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Macrozooplankton near the pack ice between Elephant Island and the South Orkney Islands (December 1988 – January 1989)

ABSTRACT: Macrozooplankton was caught at 17 stations with a Bongo net from the 0-200 m layer. The stations were located near the pack ice edge, between Elephant Islands and the South Orkney Islands. The cluster analysis of 58 recognized taxa allowed to distinguish three regions: the western — near Elephant Island, the middle and the western one — at the South Orkney Islands. No clear difference in macrozooplankton species composition at the open sea stations and those near pack ice was found. The average biomass of macrozooplankton in the investigated area amounted to 82.8 g/1000 m^3 (95% CL: 47.2-94.2 g/1000m^3). Macrozooplankton was dominated by salps and krill. The biomass and 95% confidence limits were 52.0 g/1000 m^3 (15.6-59.2 g/1000 m^3) and 26.1 g/1000 m^3 (8.4-30.4 g/1000 m^3), respectively. Differences in the biomass distribution of some taxa in three distinguished regions were observed. Except of salps the biomass of particular taxa caught near the pack ice edge and the same taxa caught in stations distant from this edge were similar. The biomass of salps was evidently higher in most northern stations.

Key words: Antarctic, zooplankton, pack ice.

Introduction

The part of the Southern Ocean situated in the Scotia Arc region between the South Shetland and the South Orkney Islands arouses the great interest of oceanologists recently. The water masses coming from the Weddell Sea meet the waters of the Bellingshausen Sea origin here and form together the mixing zone called the Weddell-Scotia Confluence (Patterson and Sievers 1980, Stein 1981, Stein and Rakusa-Suszczewski 1983, Grelowski and Wojewódzki 1988, Rakusa--Suszczewski 1988). During austral summer pack-ice usually occurs in this region, drifted with the Weddell Sea currents. This special situation, highly dynamic and complicated from the hydrological point of view induced many authors to analyse the distribution of pelagic organisms both, in the confluence zone and in the marginal ice zone (Brinton and Antezana 1984, Torres *et al.* 1985, Nast 1986, Ainley, Frazer and Daly 1988, Kittel, Siciński and Łuczak 1988, Cuzin-Roudy and Schalk 1989, Lancraft, Torres and Hopkins 1989, Rakusa-Suszczewski 1989, and others). The distribution, population structure and biology of krill in the vicinity of ice edge were also the subject of quite a few papers (Brinton 1985; Macaulay, Daly and English 1985, O'Brien 1987, Daly and Macaulay 1988, Marshall 1988, Cadee *et al.* 1989, Siegel *et al.* 1990, Kittel and Siciński 1991, are some examples).

This paper is a contribution to the knowledge of biological situation in the pelagic zone of the above mentioned area. The aim of the study was to recognize the structure of macrozooplankton assemblages in surface waters between Elephant Island and the South Orkney Islands in summer season. Secondly, the intention of authors was to recognize an interdependence between the character of assemblages and occurring here different kinds of water masses, described recently by Tokarczyk *et al.* (1991). And finally, possible influence of the pack ice on macrozooplankton assemblages character would be the last purpose of the present study.

Investigated area, material and methods

Macrozooplankton samples were collected between 29 December 1988 and 8 January 1989 during the Antarctic expedition on board of r/v „Profesor Siedlecki" in the Sea Ice Zone between Elephant Island and the South Orkney Islands (Fig. 1). The sampling area was situated near the pack-ice edge in the northern part of the Weddell Sea (Rakusa-Suszczewski 1991).

Four types of water masses were distinguished there on the ground of temperature and salinity analyses as well as silicates, nitrates, oxygen and chlorophyll *a* concentrations (Tokarczyk *et al.* 1991). The following hydrological picture was presented by these authors (Fig. 2). The western part of the investigated area was occupied by surface waters of the Bellingshausen Sea origin flowing through the Drake Passage and the Bransfield Strait. This water layer, about 150 m thick, had relatively high temperature (from +0.4° to +0.8°C) and its salinity was about 34.0‰. Below these waters, down to 200 m, the circumpolar Warm Deep Waters with temperature of about +1.8°C and salinity 34.6‰ were found. The eastern border of these two water masses indicates, according to these authors, the position of the Weddell-Scotia Confluence. Grelowski (pers. comm.) suggested that there was a hydrological front in this place, parallel to the northern slope of Elephant Island up to 53° W and changing direction to the north there. The

