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Antarctic neritic zooplankton community (Admiralty Bay, King George Island, South Shetland Islands)

ABSTRACT: Sixty seven zooplankton taxa were recorded in a total of 54 WP-2 net vertical hauls carried out in a year round cycle in Admiralty Bay. Copepoda were the most common and abundant group and *Oithona similis* was the dominant species throughout the area. Polychaeta, Ostracoda and Chaetognatha were also rather common and abundant. Euphausiacea, Amphipoda and Salpae occured mainly in the central part and the outlet area of the bay. No differences in zooplankton assemblages diversity in the four investigated areas of Admiralty Bay were encountered. However, distinct differences in species richness between the zooplankton of Ezcurra Inlet and the main basin of the bay were observed. The composition of zooplankton was rather stable throughout the year, but seasonal occurrences of larvae of Polychaeta, Crustacea, Echinodermata and Ascidiacea were noted. A list of the 174 zooplankton taxa ever found in Admiralty Bay is presented by combining the present results with the existing scientific data.

Key words: Antarctic, Admiralty Bay, diversity, zooplankton.

Introduction

Shallow marine coastal areas present an interesting subject of biological studies because of their productivity and the diversity of organisms which occur there. The interactions between plankton and benthic communities are here closer and more dynamic than in the open oceanic areas. The land – ocean interactions and their influence on the character and distribution of coastal zone zooplankton assemblages seem to be interesting as well. White (1984) and Gallardo (1987) were of the opinion that we are still lacking complete information regarding the shelf communities. This observation concerning the benthos refers also to the neritic plankton communities, including these in Antarctic waters. Admiralty Bay, the key site for intensive international scientific activity and the Antarctic Special Management Area, appears to be a proper basin for investigations focused on the above-mentioned questions.

The earliest zooplankton research in Admiralty Bay concerned krill (Kittel 1980, Kittel and Presler 1980, Rakusa-Suszczewski and Stępnik 1980, Stępnik 1982). Five euphausiid species, typical for Antarctic waters, were then identified. Species composition of Copepoda and their biomass and life cycles were the subject of studies carried out by Chojnacki and Węgleńska (1984) and Żmijewska (1993). Menshenina and Rakusa-Suszczewski (1992) presented the seasonal variations of zooplankton based on a year-round investigation of the central basin of Admiralty Bay. Freire *et al.* (1993) observed the daily changes in zooplankton caused by tides and winds. Recent studies on Protozoa (Wasik and Mikołajczyk 1990) have revealed the presence of 16 species of Tintinnina in Admiralty Bay. The species composition of fish larvae were studied by Skóra (1993). This author confirmed the presence of 20 species of fish larvae or post-larval stages in the waters of the bay.

The aim of this study was to determine the specifity and heterogeneity of the zooplankton community in the West Antarctic coastal ecosystem. The present study is based on the materials collected in a year-round sampling in Admiralty Bay at four near-shore stations with different environmental characteristics.

Study area

Several authors have described many aspects of the environment of Admiralty Bay. Detailed information on its hydrology and hydrography is given by Pruszak (1980), Samp (1980), Marsz (1983), Lipski (1987), and others.

Admiralty Bay (Fig. 1) is the largest bay of King George Island, with an area of ca 120 km^2 and a maximum depth of about 500 m. It opens to the Bransfield Strait with an outlet which is approximately 8 km wide. The bay has the character of a fiord with a system of smaller inlets, branching to the Ezcurra Inlet, the MacKellar Inlet, and the Martel Inlet.

The water throughout the bay is well-mixed and neither well-outlined halocline nor thermocline occur there (Szafrański and Lipski 1982). However, in areas situated near ice barriers an upper, 15–40 m deep layer of water column, characterized by lower salinity, lower temperature, and higher oxygen content, is distinguishable (Bojanowski 1984, Szafrański and Lipski 1982). In areas neighbouring glaciers, close to the freshwater inflow, low salinity less than 20‰ may be observed in summer in the 1 m surface layer.

Water circulation in Admiralty Bay is generated on one hand by deep-water currents transporting water into the bay and surface currents pushing water out of the bay towards the Bransfield Strait. The entire exchange of water down to the depth 100 m lasts for about 1–2 weeks (Pruszak 1980).

The sea floor in the center of the bay is rather even and the depth increases regularly towards the outlet down to over 500 m. Ridges occur mainly at the entrances to the inlets. They are an important morphogenic feature, influencing the creation of whirls and upwellings of water masses flowing into the bay from the Bransfield Strait. Thus, the prevailing westerly winds and the particular bottom configuration causes upwellings in the eastern part of Ezcurra Inlet (Rakusa-Suszczewski 1980).

Suspended matter reaching the sea mostly from subglacial streams are among the most important abiotic factors of the pelagial. Pęcherzewski (1980) found 12.4 mg dm^{-3}, on the average, of inorganic suspended matter in the surface layer of central part of the bay. This value decreased markedly below the depth of about 15 m. According to Rakusa-Suszczewski (1993) the highest content of suspended matter, amounting 100–150 mg dm^{-3}, was observed in front of glaciers. The water transparency in the central basin of Admiralty Bay varies seasonally from 2–3 m in summer to 32 m in winter (Lipski 1987). The suspended matter content in Admiralty Bay is about ten times higher than it is in the open ocean (Pęcherzewski 1980).

Material and methods

Materials were collected during the XVII Polish Antarctic Expedition of Polish Academy of Sciences to the *Arctowski* Station (1992–1994) between February 1993 and January 1994.

In collecting the materials a WP-2 net was used with a square mouth opening of 0.25 m^2 and 0.2 mm mesh size. Zooplankton was collected at four stations located in hydrologically different areas of the bay (Fig. 1). Station H was situated in Herve Cove, a small shallow glacial lagoon isolated to some degree from the Ezcurra Inlet by the submerged moraine and influenced by the intensive input of freshwater and mineral suspension. The layer sampled there was 0–15 m. Some results of Herve Cove zooplankton assemblage were already presented in the paper by Siciński *et al.* (1996). Station "C" was located in Cardozo Cove inside Ezcurra Inlet, at a maximum depth of 150 m. The layer sampled at this station was 0–130 m. In the central part of Admiralty Bay (station "A" of over 400 m depth) the layer sampled was 0–400 m. Finally, station "B" was situated at the bay outlet of Admiralty Bay to the Bransfield Strait. The depth there exceeds 500 m and samples were also taken from the layer 0–400 m. Samples were collected at each station every three weeks between February 1993 and January 1994 (except for July). A total of 54 zooplankton samples (= hauls) were collected.

