POLISH POLAR RESEARCH (POL. POLAR RES.) POLSKIE BADANIA POLARNE	4	1—4	21—32	1983

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Phytoplankton of the Olaf Prydz Bay (Indian Ocean, East Antarctica) in February 1969

ABSTRACT: Qualitative and quantitative composition of phytoplankton of the Olaf Prydz Bay (Indian Ocean, East Antarctica) was determined on the basis of 49 samples collected at 34 sampling stations during the period from the 15th to 24th February 1969. Altogether 59 taxa of algae were identified — among them: 57 taxa of the class *Bacillariophyceae*, 1 species of the class *Chrysophyceae* and 1 genus of the class *Dinophyceae*. Species occurring most frequently and most abundantly in the Olaf Prydz Bay are diatoms: *Thalassiothrix antarctica, Chaetoceros criophilus, Nitzschia curta, Rhizosolenia alata*. At some stations *Chaetoceros dichaeta* occurred in great numbers. A decrease in phytoplankton numbers in the areas south of 67 S is associated with the lack of neritic algae among dominant species.

Key words: Antarctic, Indian Ocean, algae, phytoplankton

1. Introduction

The Indian Ocean sector of the Antarctic and the Sub-Antarctic is the least known of the three sectors of the Southern Ocean from the biological point of view (El-Sayed et. al. 1979). Polar regions of all the oceans are the areas a very rich development of phytoplankton (Semina 1974). An area of particularly high abundance of phytoplankton extends around Antarctica south of the Antarctic Divergence zone, north of that zone, however, a decrease in phytoplankton abundance is observed (Beklemišev 1958, Kozlova 1964). In the spring-summer season of 1957, Beklemišev (1958) observed in the Olaf Prydz Bay the occurrence of diatoms bloom. Large numbers of diatoms were also observed in the Bay in the period 1955—1959 (Kozlova 1964).

Along with the collection of the materials presented in this study Savatjugin and Kamova (1971) carried out hydrological studies in the Olaf Prydz Bay.

Temperatures of the surface water layers in the middle and southern part of the Bay were above freezing point (Max. +2.14°C). Lower temperatures were recorded in the western (Min. −1.49°C) and northeastern part of the Bay (Min. −1.72°C). In the vertical cross section of the water masses these authors observed warm surface waters and cold deep and bottom waters. Salinity of the surface water layers of the Olaf Prydz Bay was the highest (Max. 34.14°/$_{oo}$) in the eastern part and in the southwestern part of the Bay at the shelf ice (Max. 34.5°/$_{oo}$). Salinity of the Bay water decreases gradually southwards down to 32°/$_{oo}$.

The aim of this work is a qualitative and quantitative study of phytoplankton collected in the Olaf Prydz Bay in February 1969. The composition and distribution of zooplankton is described by Żmijewska (1983).

2. Material and methods

Plankton samples were collected by Polish biologists, Dr. S. Rakusa-Suszczewski and K. Opaliński M. Sc., during the Fourteenth Soviet Antarctic Expedition (14th S.A.E.). Investigations were carried out during the period from the 15th to 24th February 1969. Sampling stations were situated in the coastal waters zone of Antarctica (Indian Ocean sector), in the Olaf Prydz Bay between latitudes 65°51'S and 69°19'S and longitudes 69°58'E and 81 58'E (Fig. 1, Table I). The analyses of phytoplankton were based on 49 samples collected at 34 sampling stations (Table I). Samples were collected with a plankton net No. 25 (55 μm mesh) at 11 stations from depths