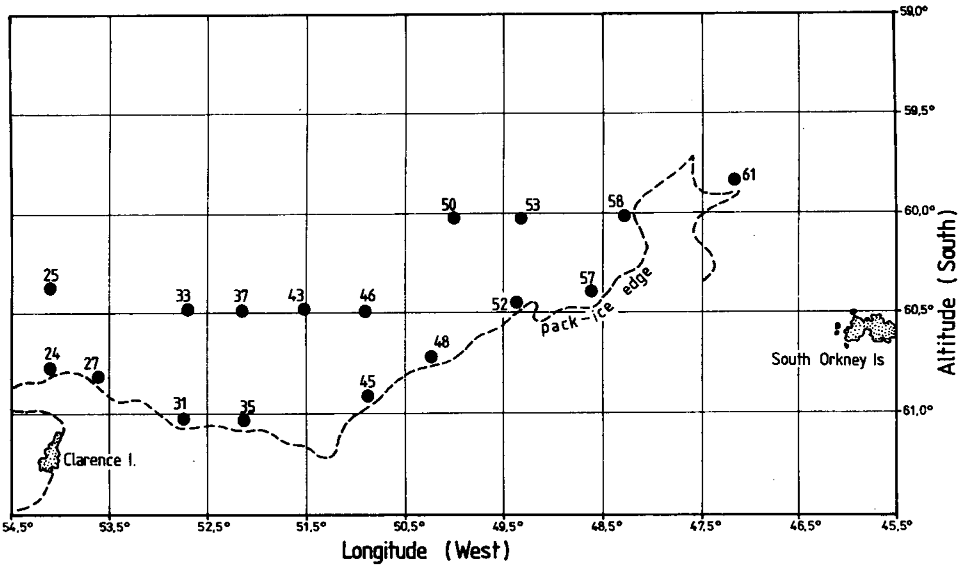

Fig. 1. The position of sampling stations in the investigated area

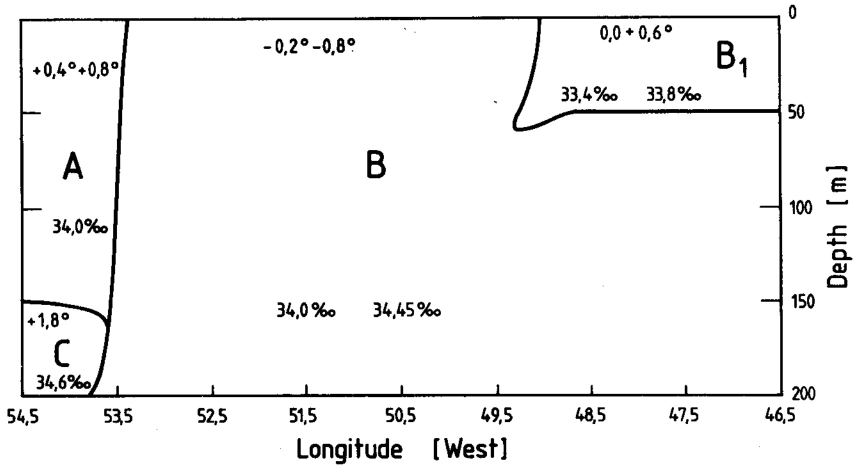

Fig. 2. Vertical distribution of water masses (according to Tokarczyk *et al.* 1991): A — Antarctic Surface Water flowing from the Drake Passage and Bransfield Strait, B — Weddell Sea Surface Water of winter modification, B_1 — Weddell Sea Surface Water of summer modification, C — Circumpolar Warm Deep Water (CWDW)

central and eastern parts were occupied by the cold Weddell Sea surface waters of winter modification. However, in the eastern part of the study area, near the South Orkney Islands, a thin water layer (about 50 m) was distinctly warmer (from 0.0° to +0.6°C) and of lower salinity (from 33.4 to 33.8‰.), forming the lens of the Weddell Sea surface waters of summer modification. According to

Grelowski (pers. comm.) these water masses might have been brought from the Scotia Sea. Below the depth of about 50 m temperature and salinity were typical for cold water of the central part of the sampling area.

Material was collected at 17 stations (Fig. 1) with a Bongo net with the opening of each part equal 0.28 m^2. The 333 µm mesh gauze was used. At each station double oblique trawling was made, from the surface down to 200 m and then hauled up at the speed of about 3 knots. The filtered water volume was estimated from the flowmeter and the ship's log indications and ranged from about 1500 to 1900 m^3, 1700 m^3 on the average.

The wet weight of animals, preserved in 5% formaldehyde, was used as an indicator of the biomass.

An attempt of multivariate analysis was made to divide the investigated area according to the structure of macrozooplankton assemblages. The data matrix comprises abundance values (ind./1000 m^3) of 58 taxa distinguished at 17 stations. The „Cluster" computer program of Florczyk (1989)[1] was applied. Canberra metric was used to calculate the distance values of stations as well as the taxa. These calculations were made on the logarithmicly transformed data. The Ward method was adapted to group individuals. Than, Table 1 was prepared, in which the taxa as well as the stations were arranged according to their sequence in two obtained dendrograms (Figs. 3, 4) respectively.