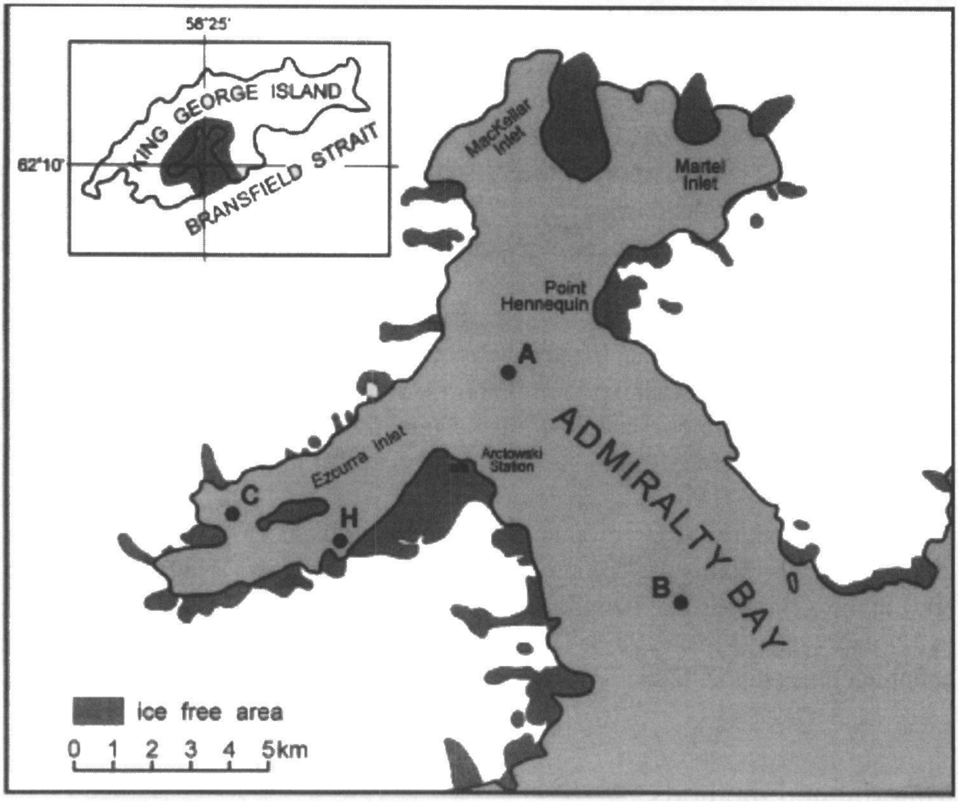

Fig. 1. Admiralty Bay, location of sampling sites: A – central part, B – outlet area, C – Cardozo Cove, H – Herve Cove.

Our assumption was that the sample consisted of water collected from the bottom to the surface area. The aim was not to accomplish a vertical assortment, but rather to capture the entire sampling of zooplankton in four locations with varying hydrological conditions.

Abundances of 67 zooplankton taxa were used to detect clusters of samples. The "Canberra" metric was employed to classify these 54 sampling units. Calculations were carried out using raw, non-transformed data. Object grouping was done by a "flexible sorting" method using the coefficient of grouping efficiency "β" = –0.25.

The "degree of association index" (Salzwedel *et al.* 1985) is used in the text. This expresses the percentage of individuals of a given taxon recorded in each of the four investigated areas within the total number of specimens of that taxon in the overall study area.

The density of taxa was taken into account in the biodiversity analysis. The Shannon index, as well as evenness (Pielou 1966) and Simpson (1949) indices, were used for this purpose. Species richness was estimated by means of the Margalef (1958) index. Mathematical expresions of the above mentioned formulas were the following:

Shannon index: $H' = -\Sigma(n_i/N) \ln(n_i/N)$
evenness: $E = H'/\ln S$
Simpson index: $S_i = 1 - \Sigma(n_i/N)^2$
Margalef index: $MG = (S - 1)/ \ln N$

where: N – total number of individuals, S – number of taxa, n_i – number of individuals of particular taxon.

Results

Sixty seven taxa were recorded in Admiralty Bay. Most of them were identified to the species level (Table 1).

Table 1

Taxa of zooplankton in Admiralty Bay (February 1993 – January 1884).
(% – frequency of the occurrence in particular station, s – average number of individuals per 1000 m^3; D – domination and F – frequency of the whole collected material).

No.	Taxon	Herve Cove		Cardozo Cove		Central part		Outlet area		D	F
		%	s	%	s	%	s	%	s	%	%
1	Foraminifera			14	1.2	14	0.1	23	3.4	0.0*	13.0
2	Siphonophora	7.6	19	50	40	86	56	100	68	0.1	61.1
3	Hydromedusae			28	11	43	7	46	25	0.0	31.5
4	Coelenterata					14	1.5	7	0.8	0.0	5.6
5	Ctenophora					7	0.7			0.0	1.9
6	Nematoda	7.6	19	21	24	64	20	30	3	0.0	24.1
Polychaeta:											
7	*Maupasia coeca* Viguier, 1886					7	0.7	15	1.7	0.0	5.6
8	*Pelagobia longicirrata* Greeff, 1879	15	300	43	90	78	170	92	130	0.2	59.3
9	*Rhynchonereella bongraini* (Gravier, 1911)					7	0.7			0.0	1.9
10	*Tomopteris* spp.			17	7	64	16	61	1	0.0	35.2
11	*Travisiopsis levinseni* Southern, 1910					7	0.7			0.0	1.9
12	*Typhloscolex muelleri* Busch, 1851			14	4	7	1.6	38	6.8	0.0	14.8
13	*Autolytus* sp.			7	2					0.0	1.9
14	Spionidae – larvae					71	50	53	42	0.0	31.5
15	chaetosphaera f.1	7.6	650	36	70	38	30	54	70	0.3	33.3
16	chaetosphaera f.2			14	24	38	16	38	15	0.0	22.2
17	chaetosphaera f.3					7	0.7	30	0.6	0.0	9.3
Pteropoda:											
18	*Limacina helicina* f. *antarctica* Woodward, 1850	4.6	48	14	7	43	8	31	1	0.0	25.9
19	*Limacina helicina* f. *rangi* (d'Orbigny, 1836)							7	1.7	0.0	1.9