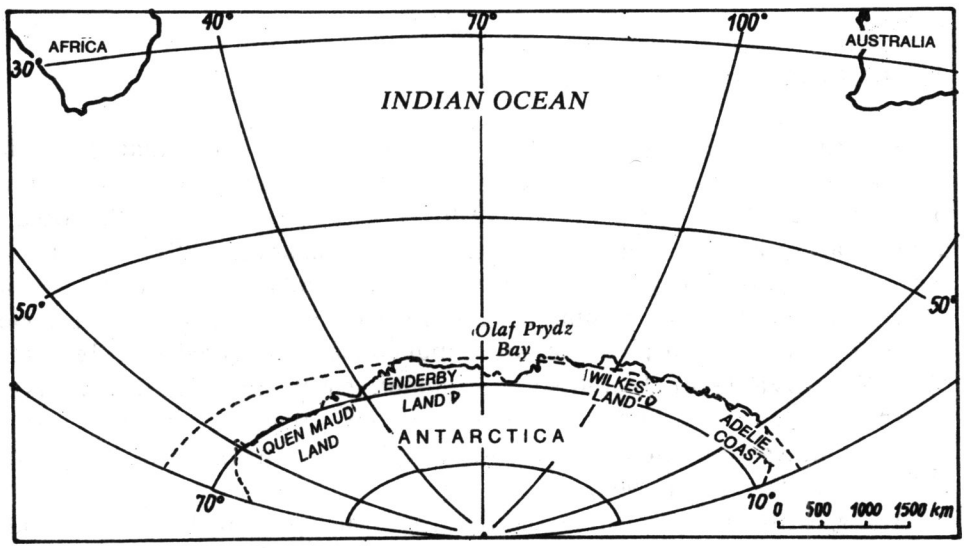

Fig. 1. Indian sector of Southern Ocean

Table I

Sampling stations in the Olaf Prydz Bay

No. of stations	Latitude S	Longitude E	Depth to the bottom (m)	Depth of net sampling (m)
1012	65°51′	70°08′	2705	220
1013	66°25′	70°25′	2100	220
1014	66°45′	69°58′	1125	220
1015	66°59.5′	71°06′	490	220
1016	67°30′	71°00′	475	220
1017	67°59′	70°26′	400	220
1018	68°42.5′	71°06′	635	220
1020	68°00′	72°00′	735	220
1021	67°32.8′	72°00′	610	220
1022	67°00′	71°30′	540	220
1023	66°24′	72°04′	1600	220
1029	68°00′	74°00′	580	220, 230
1030	67°30′	74°02′	500	220
1031	67°00′	74°00′	660	220
1032	66°30′	74°00′	2280	600, 220, 100
1033	66°30′	76°00′	2260	600, 210
1034	67°00′	76°00′	335	220
1035	67°44.8′	76°00′	380	210
1036	68°30′	76°00′	640	210
1037	68°30′	74°00′	700	610, 210
1038	68°30′	73°00′	675	200
1040	68°45′	71°30′	620	220
1041	68°50′	72°00′	570	200
1042	69°09.4′	73°01′	845	210
1043	69°00′	74°00′	705	210
1045	69°10′	76°00′	700	200
1046	68°25′	77°57′	110	100
1049	66°31′	78°10′	980	200, 230
1050	65°54′	78°00′	1820	200
1051	67°00.5′	80°01′	605	200
1052	67°56′	80°03′	380	200, 230
1053	67 12′	81°58′	870	200, 230
1054	66 30′	81°22′	760	230
1055	66 03.2′	81°29.2′	—	200

of 200, 220 or 230 metres (Fig. 2). Using a plankton net No. 5 (270 μm mesh) 14 samples were collected at 11 stations from depths 100, 200, 210, 220, 230, 600 or 610 metres (Fig. 3). Using a net No. 5, but hauling twice, samples were collected at 24 stations from depths 200, 210, 220 or 230 metres (Fig. 4).

To make microscopic slides of the collected phytoplankton samples a constant (0.5 cm^3) volume of condensed phytoplankton was passed through the "Synpor" membrane filters (diameter 24 mm, pore diameter 0.3 μm), using a Millipore "filter holder" setling the suspension on a filter