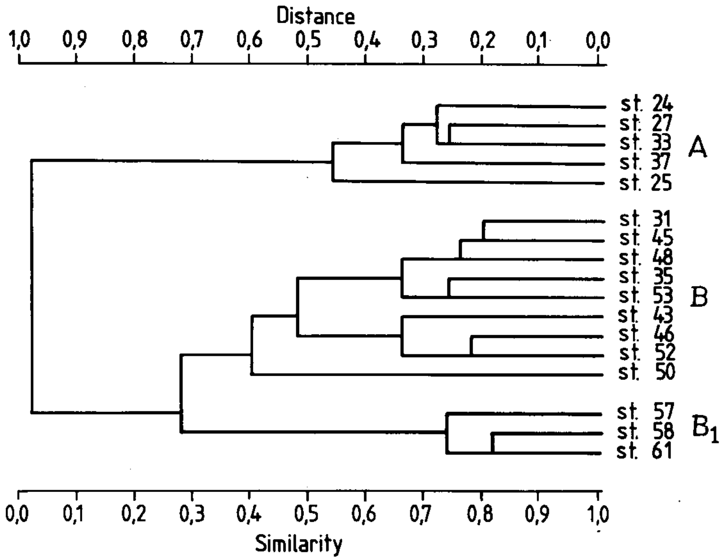

Fig. 3. Dendrogram of stations derived from abundances of 58 macrozooplankton taxa

[1] Florczyk I., 1989. CLUSTER, pakiet programów umożliwiający przeprowadzenie analizy skupień. Wersja 2, Instytut Oceanografii, Uniwersytet Gdański.

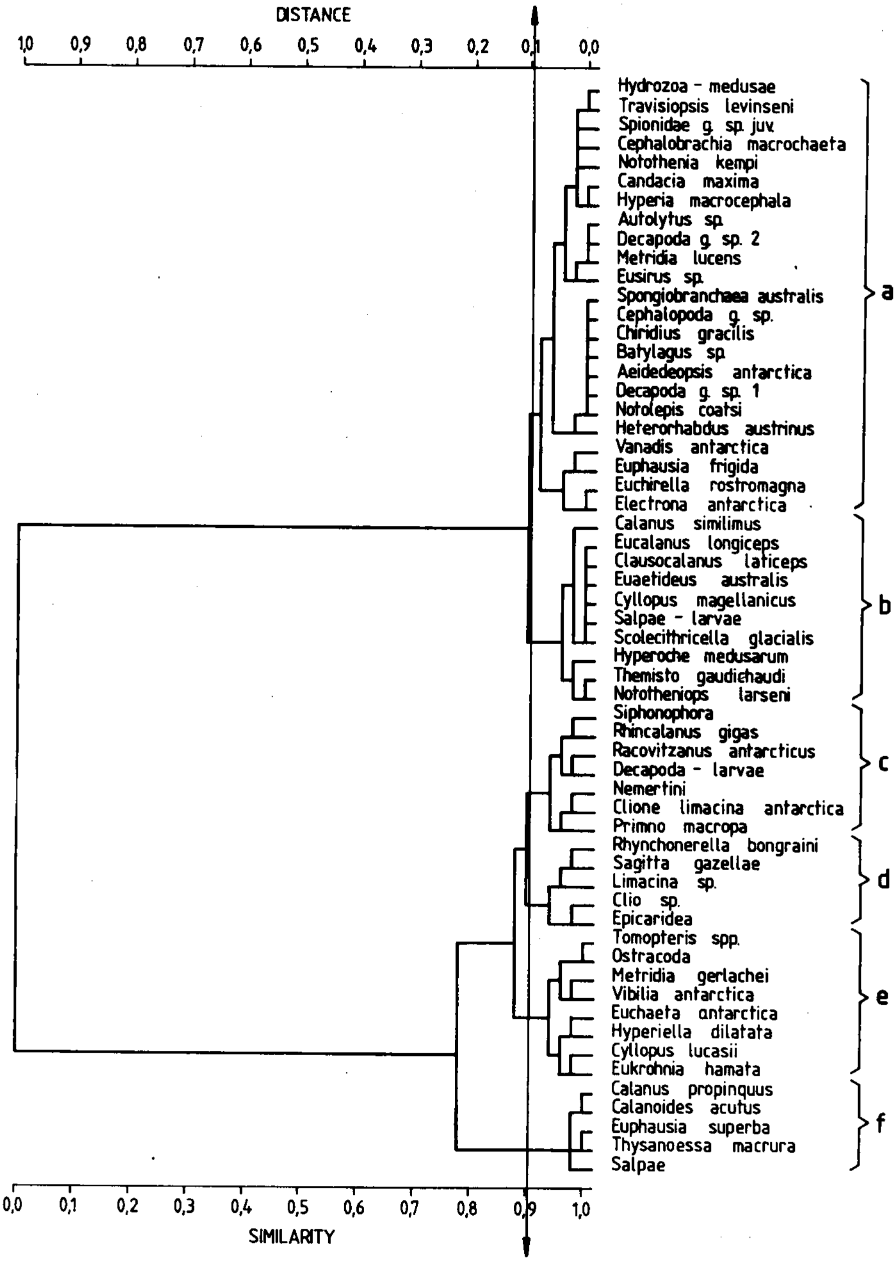

Fig. 4. Dendrogram of 58 macrozooplankton taxa derived from their abundances

The distribution and the abundance (ind./1000 m^3) for 58 macrozooplankton taxa caught near the pack
The stations and the species are rearranged according to

