strait originating from the Bellingshausen Sea (Pruszek 1980; Szafranski and Lipski 1982; Grelowski and Tokarczyk 1985) *Corethron criophilum* was a most frequent dominant (Ligowski 1986). Brandini and Kutner (1986) noted that in the surface waters of the Bransfield Strait originating from the Bellingshausen Sea *C. criophilum* reached its maximal concentration.

In the investigated polygon in the layer 0–100 m there occurred waters of winter modification under the influence of ice situated to the north (Grelowski and Wojewódzki 1988). In the meso-scale the 0–100 m water column was inhabited in this region by a relatively uniform net phytoplankton community distinctly dominated by *Corethron criophilum*, which should be related to the influence of cold water masses connected with the Bellingshausen Sea.

In coarse-scale, within the investigated polygon hydrologically different stations of various degrees of similarity were distinguished (Rakusa-Suszczewski 1988b). The net phytoplankton species composition enabled to distinguish biogeographical groups of stations and this division in general was concordant with hydrological data.

In the eastern part of the Bransfield Strait a different dominant species composition occurred and the occurrence of this net phytoplankton community was related to waters originating from the Weddell Sea.

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5. References

- Bodungen B., V. S. Smetacek, M. M. Tilzer and B. Zeitzschel. 1986. Primary production and sedimentation during spring in the Antarctic Peninsula region. — *Deep-Sea Res.*, 33: 177—194.
- Brandini F. P. and B. B. Kutner. 1986. Composition and distribution of summer phytoplankton in the Bransfield Strait, Antarctica. — *An. Acad. brasil. Ciênc.*, 58, Suppl.: 3—11.
- Drits A. V., T. N. Semenova and L. G. Toth. 1986. Some aspects of *Euphausia superba* feeding. — 21st European Marine Biology Symp., Abstr.: 92.
- Frenquelli J. and H. A. Orlando. 1958. Diatomeas y Silicoflagelados del sector antártico sudamericano. — *Publ. Inst. Antárt. Argent.*, 5: 1—191.
- Fryxell G. A. and G. R. Hasle. 1971. *Corethron criophilum* Castracane: its distribution and structure. In: G. A. Llano and I. E. Wallen (eds.), *Biology of the Antarctic Seas.* — *Antarc. Res. Ser. IV*, 17: 335—346.
- Gieskes W. W. C. and M. Elbrächter. 1986. Abundance of nannoplankton — size chlorophyll — containing particles caused by diatom disruption in surface waters of the Southern Ocean (Antarctic Peninsula region). — *Netherlands Journal of Sea Research*, 20: 291—303.
- Grelowski A. and R. Tokarczyk. 1985. Hydrological conditions in the region of Bransfield Strait and southern part of Drake Passage in the period from December 10, 1983 to January 8, 1984 (BIOMASS-SIBEX). — *Pol. Polar Res.*, 6: 31—41.
- Grelowski A. and T. Wojewódzki. 1988. Hydrography of the region between the King George and Elephant Islands (BIOMASS III, October—November 1986). — *Pol. Polar Res.*, 9: 165—180.
- Hardy A. C. 1935. The phytoplankton. In: A. C. Hardy and E. R. Gunther (eds.), *The plankton of the South Georgia whaling grounds and adjacent waters, 1926—1927.* — *Discovery Rep.*, 11: 39—87.
- Hardy A. 1967. *Great waters.* — Harper and Row, New York; 542 pp.
- Hart T. J. 1934. On the phytoplankton of the South-West Atlantic and the Bellingshausen Sea, 1929—1931. — *Discovery Rep.*, 8: 1—268.
- Hart T. J. 1942. Phytoplankton periodicity in Antarctic surface waters. — *Discovery Rep.*, 21: 261—356.
- Hasle G. R. 1969. An analysis of the phytoplankton of the Pacific Southern Ocean: abundance, composition and distribution during the Bratęgg expedition, 1947—1948. — *Hvalrad. Skr.*, 52: 1—168.
- Hendey N. I. 1937. The plankton diatoms of the Southern Seas. — *Discovery Rep.*, 16: 151—364.
- Kanaeva I. P. 1969. O količestvennom raspredelenii fitoplanktona v More Skotija i pri-ležaščich rajonach. — *Trudy VNIRO*, 66: 168—176.
- Kopczyńska E. E. and R. Ligowski. 1982. Phytoplankton abundance and distribution in the southern Drake Passage and the Bransfield Strait in February—March 1981 (BIOMASS-FIBEX). — *Pol. Polar Res.*, 3: 193—202.
- Kopczyńska E. E. and R. Ligowski 1985. Phytoplankton composition and biomass distribution in the southern Drake Passage, the Bransfield Strait and the adjacent waters of the Weddell Sea in December 1983 — January 1984 (BIOMASS-SIBEX). — *Pol. Polar Res.*, 6: 65—77.
- Ligowski R. 1986. Net phytoplankton of the Admiralty Bay (King George Island, South Shetland Islands) in 1983. — *Pol. Polar Res.*, 7: 127—154.
- Ligowski R., M. Lipski and K. Zieliński. 1988. Algae of drifting sea ice north of Elephant Island (BIOMASS III, October 1986). — *Pol. Polar Res.*, 9: 217—229.