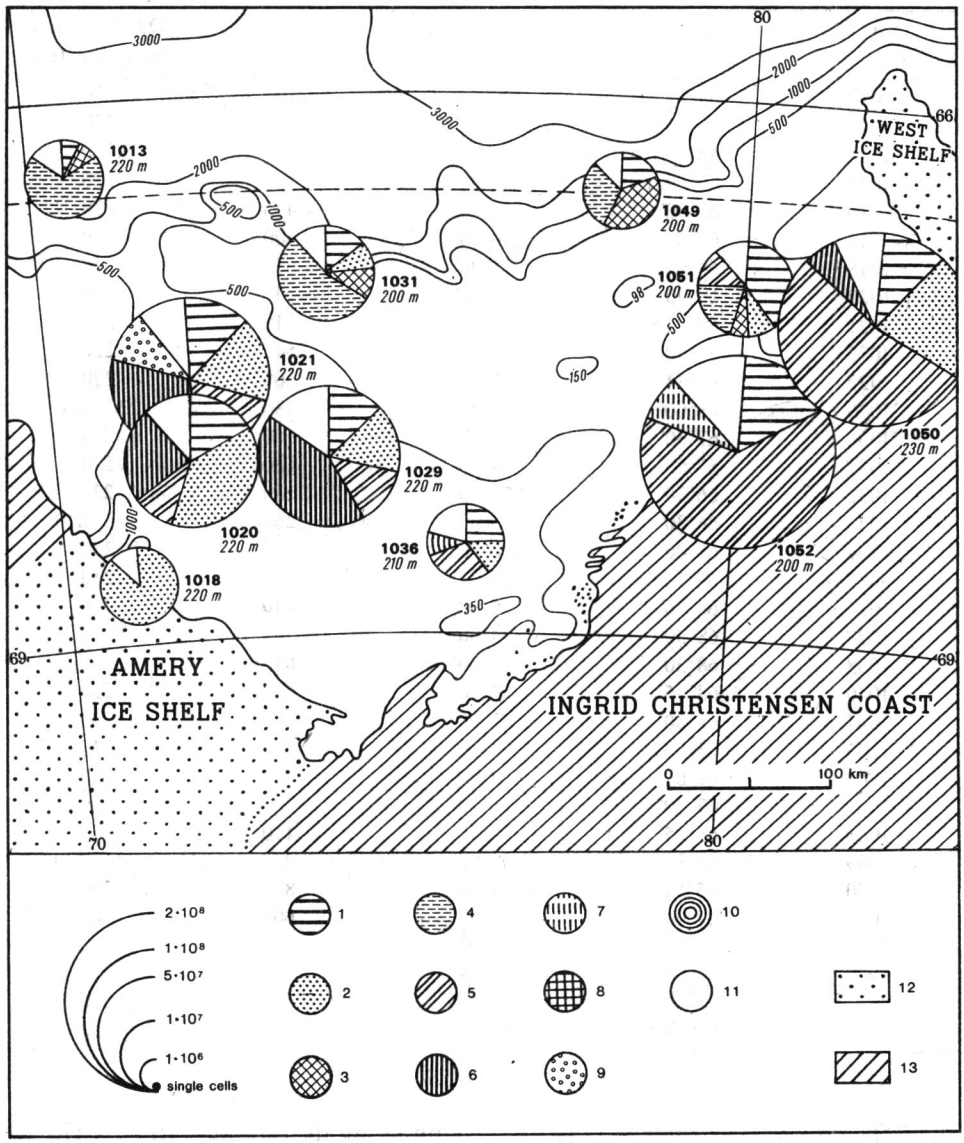

Fig. 2. Number of algal cells in the Olaf Prydz Bay

Material collected with a net No. 25 (mesh size 55 μm). 1 — *Thalassiothrix antarctica*, 2 — *Nitzschia curta*, 3 — *Chaetoceros criophilus*, 4 — *Rhizosolenia alata*, 5 — *Chaetoceros dichaeta*, 6 — *Nitzschia barkleyi*, 7 — *Nitzschia sublinearis*, 8 — *Rhizosolenia hebetata* f. *styliformis*, 9 — *Nitzschia cylindricus*, 10 — *Chaetoceros atlanticus*, 11 — other species, 12 — ice shelf, 13 — coasts. Circle center indicates the position of the sampling station.