	Region A						
Station	24	27	33	37	25	31	45
Sounding (m)	1160	650	550	602	3000	1050	1150
Filtrated water volume (m^3)	1855	1528	1752	1558	1895	1720	1849
Total biomass (g/1000 m^3)	86,1	50,4	137,9	100,4	42,2	48,9	36,9
Integrated values 0–150 m of chlorophyll α (mg/m^2)[1)]	55,9	49,8	48,4	52,1	29,4	37,9	27,9
Hydrozoa – medusae	1						
Travisiopsis levinseni (Southern)							
Spionidae gen. sp. juv.							
Cephalobrachia macrochaeta Bonnevie							1
Notothenia kempi Norman							
Candacia maxima Vervoort				2			
Hyperia macrocephala (Dana)				41			
Autolytus sp.							
Decapoda gen. sp. 2							
Metridia lucens Boeck							
Eusirus sp.		1					1
Spongiobranchaea australis d'Orbigny							
Cephalopoda gen. sp.							
Chiridius gracilis Farran							
Batylagus sp.							
Aetideopsis antarctica (Wolfenden)							
Decapoda gen. sp. 1							
Notolepsis coatsi Dollo							
Heterorhabdus austrinus Giesbrecht				3			
Vanadis antarctica (McIntosh)			1				
Euphausia frigida Hansen			2	2			
Euchirella rostromagna Wolfenden							
Electrona antarctica (Günther)							
Calanus similimus Brady	1				2		
Eucalanus longiceps Matthews					1		
Clausocalanus laticeps Farran					1		
Euaetideus australis Vervoort					1		
Cyllopus magellanicus Dana					1		
Salpae – larvae					5		
Scolecithricella glacialis Giesbrecht					1		
Hyperoche medusarum Kröyer			1	1	1		
Themisto gaudichaudii (Guérin–Méneville)	1	2	1	4	1		
Nototheniops larseni (Loenberg)	7	6		3	2	2	

Table 1

ice edge between Elephant Island and the South Orkney Islands (December 1988 - January 1989). dendrogram sequencies, as in figs. 3 and 4

Region B							Region B_1			
48	35	53	43	46	52	50	57	58	61	group of species
1400	1000	3240	2520	1950	1520	3150	1900	3850	4700	
1725	1494	1721	1781	1578	1866	1547	1690	1741	1866	
22,0	34,8	110,0	120,0	126,9	113,7	253,6	33,4	53,2	37,7	
39,3	23,9	101,4	62,8	57,0	64,5	109,3	98,0	47,8	58,5	
				1						a
					1					
		1								
			1							
			1							
			1			8				
			1			1				
						1				
						1				
						1				
						1				
						5				
						1		1		
						1	2			
		1				3	1			
			1	1	1					
	1		10	6		1				
			1	4	3	3	3	1	1	
					1		7	2	1	
								1	3	b
						2				
		1							1	
	3									

	Region A						
Station	24	27	33	37	25	31	45
Sounding (m)	1160	650	550	602	3000	1050	1150
Filtrated water volume (m^3)	1855	1528	1752	1558	1895	1720	1849
Total biomass ($g/1000\,m^3$)	86,1	50,4	137,9	100,4	42,2	48,9	36,9
Integrated values 0–150 m of chlorophyll α (mg/m^2) [1]	55,9	49,8	48,4	52,1	29,4	37,9	27,9
Siphonophora					2		1
Rhincalanus gigas Brady					3	1	5
Racovitzanus antarcticus Giesbrecht		1					
Decapoda gen. sp. – larvae							
Nemertini		1		1		1	1
Clione limacina antarctica Smith				1			2
Primno macropa Guérin–Méneville						1	
Rhynchonerella bongraini (Gravier)		5	1	1	5	1	1
Sagitta gazellae Ritter–Zahony	1			1	2	1	4
Limacina sp. [2]	3	2	1	3	2	4	2
Clio sp. [2]	1				1	6	1
Epicaridea – Cryptoniscium stage	1		1		1	1	1
Tomopteris spp.		1		1	4		1
Ostracoda		1	1	13	2		1
Metridia gerlachei Giesbrecht	1		5	116	1	1	1
Vibilia antarctica Stebbing	8	2	11	5	4	6	3
Eüchaeta antarctica Giesbrecht		6	2	9	31	1	1
Hyperiella dilatata Stebbing			7	3	3	1	2
Cyllopus lucasii Bate	10	2	2	3	7	1	1
Eukrohnia hamata (Möbius)				2	3	2	1
Calanus propinquus Giesbrecht	5	11	33	17	18	12	21
Calanoides acutus Giesbrecht	3	18	2	6	7	49	59
Euphasia superba Dana	181	93	109	28	31	97	74
Thysanoessa macrura G. O. Sars	222	123	143	576	82	114	225
Salpae	95	61	277	170	83	22	56

[1] according to Lipski (1991);
[2] the major part of material damaged; on the ground of few well preserved specimens one can suppose these are most likely *Limacina helicina* and *Clio pyramidata sulcata*.