- Manguin L. 1915. Phytoplankton de l'Antarctique. Expédition du "Pourquoi-Pas?" 1908—1910. — Deuxième Expéd. Antarct. Fr. 1908—1910, Sci. nat. Doc. scient.: 1—96.
- Movčan O. A. 1973. Sostav i raspredelenije fitoplanktona v More Skotija i priležaćih vodach v marte-aprele 1970. — Trudy VNIRO, 84: 55—62.
- Movčan O. A. 1982. Zavisimost' obilija fitoplanktona ot vertikal'nych dviženij vody v More Skotija. In: A. A. Nejmar, E. V. Vladimirskaia and V. I. Čekunova (eds.), Charakteristika pelagičeskogo soobščestva Moria Skotija i sopredel'nych vod. — Izd. VNIRO, Moskva: 7—30.
- Nast. F. and W. Gieskes. 1986. Phytoplankton observations relative to krill abundance around Elephant Island in November 1983. — Arch. Fisch. Wiss., 37, Beih. 1: 95—106.
- Patterson S. L. and H. A. Sievers. 1980. The Weddell-Scotia Confluence. — J. Phys. Oceanogr., 10: 1584—1610.
- Priddle J. 1985. Species composition of net phytoplankton from Drake Passage, Bransfield Strait and Scotia Sea during summer 1982. — Meeresforsch., 30: 240—250.
- Priddle J., R. B. Heywood and E. Theriot. 1986. Some environmental factors influencing phytoplankton in the Southern Ocean around South Georgia. — Polar Biol., 5: 65—79.
- Pruszek Z. 1980. Currents circulation in the waters of Admiralty Bay (region of Arctowski Station on King George Island). — Pol. Polar Res., 1: 55—74.
- Rakusa-Suszczewski S. 1988a. Report on the Antarctic expedition of the r/v "Profesor Siedlecki". BIOMASS III 1986/87. — Pol. Polar Res., 9: 153—164.
- Rakusa-Suszczewski S. 1988b. Coarse-scale structure of the water column between King George and Elephant Islands (BIOMASS III, October—November 1986). — Pol. Polar Res., 9: 181—194.
- Rat'kova T. N. 1978. Fitoplankton avstralijskogo sektora Južnogo okeana v janvare—fevrale 1976 g. — Trudy Inst. Okeanol., 112: 83—92.
- Romaniszyn W. 1972. Uwagi krytyczne o definicji Sørensenia i metodzie Renkonena. Obliczenia współczynników podobieństwa zbiorów. — Wiad. Ekol., 18: 375—380.
- Sanina L. V. 1973. Kačestvennyj sostav i količestvennoe raspredelenie fitoplanktona v more Skotija i priležaćih k nemu rajonach v janvare—marte 1965 g. — Trudy VNIRO, 84: 41—54.
- Semina H. I. and V. V. Zernova. 1986. Phytogeographical characteristics of the South Ocean plankton flora. — 21st European Marine Biology Symp., Abstr.:
- Siemińska J. 1964. Bacillariophyceae, Okrzemki. — Flora Ślaskowodna Polski, 6, PWN, Warszawa; 610 pp.
- Sommer U. and H.—H. Stabel 1986. Near surface nutrient and phytoplankton distribution in the Drake Passage during early November. — Polar Biol., 6: 107—110.
- Sorokin C. 1979. Growth measurements. Dry weight, packed cell volume and optical density. In: J. R. Stein (ed.), Handbook of phycological methods. Culture methods and growth measurements. — Cambridge University Press, Cambridge—New York—Melbourne: 321—344.
- Stein M. 1987. Variation of geostrophic circulation on the Antarctic Peninsula and in the southwest Scotia Sea. 1975—1985. Scientific Seminar on Antarctic Ocean Variability on its Influence on Marine Living Resources, particularly krill, Paris: Paris, 2—6 June 1987, CCAMLR.
- Sušin V. A., H. H. Žigalova, I. V. Krasovskij, S. H. Semenova, P. P. Feduchov and V. H. Jakovlev. 1985. Planktonnyje soobščestva antarktičeskoi časti Atlantika. In: E. Vinogradov and M. V. Flint (eds.), Biologičeskije osnovy promyslovogo osvoenija otkrytych rajonov okeana. — Izd. Nauka, Moskva: 29—39.
- Swift E. 1967. Cleaning diatom frustules with ultraviolet radiation and peroxide. — Phycologia, 6: 161—163.
- Szafrancki Z. and M. Lipski. 1982. Characteristics of water temperature and salinity at