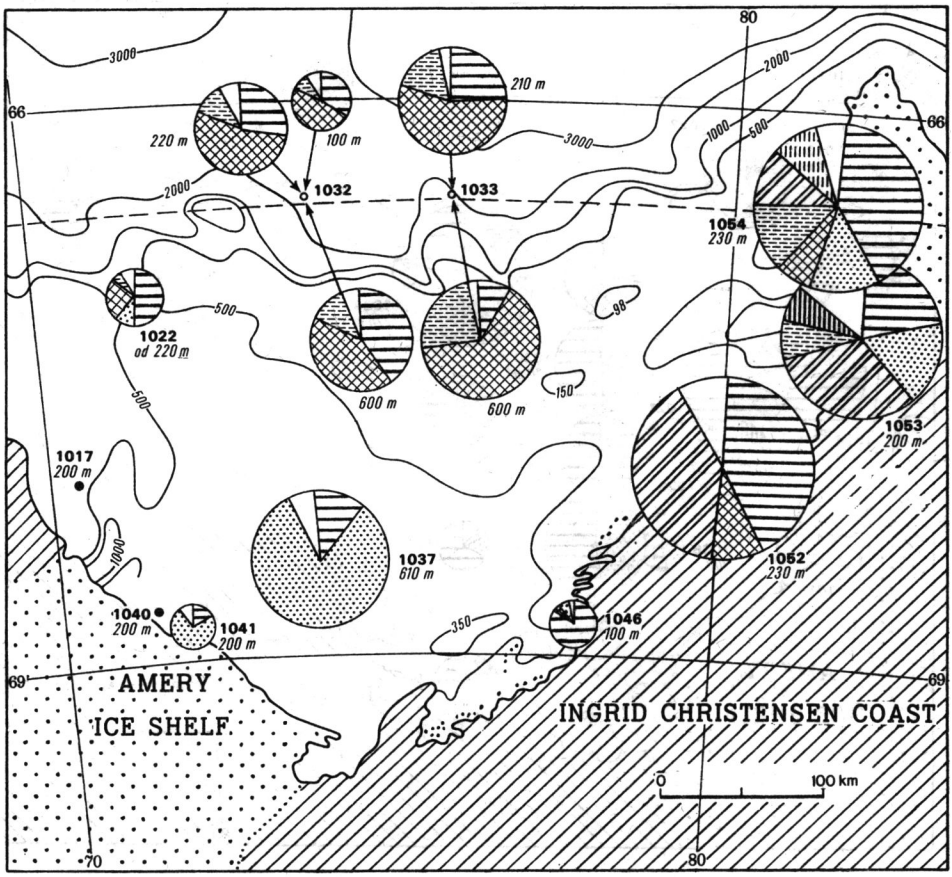

Fig. 3. Number of algal cells under 1 m^2 in the Olaf Prydz Bay
Material collected with a net No. 5 (mesh size 270 μm). Legend as in Fig. 2.

paper surface (15 mm in diameter). The deposited algae cells were distributed evenly over the whole surface of the filter paper. After dessication and xylene treatment the filter paper with algal cells was embedded in Canada balsam under a 24 mm × 24 mm cover glass (Kozlova 1964). So prepared permanent slide enables observation of phytoplankton using oil immersion.

The data on species composition are based on the analysis of all organisms found on the surface of the filter and on the observations of three small subsamples of phytoplankton taken additionally from each of the collected samples. To determine the percentage share of various species in the sample several hundreds of diatom cells were counted and identified (Cholnoky 1968). The counts were made at the confidence level of 5% (Kadłubowska 1975). An exception to this rule were samples collected with a net of 270 μm mesh at the stations Nos. 1017, 1018 and 1040, in which the number of algal cells was very low. The quantitative data