20	*Spongiobranchaea australis* d'Orbigny, 1836			7	2	57	1	54	13	0.0	31.5
21	Bivalvia – larvae					21	3.2			0.0	5.6
Ostracoda:											
22	*Alacia belgicae* (Müller, 1906)	38	160	57	120	93	120	92	100	0.2	70.4
23	*Alacia hettacra* (Müller, 1906)	7.6	38	38	140	71	40	53	44	0.0	42.6
24	*Boroecia antipoda* (Müller, 1906)					7	0.7	15	1.7	0.0	5.6
25	*Metaconchoecia isocheira* (Müller, 1906)			36	50	93	100	92	94	0.1	55.6
26	*Metaconchoecia skogsbergi* (Iles, 1953)					21	3.1			0.0	5.6
27	*Procecorecia brachyaskos* (Müller, 1906)							7	0.8	0.0	1.9
Copepoda:											
28	*Calanus propinquus* Brady, 1883	46	260	93	290	100	160	100	130	0.3	85.2
29	*Calanoides acutus* Giesbrecht, 1902	46	300	50	140	100	130	100	90	0.2	74.1
30	*Rhincalanus gigas* Brady, 1883	15	900	64	50	100	90	84	70	0.3	66.7
31	*Ctenocalanus citer* Heron *et* Bowman, 1971	92	10060	78	9710	100	13270	100	18580	17.4	92.6
32	*Microcalanus pygmaeus* G.O.Sars, 1903	46	780	86	8330	100	6430	92	9940	8.4	81.5
33	*Stephos longipes* Giesbrecht, 1902	7.6	20	57	390	28	150	46	1310	0.6	29.6
34	*Euchaeta antarctica* (Giesbrecht, 1902)	7.7	19	62	100	78	100	92	88	0.1	61.1
35	*Scolecithricella glacialis* (Giesbrecht, 1902)	15	58	71	200	100	400	84	620	0.4	68.5
36	*Racovitzanus antarcticus* Giesbrecht, 1902	23	38	28	24	78	20	76	19	0.0	50.0
37	*Scaphocalanus* spp.	23	60	57	1510	64	1030	76	610	1.1	55.6
38	*Heterorhabdus* spp.					57	16	54	15	0.0	27.8
39	*Metridia gerlachei* Giesbrecht, 1902	85	6190	93	10220	100	12470	100	9840	13.4	94.4
40	*Lucicutia* sp.			7	18					0.0	1.9
41	*Oithona frigida* Giesbrecht, 1902	23	210	71	2040	62	1800	92	3680	2.5	63.0
42	*Oithona similis* Claus, 1863	92	26000	93	30990	100	43770	100	62800	41.7	88.9
43	*Oncaea antarctica* Heron, 1977	23	870	78	170	57	1260	61	1050	1.1	44.4
44	*Oncaea curvata* Giesbrecht, 1902	54	2600	71	3390	86	5810	92	9980	7.4	75.9
45	Harpacticoida	85	9070	64	1550	28	30	15	1.6	3.3	48.1
Amphipoda:											
46	*Vibilia antarctica* Stebbing, 1888					21	3.2			0.0	5.6

47	*Cyllopus magellanicus* Dana, 1853					7	0.3	15	1.7	0.0	5.6
48	*Hyperiella dilatata* Stebbing, 1888					28	3	46	7	0.0	16.7
49	*Themisto gaudichaudii* Guerin, 1825					7	0.7	7	0.8	0.0	3.7
50	*Primno macropa* Guerin-Meneville, 1836					7	0.7	15	1.7	0.0	9.3
51	*Hippomedon kergueleni* (Miers, 1875)							7	0.8	0.0	1.9
52	Isopoda			14	4	43	6	31	5.2	0.0	22.2
53	Cumacea			7	2					0.0	5.6
Euphausiacea:											
54	*Euphausia crystallorophias* Holt *et* Tattersall, 1906					7	0.7			0.0	1.9
55	*Euphausia superba* Dana, 1850					14	1.5	7	1.7	0.0	5.6
	E. superba – larvae			28	90	28	22	69	83	0.1	31.5
56	*Thysanoessa macrura* G.O. Sars, 1883					38	6	31	5	0.0	14.8
	T. macrura – larvae					28	130	7	92	0.1	9.3
57	Decapoda – larvae			7	4	7	0.7	7	2.6	0.0	5.6
Chaetognatha:											
58	*Eukrohnia bathypelagica* Alvarino, 1962							23	3.4	0.0	5.6
59	*Eukrohnia fowleri* Ritter–Zahony, 1909			7	3	14	1.5	15	4.4	0.0	9.3
60	*Eukrohnia hamata* Mobius, 1875	54	240	86	310	100	310	100	350	0.3	85.2
61	*Sagitta gazellae* Ritter–Zahony, 1909	38	130	7	2	71	10	38	8	0.0	38.9
62	*Sagitta marri* David, 1956	7.6	21	14	4	50	10	54	9	0.0	31.5
63	Echinodermata – larvae			28	70	37	110	69	68	0.1	38.9
64	Appendiculariae			14	22	38	12	54	43	0.0	25.9
65	Ascidiacea – larvae			36	190	43	60	53	38	0.1	33.3
66	Salpae			7	2	57	36	54	170	0.1	29.6
67	Pisces –larvae					7	0.7	7	0.7	0.0	5.6
Total number of taxa		26		44		60		57			

* 0.0 – less than 0.1

Average zooplankton abundance calculated for the entire depth range on the basis of 54 sampling units (= hauls) amounted to about 85000 ind.1000 m^{-3} (± SD = 71000 ind.1000 m^{-3}). The mean annual zooplankton biomass varied from about 7 g 1000 m^{-3} in Cardozo Cove to about 60 g 1000 m^{-3} in the outlet area.

About 90% of the entire Admiralty Bay zooplankton community is made up of commonly occurring copepods, namely *Oithona similis* making up almost 50% of the collected animals, *Ctenocalanus citer* (about 15% of the collection), *Metridia gerlachei* (about 12%), *Microcalanus pygmaeus* (ca 7.5%) and *Oncaea curvata*

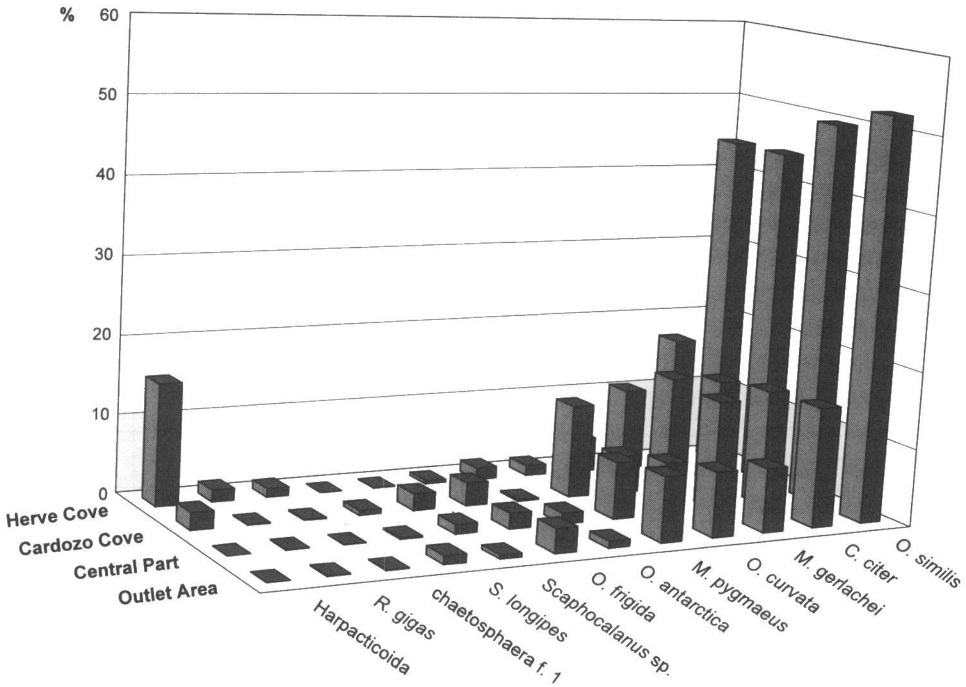

Fig. 2. The density domination (in %) of the most abundant species in the four investigated areas.