Results

According to the strong and most general dendrogram division stations gather quite evidently in two groups (Fig. 3). According to more specific division three groups of stations can be distinguished (Fig. 3; A, B, B_1). Such stations assembling, in two or three groups, appeared also in most dendrograms obtained by different methods of distance counting and by different ways of clustering.

The investigated part of the ocean can be divided into two regions differing

Table 1 cont.

Region B							Region B_1			
48	35	53	43	46	52	50	57	58	61	group of species
1400	1000	3240	2520	1950	1520	3150	1900	3850	4700	
1725	1494	1721	1781	1578	1866	1547	1690	1741	1866	
22,0	34,8	110,0	120,0	126,9	113,7	253,6	33,4	53,2	37,7	
39,3	23,9	101,4	62,8	57,0	64,5	109,3	98,0	47,8	58,5	
8	12	10	3	1	5	8	3			
10	2	5	1	16	19	6	8	1		
	3	1	5	3	1	6	12			
2	2	5	1	1	4	5	8	6	16	c
2	2	2	2	2	2	1	3		1	
2	2	1	3		1	1	2	3	4	
2	1	1			1	1		1	2	
6	6	19	2	3	16	6	31	13	16	
27	10	15	6	2	9	12	5	3	1	
2	2		1	5	1		6	15	13	d
4		1	3	13	4	1	4	2	1	
1				1	2	1	3	2	2	
11	3		8	3	1	21				
1			21	32	3	16				
1		1	16	13	164	1424				
	10	27	7	11	7	3			1	
	2	1	1	1	3	25		1		e
	2	1	3			1	1	1	1	
23	1		1			1				
2	13	4	1			1				
11	9	23	35	18	19	83	31	18	20	
49	158	71	12	47	232	25	9	3	10	
9	9	236	8	201	364	215	50	91	115	f
12	2	191	90	129	239	183	77	156	183	
75	46	34	1556	210	28	503	1		4	

in the species composition and structure of their assemblages. First of them, the western region (A), includes the stations 24, 25, 27, 33 and 37. The second region is additionally divided into two parts: the middle region B (stations 31, 45, 48, 35, 53, 43, 46, 52, 50) and the eastern region B_1 covering the rest of the study area.

From 58 taxa six groups can be formed (Fig. 4). Their character becomes evident after an analysis of their distribution in the investigated area, what is illustrated in Tab. 1. The distinguished groups of taxa can be defined as follows.

The group „a" contains species which were rarely caught in the investigated area and usually in low number. Their distribution does not show any regularities when it is analysed according to the study area division into the three regions. Relatively common in this group of taxa were: *Euphausia frigida* and *Euchirella rostromagna.*

Themisto gaudichaudii and *Nototheniops larseni*, the two species of the group „b", occurred to be constant in the western part of the investigated area. Apart from *Hyperoche medusarum* other species of this group appeared mainly in this region. It should be also pointed out that larvae of salps were encountered only in the station 25, well, in the western part of the investigated area, to the north-east of Elephant Island.

The species of group „c" were common and relatively abundant in the middle and eastern parts of the area, i.e. in the water masses of the Weddell Sea origin. Their distribution is the most sound argument for the division of the study area into two parts. The regularity in decapod larvae distribution was observed. Their abundance increased in the eastern direction. They were most abundant near the South Orkney Islands (region B_1).

Some species from the group „d" showed the similar tendency, i.e.: *Rhynchonerella bongraini, Limacina* sp. or Epicaridea. Similarly, other species of group „d" were more common and abundant in regions B and B_1 than in the region A — near Elephant Island.

The group „e" is formed of species absent, rare or of exceptionally low abundance in region B_1.

And, finally, the group „f" consisting of 5 most eurytopic species with the highest abundance values. Salpae, however, were very scarce in the area of the South Orkney Islands (region B_1). The relatively high abundance of *Calanoides acutus* in the middle region (B) should also be noticed.

Macrozooplankton of the investigated area was dominated by Salpae. Their average biomass for the whole investigated area (n = 17) amounted to 52.0 g/1000 m^3, (95% CL: 15.6–59.2 g/1000 m^3). Only in the eastern part of this area the biomass of Salpae was very low (stations 57, 58 and 61; Tabs. 2 and 3). The overall share of salps in zooplankton biomass was about 63%.

The second dominant was krill (*Euphausia superba*) with mean biomass 26.1 g/1000 m^3 (95% CL: 8.4–30.4 g/1000 m^3). The overall share of krill in zooplankton biomass was about 32%. The mean biomass of krill in the three distinguished regions A, B and B_1 was similar.