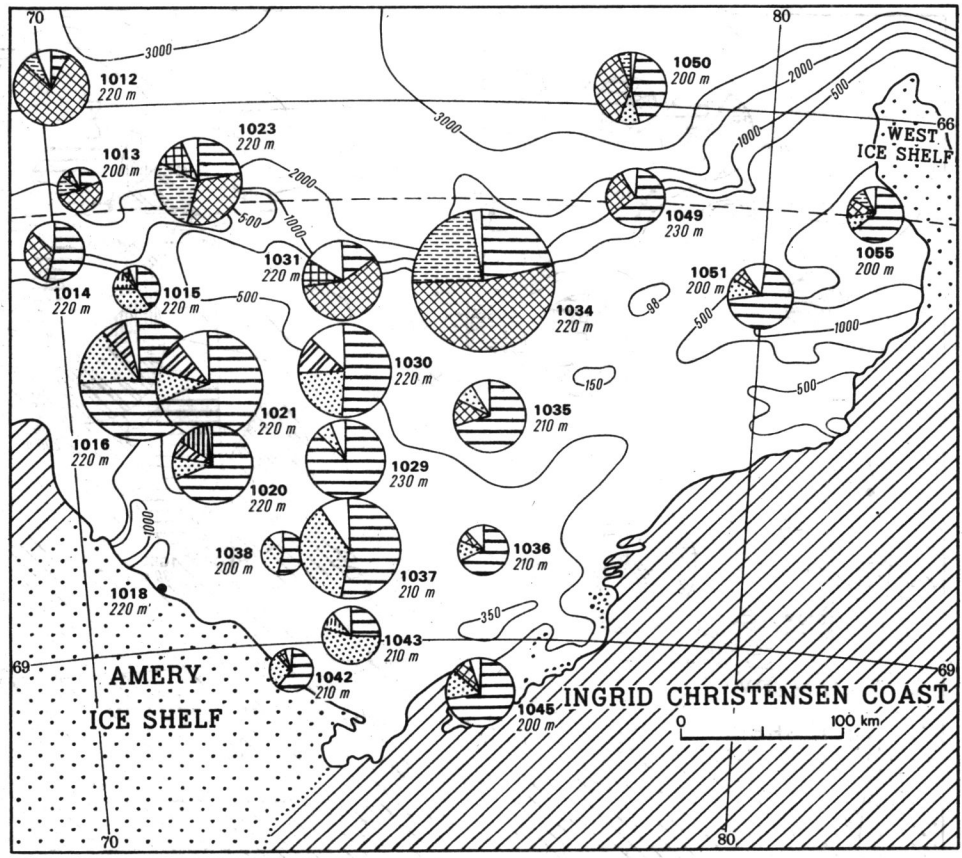

Fig. 4. Number of algal cells under 1 m^2 in the Olaf Prydz Bay
Material collected with double hauls with a net No. 5 (mesh size 270 μm). Legend as in Fig. 2.

were obtained by counting the algal cells present on the $\frac{1}{44}$ part of the filter surface area. The frequency distribution of phytoplankton (Figs. 2—4) is presented in the form of curves after Lohmann (Starmach 1955).

3. Results and discussion

Samples collected with phytoplankton nets can give only a general information about species composition (Starmach 1955). In 11 samples collected with a net of 55 μm mesh the presence of 55 algal taxa was found. In 14 samples collected by single hauls with a net of 270 μm mesh 33 algal taxa were identified. In 24 samples collected by two hauls with a net of 270 μm mesh the presence of 47 algal taxa was found. In aqueous preparations of three subsamples made in order to supplement the list of

algal taxa only in very few cases the presence of the taxa not found in permanent preparations was stated.

Altogether 59 algal taxa were identified in phytoplankton from Olaf Prydz Bay (Table II). Among them 57 belong to the class *Bacillariophyceae*, 1 — to the class *Chrysophyceae* and 1 — to the class *Dinophyceae*.

Among the identified species of plankton diatoms 19 were classified as oceanic species, 13 as eurychoric neritic species and 14 as neritic species (Hart 1942, Kozlova 1964, Abbott 1974) (Table II). Benthic species which may occur in neritic plankton were not found in the examined samples (Drebes 1974). Kozlova (1964) reports that the mixing zone of the oceanic and neritic species in the Indian Ocean sector of the Antarctic occurs between 66° and 63° S; the northern part of that zone runs over the depths of 4300 to 5000 metres. The southern part of that zone extends mainly over the continental slope.