(ca 6.5%). *O. similis* was the dominant species in 45 of 54 hauls. The domination value of that species ranged from 25% to 80%, being 50% on average. Less abundant but very common in the Admiralty Bay zooplankton community was *Calanus propinquus, Calanoides acutus*, *Rhincalanus gigas, Scolecithricella glacialis* as well as the chaetognath *Eukrohnia hamata* and the ostracod *Alacia belgicae.* All these species were found in more than 2/3 of collected samples. A detailed analysis of Harpacticoida (not taken into consideration in this paper) will be the subject of another study. The domination structure of the zooplankton community in each of the four sampling sites described here is presented in Tab. 1 and Fig. 2.

Maximal densities of particular species amounted to a dozen or so thousands, but in the case of *Oithona similis* even scores of thousands of individuals in 1000 m^3 of water were noted.

Pelagobia longicirrata was the most abundant among polychaetes. Six other species were less common and their abundances were low.

Six species of Ostracoda were found but only *Alacia belgicae* and *Alacia hettacra* occured at all stations.

Six species of Amphipoda were also noted. They were caught rarely and in very small numbers, mainly in the central part and the outlet area of the bay.

Chaetognatha were represented by five species. *Eukrohnia hamata* was the most common and appeared in significant abundances.

Table 2

The mean density (ind. 1000 m^{-3}) of dominant taxa in four investigated areas of the bay.

Vertical haul (m) / Taxon	Herve Cove 15–0	Cardozo Cove 130–0	Central part 400–0	Outlet part 400–0
Harpacticoida	9070	1550	30	2
Rhincalanus gigas	900	50	90	70
chaetosphaera f.1	650	70	30	70
Stephos longipes	20	390	150	1310
Scaphocalanus sp.	60	1510	1030	610
Oithona frigida	210	2040	1800	3680
Oncaea antarctica	870	170	1260	1050
Microcalanus pygmaeus	780	8330	6430	9940
Oncaea curvata	2600	3390	5810	9980
Metridia gerlachei	6190	10220	12470	9840
Ctenocalanus citer	10060	9710	13270	18580
Oithona similis	26000	30940	43770	62800

Table 3

The mean biomass (wet weight in g 1000 m^{-3}) of higher taxa in four investigated stations of the bay.

Vertical haul (m) / Taxon	Herve Cove 15–0	Cardozo Cove 130–0	Central part 400–0	Outlet area 400–0
Ostracoda	0.13	0.06	0.01	0.10
Amphipoda	0.0	0.03	0.02	0.11
Thysanoessa macrura	0.0	0.0	0.26	0.22
Polychaeta	0.05	0.12	0.26	0.12
Siphonophora	0.04	0.30	0.50	0.25
Other	0.92	0.23	0.72	0.53
Chaetognatha	0.74	0.27	1.19	1.00
Copepoda	17.11	4.74	8.12	7.30
Salpae	0.0	1.50	6.56	48.00
Mean total	18.99	7.25	17.91	57.63
± SD	14.70	7.12	13.23	95.08
Range	3.2–42.8	1.2–28.4	4.2–58.2	3.2–320.7

Three species of Pteropoda were noted, with the *Limacina helicina* f. *antarctica* being the most common.

Adult Euphausiacea, namely *Euphausia crystallorophias, E. superba and Thysanoessa macrura* were sporadically recorded. In the collected material larvae of *T. macrura* and of *E. superba* also occurred.

Siphonophora, Salpae, and larvae of echinoderms were fairly numerous. Other taxa were noted sporadically.

The density and biomass of dominant species or higher taxa in four investigated areas are presented in Tables 2 and 3.

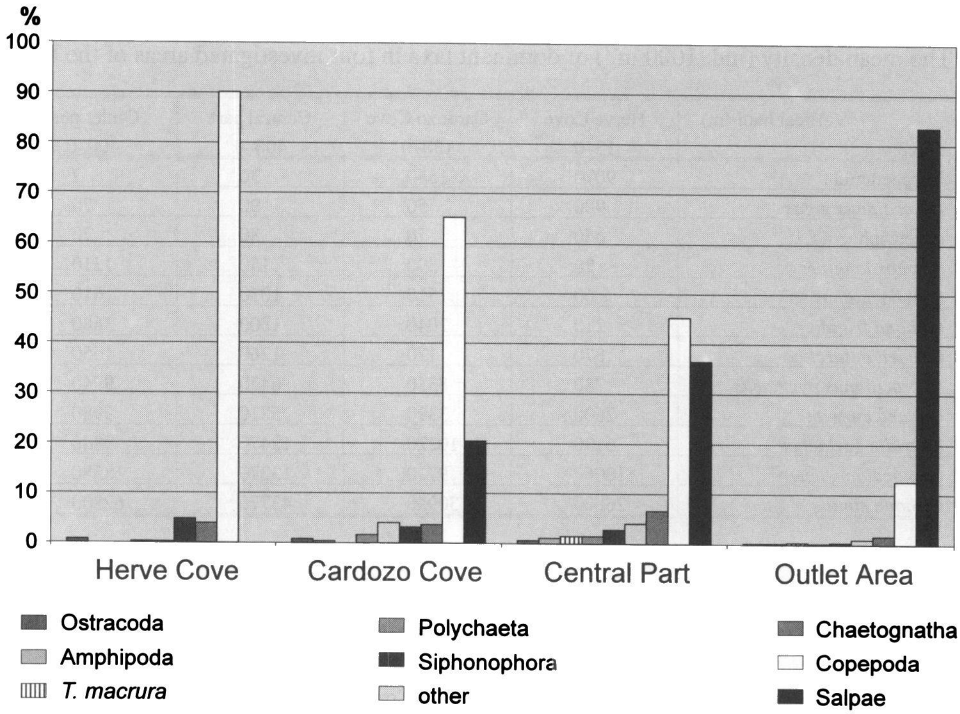

Fig. 3. The biomass domination of higher taxa in four investigated areas.

In Herve Cove only 26 macrozooplankton taxa were noted. The assemblage was dominated by the above-mentioned eurytopic copepods. Harpacticoida were highly abundant there with a domination value of about 16% (Fig. 2). Together with *Oithona similis, Ctenocalanus citer*, and *Metridia gerlachei* they constituted a constant element of the assemblage. In Herve Cove copepods made up over 90% of zooplankton biomass (Fig. 3). Harpacticoida, *Rhincalanus gigas*, chaetosphaera f.1, and *Sagitta gazellae* were, on the other hand, very characteristic components taking into account the degree of association within the disscussed area (Fig. 4). Most of the collected individuals of these last-mentioned taxa came from Herve Cove.