Thysanoessa macrura constituted about 3% of the whole assemblage biomass, 2.5 g/1000 m^3 on the average (95% CL: 0.9–3.1 g/1000 m^3) and, just as for *Euphausia superba*, the differences in the biomass values of *T. macrura* in the three distinguished regions were not recognized.

The mean macrozooplankton biomass in the whole investigated area amounted to 82.8 g/1000 m^3 (95% CL: 47.7–94.2 g/1000 m^3). The biomass distribution did not show any particular regularities. The three above mentioned regions –

A, B and B_1 do not differ from each other in this respect. On the other hand, some peculiar tendencies are visible in the biomass distribution of some taxa (Tabs. 2 and 3). These were first of all salps and amphipods with the low biomass values in the eastern part of the investigated area (region B_1). The biomass of Thecosomata was lower in the western part (region A) whereas the biomass of Chaetognatha in the western and eastern parts (region A and B_1). Gymnosomata were almost absent in the western part (region A) while Siphonophora occurred mainly in the middle region.

The biomass of particular taxa caught near the pack ice edge and the same taxa from the stations distant from this edge do not show any significant differences (Tab. 4). However, the salps are an emphatic exception. Their biomass was evidently higher in most of the northern stations, i.e. more distant from the pack ice edge (Tab. 4). The greater amount of ostracods was also recorded in this group of stations (Tab. 2). It is worth emphasizing that *Vanadis antarctica* and *Euphausia frigida* were two species found almost entirely in the northern stations of middle region.

Discussion

The division of the surface waters of the study area resulting from abundance distribution of 58 macrozooplankton taxa (Fig. 3) fits well into division suggested by Tokarczyk *et al.* (1991), based on physical and chemical features analyses. Two groups of the surface water masses were distinguished by above cited authors. One of these were the warm surface waters of the Bellingshausen Sea origin flowing through the Bransfield Strait and the Drake Passage. The other were the cold surface waters from the Weddell Sea. The frontal zone between these two types of water masses runs, approximately, along 53°30′W meridian. The division of our study area into two distinct regions (the more general division) also agrees with the hydrological picture of this area proposed by Stein (1986). According to many years research of this author, hydrological Scotia Front runs along the northern slope of Elephant Island. The present results would confirm all above mentioned observations. The pattern of the macrozooplankton distribution and the dendrogram (Fig. 3) as a result shows that such hydrological front might be situated between stations 27 and 37 on the one side, and 31 and 43 on the other (Fig. 1). Then, the surface waters of the Bellingshausen Sea origin of relatively high temperature, lower silicate content and salinity (Tokarczyk *et al.* 1991) surround the western group of stations (region A). For this area the species of the group „b" (Fig. 4, Tab. 1) was separated in the cluster analysis. Among them *Themisto gaudichaudii* is regarded as a species typical for the warmer Antarctic waters (Mackintosh 1934), and was encountered frequently and in the great abundance in the Drake Passage and the Bransfield Strait (Jażdżewski and Presler 1988), mostly in the warmer surface waters. This species has

The biomass for particular taxa in the investigated area. (Salps and

STATION No / TAXON	24	27	33	37	25	31	45
Salpae	30,9	26,8	105,5	83,3	26,6	25,2	25,0
Euphausia superba	50,0	23,1	28,6	6,7	11,8	20,7	7,6
Thysanoessa macrura	4065	195	2731	6442	1483	1616	3622
Amphipoda	341	265	601	3626	561	364	142
Copepoda	19	36	178	166	77	90	187
Thecosomata	117	24	8	43	9	767	79
Chaetognatha	43			15	10	115	29
Rhynchonerella bong.		3	1	1	13	1	2
Nemertini		9		22		10	15
Gymnosomata				42			34
Siphonophora					714		169
Ostracoda		1	1	12	1		1
Tomopteris spp.		1		3	889		2
Decapoda – larvae							
Vanadis antarctica			210				
Euphausia frigida			38	37			
Pisces – larvae	27	14		5	3	26	
others	600 [1]				40 [2]		
Biomass total (g/1000 m^3)	86,1	50,4	137,9	100,4	42,2	48,9	36,9
Biomass excepting *Salpae* and krill (g/1000 m^3)	5,2	0,5	3,8	10,7	3,8	3,0	4,3

[1] Hydromedusae
[2] Salpae – larvae
[3] Decapoda gen. sp. 2, *Autolytus* sp.
[4] *Travisiopsis levinseni*

been so far not encountered in Weddell Sea (Piatkowski 1987). Similarly, *Cyllopus magellanicus*, the species connected with rather warmer waters was hitherto recorded in the Bransfield Strait, the Drake Passage (Weigmann-Haass 1983, Jażdżewski and Presler 1988) and the vicinity of South Georgia Island (Jażdżewski and Presler 1988). Two records of *Cyllopus magellanicus* from the Weddell Sea indicate at the same time its southern border of extent (Piatkowski 1987, Boysen-Ennen 1987). Among copepods *Calanus similimus* and *Eucalanus longiceps*, considered to be subantarctic forms (Żmijewska 1985), prefer also the warmer waters. According to Kellermann (1990) the larvae of *Nothoteniops larseni* occur principally in the area west of the Antarctic Peninsula and South Georgia, that is to say also in the warmer waters. They were not found in the Weddell Sea, the area investigated by above cited author, too.