In the samples collected in the Olaf Prydz Bay in February 1969 a co-occurrence of oceanic and neritic species was observed in nearly all the samples collected in the area between 65°51'S and 69°19'S. The depth of water in the places of sampling (Table I) did not reach the values of the depths given by Kozlova (1964) as the northern limit of the zone of mixing of oceanic and neritic species. Yet, north of 67° S a lack of neritic species is observed among the dominant species at Olaf Prydz Bay (Figs. 2—4). This is probably connected with an abrupt depression of the ocean floor at the latitude of 67° S. It may be suggested that the northern limit of the distribution of neritic species at Olaf Prydz Bay depends not upon geographical latitude but upon sea depth. At the sampling stations far from the land the greater part of the occurring species was classified as oceanic organisms (Kozlova 1964, Abbott 1974). Among these species the most numerous were diatoms: *Rhizosolenia alata, Thalassiothrix antarctica, Chaetoceros criophilus, Rhizosolenia styliformis, Rhizosolenia hebetata* f. *semispina* (Figs. 2—4). In the samples collected nearer to the land the most numerous were: the neritic species *Nitzschia curta,* the eurychoric neritic species *Chaetoceros dichaeta* and the oceanic species *Thalassiothrix antarctica* (Figs. 2—4). Species belonging previously to the genus *Fragilariopsis* are included after Hasle (1972) to the genus *Nitzschia*. A high frequency of occurrence of *Nitzschia* in the littoral phytoplankton, decreasing at the stations situated northwards, was reported from this region by Kozlova (1962, 1964). In our samples very often cells of *Thalassiothrix antarctica* were predominant (Figs. 2—4). According to Kozlova (1962, 1964) in the coastal waters of Antarctica in the Indian Ocean sector the share of *Thalassiothrix antarctica* is very low, but it increases markedly in the regions of greater depths. In the samples from Olaf Prydz Bay collected with 55 μm mesh net the share of *Thalassiothrix antarctica* was lower than in the samples collected with 270 μm mesh net. In the course of sampling with such net large cells of this species were collected with higher efficiency

Table II

Frequency of algal species in 49 samples collected in the Olaf Prydz Bay

Taxa	No. of samples
Oceanic	
Thalassiothrix antarctica Cl. et Grun.	48
Chaetoceros criophilus Castr.	44
Rhizosolenia alata Bright.	35
Rhizosolenia alata f. *inermis* (Castr.) Manguin	31
Rhizosolenia hebetata f. *semispina* Gran	25
Nitzschia kerguelensis (Hust.) Hasle	24
Nitzschia barkleyi Hust.	22
Rhizosolenia styliformis Bright.	20
Coscinosira antarctica Kozlova	19
Chaetoceros atlanticus Cl.	19
Dactyliosolen antarcticus Castr.	9
Coscinodiscus furcatus Karst.	8
Navicula criophila De Toni	7
Asteromphalus hookeri Ehr.	6
Coscinodiscus lentiginosus Janisch	4
Coscinodiscus tabularis Grun.	4
Chaetoceros bulbosus Heiden	2
Coscinodiscus gyratus Janisch	1
Nitzschia separanda (Hust.) Hasle	1
Eurychoric neritic	
Nitzschia rhombica (Hust.) Hasle	35
Corethron criophilum Castr.	33
Chaetoceros dichaeta Ehr.	30
Thalassiosira gracilis Hust.	27
Asteromphalus parvulus Karst.	13
Nitzschia obliquecostata (Van Heurck) Hasle	11
Tropidoneis fusiformis Manguin	7
Schimperiella antarctica Karst.	6
Asteromphalus hyalinus Karst.	1
Nitzschia ritscherii (Hust.) Hasle	1
Thalassiosira antarctica Comber	1
Tropidoneis glacialis Heiden	1
Tropidoneis belgicae Heiden	1
Neritic	
Nitzschia curta (Van Heurck) Hasle	41
Nitzschia sublinearis (Hust.) Hasle	32
Eucampia balaustium Castr.	27
Charcotia actinochilus Hust.	20
Porosira pseudodenticulata (Hust.) Jouse	19
Nitzschia cylindrus (Grun.) Hasle	17
Coscinodiscus bouvet Karst.	13
Coscinodiscus symbolophorus Grun.	12
Goscinodiscus inflatus Karst.	7

1	2
Coscinodiscus oculoides Karst.	7
Coscinodiscus ritscherii Hust.	2
Navicula jejinoides f. *longissima* V. Heurck	1
Nitzschia seriata Cl.	1
Others	
Chaetoceros sp.	13
Dactyliosolen sp.	10
Thalassiosira sp.	9
Rhizosolenia alata f. gracillima (Cl.) Grunow	5
Coscinodiscus sp.	4
Nitzschia sp.	2
Biddulphia sp.	1
Chaetoceros atlanticus var. *skeleton* (Schütt) Hust.	1
Navicula sp.	1
Nitzschia curta f. minima (Kozlova) Hasle	1
Pleurosigma sp.	1
Rhizosolenia sp.	1
Dictyocha speculum Ehr.	2
Peridinium sp.	1

than cells of other species. It may be assumed, therefore, that high frequency of *Thalassiothrix antarctica* was caused by using a plankton net with larger mesh size.