In Cardozo Cove 44 zooplankton taxa were recorded. The assemblage was dominated by the same common, above-mentioned copepods. No characteristic species, being at the same time numerous and frequent, were found there. It should be mentioned however, that just in Cardozo Cove a rather high number of ascidian larvae were found (Fig. 4). A distinctly higher domination of salps, in comparison with Herve Cove, was observed here.

A very rich zooplankton assemblage composed of 60 taxa was found in the central part of Admiralty Bay. A group of dominant species was similar to that found in Cardozo Cove. No characteristic taxa with high values of association in-

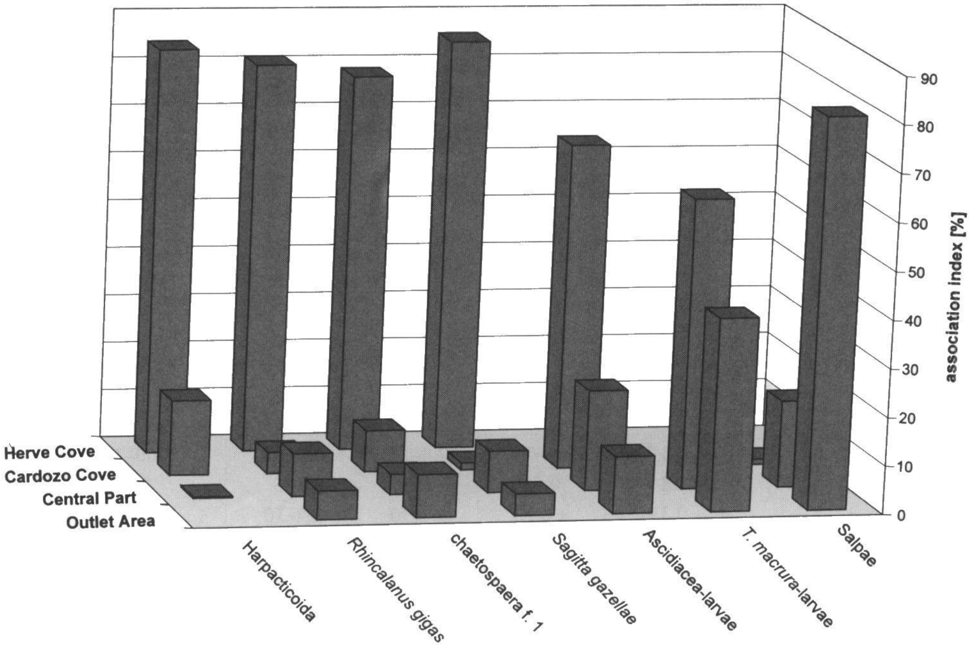

Fig. 4. Index of assiociation for some characteristic taxa in particular areas of research.

dex were encountered among numerous and frequent species. In terms of biomass, the domination of copepods and salps were more or less equal there (Fig. 3).

In the outlet area of the bay 57 zooplankton taxa were found. The composition of dominants noted here was very similar to that found in the central basin of the bay. It should be noted however that over 80% of salps collected in the whole area were caught in the outlet area (Fig. 4). In terms of biomass the domination value of salps also exceeded 80% there (Fig. 3).

A comparison of the four investigated stations can be described as follows:

(1) No differences in biodiversity between these stations were observed when taking into account Shannon and Simpson measures as well as evenness calculated on the basis of the Shannon index (Tab. 4).

(2) The results of cluster analysis (the grouping of 54 sampling units = hauls on the background of density of 67 zooplankton taxa) indicate some dissimilarities of Ezcurra Inlet (Herve Cove and Cardozo Cove) in comparison with the main basin (central part and outlet area) of the bay (Fig. 5). Distinct differences in both such defined areas refer to the species richness expressed by the species number and its derivative – Margalef index (Fig. 4).

(3) The composition of the group of dominant species is similar in all four investigated areas. However, in the Herve Cove the low abundance (and also the domination) of such common and numerous species as *Microcalanus pygmaeus* or *Oithona*

Table 4

Zooplankton species richness, diversity, evenness and density (range, mean and standard deviation) in four investigated sites of Admiralty Bay (S – number of taxa, n – number of sampling units = hauls, H' – Shannon diversity index, E – evenness)

S	[n]	Margalef	Simpson	H'	E	Density ind.1000 m^{-3}
26	Herve Cove [13]	0.57–1.34 **0.96** ± 0.27	0.45–0.79 **0.61** ± 0.12	0.91–1.75 **1.30** ± 0.28	0.40–0.97 **0.63** ± 0.14	1300–251600 **59000** ± 73500
47	Cardozo Cove [14]	0.74–2.78 **1.94** ± 0.56	0.35–0.81 **0.63** ± 0.15	0.81–1.90 **1.35** ± 0.33	0.32–0.96 **0.52** ± 0.18	150–165800 **70100** ± 62800
60	Central part [14]	2.58–4.11 **3.33** ± 0.47	0.48–0.85 **0.66** ± 0.12	1.03–2.27 **1.54** ± 0.36	0.30–0.74 **0.46** ± 0.12	4700–210500 **88300** ± 66800
57	Outlet area [13]	2.61–3.79 **3.21** ± 0.33	0.36–0.80 **0.65** ± 0.12	0.88–1.99 **1.50** ± 0.30	0.26–0.67 **0.45** ± 0.10	3700–232600 **120300** ± 71900
67	Admiralty Bay total [54]	0.57–4.11 **2.37** ± 1.06	0.35–0.85 **0.64** ± 0.13	0.81–2.27 **1.43** ± 0.33	0.26–0.97 **0.51** ± 0.15	150–251600 **8430** ± 70600

frigida (Fig. 2, Table 2) is worth emphasizing. Furthermore, Herve Cove is characterized by the significant domination value of Harpacticoida and *Rhincalanus gigas*. Chaetosphaera f.1 and *Sagitta gazellae* occurred in the relatively high abundance here. The presence of these four taxa is the reason why the zooplankton assemblage of Herve Cove is more or less specific. In the Cardozo Cove larvae of Ascidiacea were a characteristic component, whereas in the central part as well as in the outlet area characteristic elements were larvae of *Thysanoessa macrura* and salps (Fig. 4). Salpae were collected in high quantities particularly in the outlet area.

Some tendencies in the distribution of density and biomass in the investigated area are presented in Figs. 2 and 3. It is worth noting the abundance increase of some dominant species towards the outlet of the bay, namely: *Oithona similis, Ctenocalanus citer* or *Oncaea curvata.*

Euphausiacea show another noteworthy pattern of distribution. They were totally absent in the Herve Cove. Larvae of *Euphausia superba* were encountered in three remaining stations, whereas *Thysanoessa macrura* both larvae and adults were absent in Herve Cove and Cardozo Cove. A similar pattern of distribution is shown also by some other taxa, as for example larvae of Spionidae or salps. The distribution of Ascidiacea larvae also seems to be characteristic. They were completely absent in the Herve Cove and relatively low densities were noted in the central part and in the outlet area of the bay. On the contrary, high abundance values of Ascidiacea larvae were noted in the Cardozo Cove (Figs. 2–4). A very low number of fish larvae and decapod crustaceans larvae were recorded during the sampling period.