- Admiralty Bay (King George Island, South Shetland Islands, Antarctic) during austral summer 1978/1979. — Pol. Polar Res., 3: 7—24.
- Theriot E. and G. Fryxell. 1985. Multivariate statistical analysis of net diatom species distribution in the southwestern Atlantic and Indian Ocean. — Polar Biol., 5: 23—30.
- Vladimirskaja E. V., R. R. Makarov, V. V. Maslennikov and O. A. Movčan. 1976. Nekotoryje čerty vesennogo raspredelenija fitoplanktona v Južnoj časti Mora Skotija. — Okeanologija, 16: 1069—1075.
- Witek Z., M. Pastuszak and A. Grelowski. 1982. Net phytoplankton abundance in western Antarctic and its relation to environmental conditions. — Meeresforsch., 29: 166—180.
- Zdanowski M. 1988. Bacteria in pack-ice north of Elephant Island (BIOMASS III October 1986). — Pol. Polar Res., 9: 202—216.

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6. Streszczenie

W rejonie Frontu Scotia (konfluencja Weddell-Scotia), na zachód od Wyspy Elephant (rys. 1) w listopadzie 1986 stwierdzono stosunkowo niewielką biomasę sestonu i zagęszczenie fitoplanktonu. Największą biomasę i zagęszczenie zaobserwowano nad stokiem kontynentalnym przy Froncie Scotia, a najmniejsze na stacjach najdalej położonych w kierunku Cieśniny Drake'a. Biomasa i zagęszczenie fitoplanktonu wzrastały w kierunku Wyspy Elephant (rys. 2—5).

W rejonie konfluencji zidentyfikowano 67 taksonów glonów (tab. 1). Średnio w próbie rejestrowano ponad 32 taksony glonów. Aż 12 z nich występowało we wszystkich próbach: *Actinocyclus actinochilus*, *Chaetoceros atlanticus*, *Ch. criophilum*, *Ch. neglectum*, *Corethron criophilum*, *Coscinodiscus oculoides*, *Nitzschia angulata*, *N. obliquecostata*, *Rhizosolenia alata*, *Stellarima microtrias*, *Thalassiosira antarctica* i *Thalassiothrix antarctica*. Stwierdzono dużą jednorodność zbiorowiska fitoplanktonowego przy wyspie Elephant (rys. 6).

Porównanie składu gatunkowego fitoplanktonu pozwala wyróżnić: a) grupę stacji przylegających od południa do Frontu Scotia o najbardziej podobnym składzie gatunkowym; b) grupę stacji położonych na szelfie o średnim podobieństwie; c) grupę stacji położonych w Cieśninie Bransfielda o małym podobieństwie; d) grupę stacji o najmniejszym podobieństwie, położonych w otwartym oceanie na północ od Frontu Scotia (rys. 8). Podział na powyższe grupy stacji odpowiada w zasadzie podziałowi hydrograficznemu stacji, dokonанemu przez Rakusę-Suszczewskiego (1988b) (rys. 7).

W fitoplanktonie sieciowym w strefie konfluencji Weddell-Scotia na zachód od wyspy Elephant dominował wyraźnie *Corethron criophilum*; mniejszą, ale stałą dominację wykazywały gatunki z rodzaju *Nitzschia* z grupy *Fragilariopsis*. Taką strukturę dominacji należy wiązać z wpływem mas wodnych związanych z Morzem Bellingshausena. We wschodniej części Cieśniny Bransfielda występowało inne zbiorowisko fitoplanktonowe, związane prawdopodobnie z wodami Morza Weddella, w którym, oprócz *Corethron criophilum*, dominowały *Rhizosolenia alata*, *Chaetoceros neglectum*, *Ch. atlanticus*, *Thalassiothrix antarctica* i gatunki z rodzaju *Nitzschia* z grupy *Nitzschia*.