In the middle region (B) being under influence of the cold waters from the Weddell Sea (Tokarczyk *et al.* 1991) most of the recorded species are cold-water forms. For example, they were *Vanadis antarctica, Clione limacina antarctica,*

Table 2

E. superba – in g/1000 m^3, the remaining taxa – in mg/1000 m^3)

48	35	53	43	46	52	50	57	58	61
16,6	30,1	60,5	112,2	86,1	40,1	203,2	4,1		6,3
1,6	1,3	42,2	2,0	36,2	66,8	41,7	25,6	49,4	28,0
398	56	3634	1406	1953	3861	2467	1869	3225	2781
73	392	348	542	589	396	235	26	6	59
65	138	157	188	229	540	1697	155	61	41
813	9	37	429	1096	383	199	572	353	329
316	321	223	840	8	25	179	29	51	7
7	11	19	3	2	7	8	19	11	10
18	30	22	40	13	14	6	54		10
46	74	27	62		11	89	20	75	156
2024	2321	2840	894	297	1170	3677	957		
1			21	34	3	16			
30	12		38	8	2	69			
5	4	8	1	1	7	8	17	18	39
			1118	280	347				
	13		128	97		8			
	14	1			1	12	12	1	1
			110 [3)]	40 [4)]					
22,0	34,8	110,0	120,0	126,9	113,7	253,6	33,4	53,2	37,7
3,8	3,4	7,3	5,8	4,6	6,8	8,7	3,7	3,8	3,4

Euphausia superba and *Metridia gerlachei*. Just these species occurred here in abundances greater than in other distinguished regions.

Calanoides acutus, *Calanus propinquus* and *Rhincalanus gigas* were in the region discussed both, frequent and abundant. It seems therefore, that assemblage of the middle region is roughly similar to the „Antarctic community" of the Drake Passage described by Jażdżewski, Kittel and Łotocki (1982). On the other hand, some similarities are apparent with the „oceanic community" of the Weddell Sea presented by Boysen-Ennen (1987) and Boysen-Ennen and Piatkowski (1988). *Vanadis antarctica*, *Rhynchonerella bongraini*, *Euchirella rostromagna*, *Racovitzanus antarcticus*, *Primno macropa*, *Vibilia antarctica*, *Cyllopus lucasii* or *Metridia gerlachei* make a group of the species common for both, middle region of this study and the northern stations in the Weddell Sea. The last of the above mentioned species, the dominant of the „oceanic community" of the Weddell Sea was also abundant in the region B. Thus, it may be supposed that the species assemblage found in the middle region of the study area makes

Table 3

The mean biomass values and their absolute ranges for most common taxa in the three distinguished regions – A, B and B_1

Taxa	A (n=5)	B (n=9)	B_1 (n=3)	
Macrozooplankton as a whole	83.4 (42.2–137.9)	96.3 (22.0–253.6)	41.4 (33.4–53.2)	g/1000m³
Salpae	54.6 (26.6–105.5)	66.6 (16.6–203.2)	3.5 (0–6.3)	g/1000m³
Euphausia superba	24.0 (6.7–50.0)	24.5 (1.3–66.8)	34.3 (25.6–49.4)	g/1000m³
Thysanoessa macrura	3.0 (0.2–6.4)	2.1 (0.1–3.9)	2.6 (1.9–3.2)	g/1000m³
Amphipoda	1079 (265–3626)	342 (73–589)	30 (6–59)	mg/1000m³
Copepoda	95 (19–178)	366 (65–1697)	86 (41–155)	mg/1000m³
Thecosomata	40 (8–117)	424 (9–1096)	418 (329–572)	mg/1000m³
Chaetognatha	14 (0–43)	228 (8–840)	29 (7–51)	mg/1000m³
Rhynchonerella bongraini	3.6 (0–13)	6.7 (1–19)	13.3 (10–19)	mg/1000m³

an intermediate form between this of the Weddell Sea and that of more northern waters.

The separation of the stations 57, 58 and 61, the group characterized by appreciably different assemblage structure, is confirmed by the hydrological situation in this part of the study area as well. The Weddell Sea surface waters of the summer modification appear there (Tokarczyk *et al.* 1991). The high chlorophyll *a* concentration in the 0–50 m layer (Lipski 1991), higher temperature and somewhat lower salinity were distinctive traits as opposed to the waters of the middle region.

Despite the general distributional patterns of taxa groups (Fig. 4, Tab. 1) other tendency in the distribution of the particular taxa is also observed, *Electrona antarctica*, decapods larvae, *Rhynchonerella bongraini, Limacina* sp. and Epicaridea have the distribution concordant with a gradient of some factors, especially of chlorophyll *a*. Their abundances increase eastwards with the maximum observed in region B_1, i.e. in the South Orkney area.