Larvae of some benthic and pelagic invertebrates appeared seasonally in zooplankton. In autumn and in winter larvae of polychaetes: chaetosphaera f.1, and spionid larvae were numerous. Polychaete larvae chaetosphaera f.3 and larvae of ascidians were collected only in this period. On the contrary, in spring and summer high densities of *T. macrura* larvae were observed in the central basin of Admiralty Bay. Larvae of *E. superba* were recorded from October to January, similarly as larvae chaetosphaera f.2. Larvae of Echinodermata were collected mostly in autumn but also in spring. Furthermore the overall picture of the zooplankton community in Admiralty Bay (the taxonomic composition, structure of domination, and density) does not show any particular seasonal changes. No seasonal clusters were detected in the dendrogram (Fig. 5).

Salps and copepods formed the essential part, 80–95%, of the zooplankton biomass in Admiralty Bay. The highest biomass values were observed in the outlet area. Salps constituted there about 83% of the whole zooplankton biomass and their share in the zooplankton assemblage clearly decreased towards the interior of the bay. On the contrary, the share of copepods in the Admiralty Bay zooplankton biomass decreases in the other direction, towards the outlet area (Fig. 3). Chaetognatha and Siphonophora, apart from the two above-mentioned taxa, were a significant component of zooplankton assemblage in term of biomass domination.

Discussion

Our results are in accordance with the year-round observations by Menshenina and Rakusa-Suszczewski (1992). These authors also observed the dominance of *Oithona* and *Oncaea* in their materials. Similar dominance in abundance was also noted by Chojnacki and Węgleńska (1984) and Freire *et al.* (1993), whose studies were carried out only in the summer season.

The significant share of Harpacticoida in the shallow parts of Admiralty Bay (Herve Cove and Cardozo Cove) in our study is consistent with the observations by Freire *et al.* (1993).

The second abundant group in zooplankton were Polychaeta, with *Pelagobia longicirrata* as the dominant polychaete. This is a species of cosmopolitic distribution, occurring both in tropical zones in deep sea and emerging in the shallow water in the Antarctic (Hartman 1964), occurring there at the depths from 50 to 300 m (Orensanz *et al.* 1974, Jażdżewski *et al.* 1982, Lana and Blankensteyn 1987).

Among Ostracoda 6 species were noted; only *Alacia belgicae* and *A. hettacra* occurred in all stations; their frequency and abundance increased towards the outlet of the Bay. These two species are recognized as epi-mesopelagic, which is why they occur commonly and abundantly in Admiralty Bay. Remaining ostracods are meso- and bathypelagic species, which occurred only in the central and outlet areas of Admiralty Bay. All Ostracoda mentioned here were found also in the Bransfield

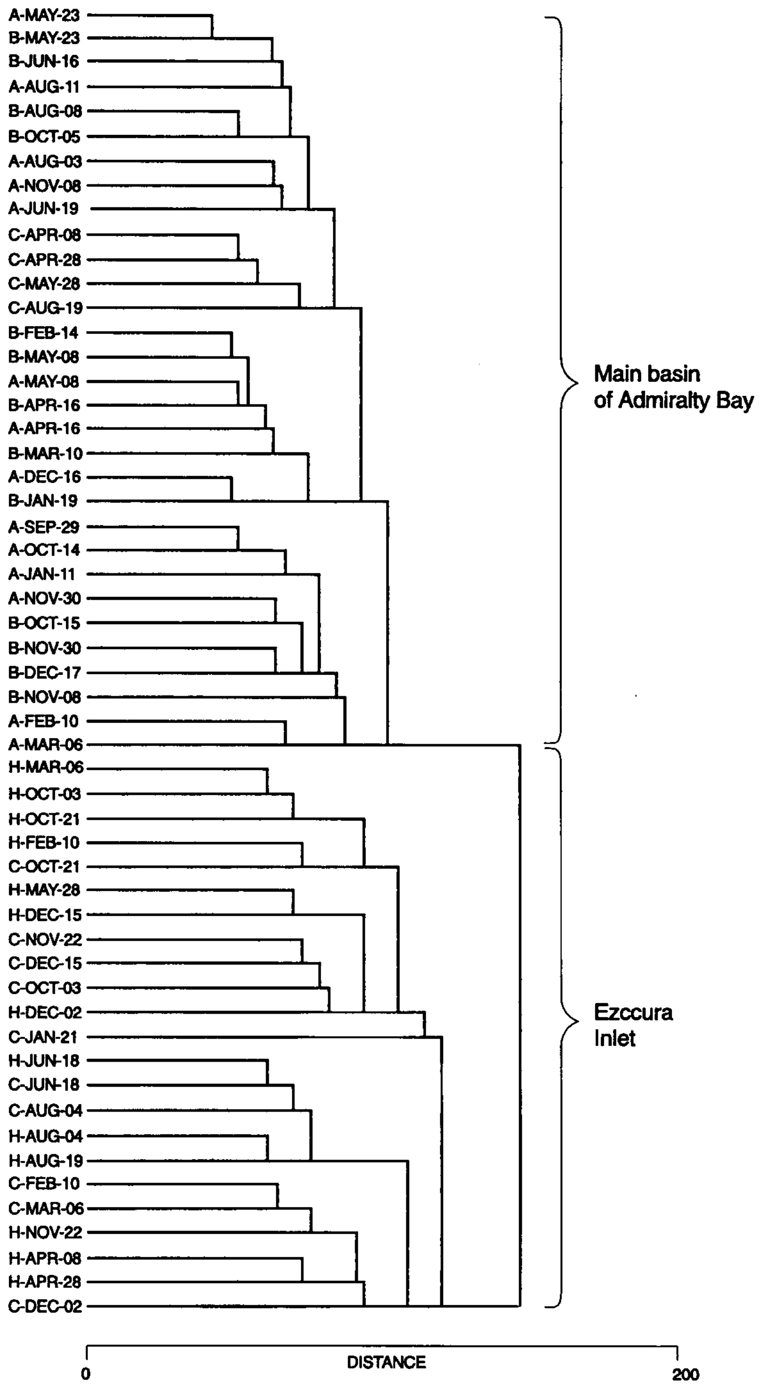

Fig. 5. Dendrogram of 54 hauls (= samples) derived from densities of 67 zooplankton taxa (capital letters denote particular areas: A – central part of the bay, B – outlet area, C – Cardozo Cove, and H – Herve Cove; data of the sampling is also presented).