In the phytoplankton from Olaf Prydz Bay the occurrence of 11 species of diatoms was observed at the majority of sampling stations. These were: *Thalassiothrix antarctica* (in 48 samples), *Chaetoceros criophilus* (in 44 samples), *Nitzschia curta* (in 41 samples), *Rhizosolenia alata* (in 35 samples), *Nitzschia rhombica* (in 35 samples), *Corethron criophilum* (in 33 samples), *Nitzschia sublinearis* (in 32 samples), *Rhizosolenia alata* f. *inermis* (in 31 samples), *Chaetoceros dichaeta* (in 31 samples), *Eucampia balaustium* (in 27 samples), *Thalassiosira gracilis* (in 27 samples) and *Rhizosolenia hebetata* f. *semispina* (in 25 samples). All these species, with the exception of *Rhizosolenia hebetata* f. *semispina*, were observed also by Kozlova (1964) in many samples from the southern part of the Indian Ocean. However, in southeastern part of the Indian Ocean, south of the Polar Front, the most frequently observed species, occurring also in the majority of the samples from Olaf Prydz Bay, were following species: *Chaetoceros dichaeta, Corethron criophilum, Eucampia antarctica, Rhizosolenia alata* f. *inermis, Rhizosolenia hebetata* f. *semispina* and *Thalassiothrix antarctica* (El-Sayed and Jitts 1973).

Among algae occurring in the Olaf Prydz Bay the following are the endemic species of Antarctica: *Charcotia actinochilus, Schimperiella antarctica, Dactyliosolen antarcticus, Corethron criophilum* and *Eucampia balaustium* (Kozlova 1964).

At the station No. 1032 samples were collected from depths of 600, 220 and 100 metres up to the surface (Fig. 3). The number of algal species in the sample collected from the depth of 100 metres is by 3 species lower than in the sample collected from a depth of 600 metres and by 1 species lower than the number of species in the sample collected from a depth of 220 metres. The share of algal species is similar in all these samples. These data agree with the findings by Kozlova (1964) suggesting that in this region water layers from 0 to 75 metres and from 0 to 150 metres are characterized by highest number of species.

The numbers of algal cells in the samples of phytoplankton collected from depths of 600 and 220 metres up to the surface differ insignificantly, whereas in the sample collected from the depth of 100 metres it was much smaller (Fig. 3). Little differences are observed in the samples collected at the station No. 1033 from depth of 600 and 210 metres. The greatest fluctuations in the species abundancy at various depths in the mentioned stations were observed in *Thalassiothrix antarctica.*

The quantitative data obtained from the samples of phytoplankton collected with plankton net may be used only for the comparison of the stations where samples were collected in the same way. Our data indicate (Figs. 2—4) that the abundance of phytoplankton is the highest near the continent, decreasing north of 67°S (except of the station No. 1034) with the increasing depths of the ocean. With the decrease of the abundance of phytoplankton north 67°S the lack of neritic algae among the dominant species is connected. According to Kozlova (1964) the region of the maximum diatoms abundance extends along the shores of the continent south of the Antarctic Divergence zone (south of 65° — 64°S). According to that author the waters of the Olaf Prydz Bay are characterized by the density of 200—400 mln diatom cells per 1 m^3. In our phytoplankton samples the number of recorded cells ranged from 0.97 mln to 282 mln under 1 m^2. Beklemišev (1958, 1959) mentioned the negative effect of the upwelling waters upon the development of the diatoms. According to that author a decrease in the numbers of diatoms in the Antarctic Divergence zone was observed also in the upwelling region north of Olaf Prydz Bay.