The mean zooplankton biomass of the Antarctic surface waters amounts to about 50 g/1000 m^3 (Foxton 1956), thus it is nearing the mean biomass value

Table 4

The comparison of the biomass arithmetic means and 95 % confidence limits for most common taxa from the stations near the pack ice edge and those distant from it.

(C comparison of samples means (Mann-Whitney U-test): + there is a difference at the 5 % level of significance, – no difference at the 5 % level of significance)

	The stations near the pack ice edge: 24, 27, 31, 35, 45, 48 and 52 (n=7)	The stations from the pack ice edge: 25, 33, 37, 43, 46, 50 and 53 (n=7)	C	
Salpae	27.9 (21.2–34.6)	96.8 (46.7–148.7)	+	g/1000m^3
Euphausia superba	24.5 (2.7–49.0)	24.2 (5.5–47.1)	–	g/1000m^3
Thysanoessa macrura	2.0 (0.2–4.2)	2.9 (1.5–4.1)	–	g/1000m^3
Amphipoda	282 (134–444)	929 (276–1352)	–	mg/1000m^3
Codepoda	154 (33–255)	385 (91–538)	–	mg/1000m^3
Thecosomata	313 (25–618)	260 (13–418)	–	mg/1000m^3
Chaetognatha	121 (6–283)	182 (3–294)	–	mg/1000m^3
Rhynchonerella bongraini	4 (1–8)	7 (1–12)	–	mg/1000m^3

counted from present data (82.8 g/1000 m^3). Similar values for the western Antarctica were already noted by Jażdżewski, Kittel and Łotocki (1982) — 96 g/1000 m^3 and Nast (1986) — 71 g/1000 m^3. On the contrary, higher values were encountered by Witek *et al.* (1985) — 320 g/1000 m^3 in the vicinity of the South Shetland Islands. However, it should be pointed out, that this high biomass value results from extremal amount of salps in the summer season 1983/1984. Witek *et al.* (1985) and Kittel, Siciński and Łuczak (1988) gave biomass values of macrozooplankton excluding, however, biomass of krill and sapls as the great sized dominants. The present results fit well these of above cited authors, i.e. the biomass values ranged from a few to a dozen or so g/1000 m^3.

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Streszczenie

W niniejszej pracy przedstawiono zróżnicowanie zgrupowań makrozooplanktonu w obszarze przyległym do krawędzi paku lodowego między Wyspą Elephant, a Południowymi Orkadami, w sezonie letnim (grudzień 1988 – styczeń 1989). Zooplankton łowiono w 17 stacjach przy pomocy sieci Bongo o średnicy oczek 333 µm z warstwy 0–200 m (rys. 1). Stosując metody

analizy wielowymiarowej, na podstawie rozmieszczenia i liczebności 58 stwierdzonych taksonów wyróżniono w obszarze badań 3 regiony, odmienne pod względem składu i struktury zasiedlających je zgrupowań makrozooplanktonu. Są to: region zachodni (A) obok Wyspy Elephant, środkowy (B) oraz wschodni (B_1) w pobliżu Południowych Orkadów (rys. 1, 3). Proponowany tu podział wód powierzchniowych pokrywa się z podziałem zaproponowanym przez Tokarczyka i in. (1992), opartym na analizach fizyko-chemicznych wód (rys. 2). Najbardziej generalny podział dendrogramu (rys. 3) na 2 grupy stacji ujawnia faunistyczną granicę, której położenie jest niemal identyczne z przebiegiem hydrologicznego Frontu Scotia, przedstawionym przez Steina (1986). W dendrogramie (rys. 4) wyodrębniono 6 grup taksonów, których swoistości rozmieszczenia uwidoczniono w tabeli 1, gdzie kolejność zarówno stacji, jak i taksonów jest zgodna z ich uporządkowaniem w dendrogramach (rys. 3 i 4). Analiza clusterowa nie ujawniła różnic w składzie zgrupowań obszaru przyległego do paku lodowego z jednej i obszaru odległego od paku z drugiej strony. Średnia biomasa makrozooplanktonu w obszarze badań wynosi 82.8 g/1000 m^3, a jej 95% przedział ufności zawiera się w granicach 47.2–94.2 g/1000 m^3. Podobne wartości biomasy zooplanktonu dla obszaru Antarktyki Zachodniej podali Foxton (1956) oraz Jażdżewski, Kittel i Łotocki (1982). Pod względem liczebności i biomasy makrozooplankton był zdominowany przez salpy, których średnia biomasa wynosiła 52.0 g/1000 m^3 oraz przez kryla (średnia biomasa 26.1 g/1000 m^3) (tab. 2,3). Znikome ilości salp stwierdzono we wschodniej części obszaru badań (region B_1). Charakterystyczne tendencje w rozkładzie biomasy najpospolitszych taksonów ilustrują tabele 3 i 4.