Strait (Hopkins 1985, Kock 1992, Błachowiak-Samołyk and Żmijewska 1995, Błachowiak-Samołyk 1999).

Among Amphipoda 6 hyperiid species were noted. They occurred only in the central and outlet parts of Admiralty Bay. Their frequency, except for *Hyperiella dilatata*, did not surpass 17% and the density was never higher than several specimens per 1000 m^3. Jażdżewski (1981) and Jażdżewski *et al.* (1991) noted 3 species of Hyperiidae (*Cyllopus lucasii, Hyperia macrocephala,* and *Themisto gaudichaudii*) from Admiralty Bay (2 last-mentioned from penguin stomachs only), whereas Menshenina and Rakusa-Suszczewski (*unpubl.*) recorded *Cyllopus* sp., *Themisto gaudichaudii*, and *Primno macropa* in Admiralty Bay. All these hyperiids belong to typically pelagic species of the open ocean (Jażdżewski and Presler 1988, Siegel and Piatkowski 1990), and in Admiralty Bay appear only sporadically. Three other pelagic amphipods (*Eusirus propeperdentatus, E. microps,* and *Cyphocaris richardi*) were recognized by Jażdżewski (1981) and Jażdżewski *et al.* (1991) in the stomachs of penguins nesting on the Admiralty Bay shores.

Chaetognatha were represented by 5 species. *Eukrohnia hamata, Sagitta gazellae* and *S. marri* were the most frequent. According to Bielecka and Żmijewska (1993), in Drake Passage and in the Bransfield Strait *E. hamata* can constitute up to 90% of all chaetognaths. All Chaetognatha recorded are Antarctic, circumpolar species, many times noted around the Antarctic Peninsula (David 1958, Jażdżewski *et al.* 1982, Alvarino *et al.* 1983, Hopkins 1985, Dinofrio 1987, Bielecka and Żmijewska 1993).

Euphausiacea were represented by 3 species: *Euhausia superba, E. crystallorophias* and *Thysanoessa macrura*, many times recorded from Admiralty Bay (Kittel 1980, Rakusa-Suszczewski and Stępnik 1980, Stępnik 1982, Freire *et al.* 1993).

The average abundance of Salpae, encountered mainly in the central and outlet areas of Admiralty Bay, was similar to the average abundances noted earlier in the West Antarctic waters (Witek *et al.* 1985, Piątkowski 1987, Siciński *et al.* 1991). In earlier studies of Admiralty Bay zooplankton (Reinke 1987, Freire *et al.* 1993, as well as Menshenina and Rakusa-Suszczewski, *unpubl.*) three species of salpae were recorded; the most abundant were *Ihlea racovitzai* and *Salpa thompsoni*.

Fish larvae were noted only sporadically in our materials. However, Skóra (1993) recorded the occurrence of larvae of 20 fish species in Admiralty Bay waters.

The observed regularity in the distribution of zooplankton must be viewed against the hydrological system of Admiralty Bay. Tides, wind, and configuration of the bottom all influence water dynamics. Many authors have stressed that there exists a high intensity of mixing (Tokarczyk 1987, Lipski 1987) and exchange of Admiralty Bay waters with the waters of Bransfield Strait (Szafrański and Lipski 1982). However, the upwelling in the eastern part of Ezcurra Inlet (Rakusa-Suszczewski 1980) isolates the inner part of the inlet from the waters of the central basin of the bay. This may explain the dissimilarity in the zooplankton community from the inner part of Ezcurra Inlet (site "C"), particularly its relatively low species richness.

Menshenina and Rakusa-Suszczewski (1992) noted seasonal changes in abundance of the dominating zooplankton species. The peak of population density usually occurred in the autumn months in some species (*Oncaea conifera*, *Oithona frigida*, *Calanoides acutus*, *Calanus propinquus*, *Rhincalanus gigas* and *Pelagobia longicirrata*), and in the spring months for others (*Microcalanus pygmaeus*, *Oncaea curvata* and *Ihlea racovitzai*); only in case of *Oithona similis* did these authors observe two peaks: in spring and in autumn. Such regularities were not observed during the present research, except for the similar dynamics in the density of the Ascidiacea larvae; peaks of their abundance fell in both cases in the spring (March, April). Besides this, the research of Menshenina and Rakusa-Suszczewski (1992) shows that the maxima of the larvae of invertebrates population density occurs in March–April and in November–December.

In Foxton's (1956) fundamental paper on Antarctic zooplankton a yearly average biomass of Southern Ocean zooplankton was calculated as 47 g per 1000^3. In the outlet area of Admiralty Bay this yearly average biomass was 58 g per 1000 m^3, *i.e.* a similar value.

A summary of the actual state of knowledge on the composition of zooplankton of Admiralty Bay is presented in Tab. 5. Altogether 174 planktonic taxa were recorded, most of them identified to the species level. The majority of species are circum-Antarctic taxa, many times noted in the Bransfield Strait and in the Drake Passage (Jażdżewski *et al.* 1982, Hopkins 1985, Piatkowski 1985, Witek *et al.* 1985, Żmijewska 1987, Siegel and Piatkowski 1990).

Table 5

List of zooplankton taxa hitherto recorded in Admiralty Bay [A – Kittel (1980), Kittel and Presler (1980); B – Rakusa-Suszczewski and Stępnik (1980), Stępnik (1982); C – Jażdżewski 1981, Jażdżewski *et al.* 1982, 1991; D – Chojnacki and Węgleńska (1984); E – Wasik and Mikołajczyk (1990); F – Menshenina and Rakusa-Suszczewski (1992); G – Freire *et al.* (1993); H – Skóra (1993); I – Żmijewska (1993); J – Siciński *et al.* (1996); K – Menshenina, Rakusa-Suszczewski (*unpubl.*); L – Żmijewska (*unpubl.*); M – present study].

No.	Taxa	A	B	C	D	E	F	G	H	I	J	K	L	M
Protozoa														
1	*Cyttarocylis conica* Brandt, 1906					+								
2	*Cymatocylis convallaria* Laackmann, 1909					+								
3	*Cymatocylis cylindrus* (Laackmann, 1909)					+								
4	*Cymatocylis drygalski* (Laackmann, 1909)					+								
5	*Cymatocylis ecaudata* (Laackmann, 1909)					+								
6	*Cymatocylis folliculis* (Laackmann, 1909)					+								
7	*Cymatocylis ovata* Laackmann, 1909					+								
8	*Cymatocylis typica* Laackmann, 1909					+								
9	*Cymatocylis vanheoffeni* (Laackmann, 1907)					+								
10	*Codonellopsis balechi* (Hada, 1970)					+								
11	*Codonellopsis glacialis* (Laackmann, 1907)					+								
12	*Codonellopsis gaussi* (Laackmann, 1907)					+								

Table 5 – continued.