In our study in the littoral zone and in the middle part of Olaf Prydz Bay the species with the greatest number of cells were, as follows: *Chaetoceros dichaeta, Nitzschia curta* and *Thalassiothrix antarctica.* In the northern part of the Bay the following species were predominant: *Chaetoceros criophilus, Rhizosolenia alata* and *Thalassiothrix antarctica* (Figs. 2—4). Kozlova (1962) observed in the Olaf Prydz Bay dominance of *Nitzschia curta* in the surface water layers. Mass occurrence of this species in the Indian Ocean sector of Antarctica was observed between 60°S and 69°S (Jouse, Koroleva and Nagaeva 1962). In the present study the greatest numbers of algal cells, ranging from 141 mln to 282 mln under 1 m^2,

were observed at the eastern shores of the Bay: the dominant species were: *Chaetoceros dichaeta, Thalassiothrix antarctica* and *Nitzschia curta* (Figs. 2 and 3). At the sampling stations Nos. 1052, 1053 and 1054, where the highest abundance of phytoplankton was observed, the temperature at the surface water layer was below −1°C, and salinity 34.00‰ (Savatjugin and Kamova 1971).

I wish to express my gratitude to Prof. Dr. S. Rakusa-Suszczewski and Dr. K. Opaliński, Institute of Ecology, Polish Academy of Sciences, for making available the phytoplankton samples and for basic information necessary for this study. My thanks are also due to Prof. Dr. S. Rakusa-Suszczewski, and to Prof. Dr. J. Z. Kadłubowska and Assoc. Prof. Dr. K. Jażdżewski, University of Łódź, for all their suggestions and valuable comments during the preparation of this paper.

4. Резюме

Диатомеи преобладали как качественно, так и количественно в фитопланктоне залива Прюдс, сектор Индийского океана, Антарктида. Было определено 59 таксонов водорослей, среди которых 57 принадлежит к классу *Bacillariophyceae*, 1 — к классу *Chrysophyceae* и 1 — к классу *Dinophyceae*. В прибрежных местах отбора проб наиболее численны были неритические виды: *Nitzschia curta* и *Chaetoceros dichaeta*, а также океанический вид *Thalassiothrix antarctica*. В местах отдаленных от берега (на север от 67° ю.ш.) наиболее численными были океанические виды: *Rhizosolenia alata, Chaetoceros criophilus. Thalassiothrix antarctica, Rhizosolenia styliformis, Rhizosolenia hebatata f. semispina*. Одновременное присутствие неритических и океанических видов наблюдалось во всем заливе. Выделено 11 видов, выступающих в большинстве мест. Чаще всего выступали: *Thalassiothrix antarctica, Chaetoceros criophilus, Nitzschia curta, Rhizosolenia alata*. На севере от 67° ю.ш. наблюдось отсутствие неритических водорослей среди доминирующих видов. Одновременно заметно снижалась численность фитопланктона.

5. Streszczenie

Okrzemki dominują jakościowo i ilościowo w fitoplanktonie występującym w Zatoce Olafa Prydza leżącej u wybrzeży Antarktydy w sektorze Oceanu Indyjskiego. Zidentyfikowano 59 taksonów glonów, z czego 57 należy do klasy *Bacillariophyceae*, 1 do klasy *Chrysophyceae* i 1 do klasy *Dinophyceae*. Na stanowiskach przybrzeżnych największy udział procentowy miały gatunki nerytyczne *Nitzschia curta* i *Chaetoceros dichaeta* oraz gatunek oceaniczny *Thalassiothrix antarctica*. Na stanowiskach oddalonych od brzegu (na północ od 67°S) największy udział miały gatunki oceaniczne: *Rhizosolenia alata, Chaetoceros criophilus, Thalassiothrix antarctica, Rhizosolenia styliformis* i *Rhizosolenia hebetata* f. *semispina*. Jednoczesne występowanie gatunków nerytycznych i oceanicznych obserwowano w całej Zatoce. Wyróżniono 11 gatunków występujących na większości stanowisk. Najczęściej występowały: *Thalassiothrix antarctica, Chaetoceros criophilus, Nitzschia curta* i *Rhizosolenia alata*. Na północ od 67°S brak jest wśród gatunków dominujących glonów nerytycznych. Jednocześnie zaznacza się spadek liczebności fitoplanktonu.

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Paper received 10 December 1979