No.	Taxa	A	B	C	D	E	F	G	H	I	J	K	L	M
13	*Laackmanniella naviculaefera* (Laackmann, 1907)					+								
14	*Laackmanniella prolongata* (Laackmann, 1907)					+								
15	*Tintinnopsis lata* Meunier, 1910					+								
16	*Tintinnopsis major* Meunier, 1910					+								
17	Foraminifera													+
18	Radiolaria				+									
Siphonophora														
19	*Diphyes antarctica* Moser, 1925											+		
20	*Dimophyes arctica* (Chun, 1897)											+		
21	*Pyrostephos vanhoeffeni* Moser, 1925											+		
22	*Eudoxia* sp.											+		
Hydrozoa														
23	*Amphinema rubra* Kramp, 1957											+		
24	*Arctapodema ampla* Vanhoffen, 1912											+		
25	*Obelia* spp.											+		
26	*Rhopalonema* sp.											+		
27	Pontellidae											+		
28	Hydrozoa non det.													+
29	Ctenophora													+
30	Nematoda													+
Polychaeta														
31	*Maupasia coeca* Viguier, 1886											+		+
32	*Pelagobia longicirrata* Greeff, 1879			+			+				+	+		+
33	*Rhynchonereella bongraini* (Gravier, 1911)						+					+		+
34	*Tomopteris* spp.											+		+
35	*Travisiopsis levinseni* Southern, 1910											+		+
36	*Typhloscolex muelleri* Busch, 1851											+		+
37	*Autolytus* sp.													+
38	Spionidae gen.sp. – larvae						+							+
39	Aphroditidae gen.sp. – larvae						+							
40	chaetosphaera f.1											+		+
41	chaetosphaera f.2													+
42	chaetosphaera f.3													+
Pteropoda														
43	*Limacina helicina* f. *antarctica* Woodward, 1850										+	+		+
44	*Limacina helicina* f. *rangi* (d'Orbigny, 1836)													+
45	*Spongiobranchaea australis* d'Orbigny, 1836													+
46	Bivalvia													+
Ostracoda														
47	*Alacia belgicae* (Müller, 1906)										+			+
48	*Alacia hettacra* (Müller, 1906)										+			+
49	*Boroecia antipoda* (Müller, 1906)													+
50	*Metaconchoecia isocheira* (Müller, 1906)													+
51	*Metaconchoecia skogsbergi* (Iles, 1953)													+
52	*Procecorecia brachyaskos* (Müller, 1906)													+
53	Cirripedia – larvae						+							
Copepoda														
54	*Calanus propinquus* Brady, 1883			+	+		+			+	+	+	+	+
55	*Calanus simillimus* Giesbrecht, 1902						+			+		+	+	
56	*Calanoides acutus* Giesbrecht, 1902			+	+		+	+	+		+	+		+

Table 5 – continued.

No.	Taxa	A	B	C	D	E	F	G	H	I	J	K	L	M
57	*Eucalanus longiceps* Matthews, 1925												+	
58	*Rhincalanus gigas* Brady, 1883				+		+	+			+	+		+
59	*Clausocalanus laticeps* Farron, 1902												+	
60	*Ctenocalanus citer* Heron et Bowman, 1971							+			+			+
61	*Ctenocalanus vanus* Giesbrecht, 1888												+	
62	*Ctenocalanus* spp.						+			+		+		
63	*Drepanopus pectinatus* Brady, 1883													
64	*Microcalanus pygmaeus* G.O. Sars, 1903						+			+	+	+	+	+
65	*Spinocalanus abyssalis* Giesbrecht, 1888									+		+		
66	*Spinocalanus magnus* Giesbrecht, 1902											+		
67	*Aetideopsis antarctica* (Wolfenden, 1908)									+			+	
68	*Aetideopsis minor* (Wolfenden, 1911)													
69	*Chiridius polaris* Wolfenden, 1911												+	
70	*Euchirella rostromagna* Wolfenden, 1911									+		+		
71	*Gaidius tenuispinus* (Sars, 1900)									+		+	+	
72	*Gaidius intermedius* Wolfenden, 1905												+	
73	*Euchaeta antarctica* (Giesbrecht, 1902)									+	+	+	+	+
74	*Euchaeta austrina* Giesbrecht, 1902									+				
75	*Euchaeta rasa* (Giesbrecht, 1902)													
76	*Euchaeta similis* Wolfenden, 1908									+				
77	*Paraeuchaeta* sp.			+										
78	*Scolecithricella glacialis* (Giesbrecht, 1902)									+	+	+	+	+
79	*Scolecithricella dentata* (Giesbrecht, 1892)													
80	*Racovitzanus antarcticus* Giesbrecht, 1902									+	+	+		+
81	*Scaphocalanus brevicornis* (Sars, 1900)											+		
82	*Scaphocalanus subbrevicornis* (Wolfenden, 1911)									+		+		
83	*Scaphlocalanus* spp.										+			+
84	*Stephos longipes* Giesbrecht, 1902									+	+	+		+
85	*Metridia curcicaudata* Giesbrecht, 1889									+		+		
86	*Metridia gerlachei* Giesbrecht, 1902			+			+	+	+		+	+		+
87	*Metridia longa* Giesbrecht, 1892													
88	*Metridia lucens* Boeck, 1893									+		+	+	
89	*Pleuromamma robusta* f. *antarctica* Steuter, 1931									+		+		
90	*Lucicutia ovalis* Giesbrecht, 1889											+		
91	*Lucicutia* spp.											+		+
92	*Heterorhabdus austrinus* Giesbrecht, 1902											+		
93	*Heterorhabdus farrani* Brady, 1818											+		
94	*Heterorhabdus pustulifer* Farran, 1929											+		
95	*Heterorhabdus* spp.												+	+
96	*Haloptilus ocellatus* Wolfenden, 1905									+		+		
97	*Haloptilus oxycephalus* (Giesbrecht, 1889)									+		+		
98	*Candacia maxima* Vervoort, 1957											+		
99	*Candacia* spp.									+				
100	*Oithona frigida* Giesbrecht, 1902							+	+		+	+		+
101	*Oithona similis* Claus, 1863						+	+	+		+	+		+
102	*Oncaea antarctica* Heron, 1977							+			+			+
103	*Oncaea conifera* Giesbrecht, 1861			+						+		+		
104	*Oncaea curvata* Giesbrecht, 1902			+			+			+	+	+	+	+
105	*Oncaea notopus* Giesbrecht, 1891						+					+		
106	*Sapphirinia* sp.													+

Table 5 – continued.

No.	Taxa	A	B	C	D	E	F	G	H	I	J	K	L	M
107	*Harpacticus flexus* Brady et Robertson, 1873							+						+
108	*Harpacticus furcifer* Giesbrecht, 1902							+						+
109	*Harpacticus littoralis* Sars, 1910							+						+
110	*Tisbe elegantula* (Stebbing, 1910)							+						
111	*Tisbe racovitzai* (Giesbrecht, 1907)									+			+	
112	*Scutellidium longicauda* (Philippi, 1840)							+						
113	*Altheutha signata* Baird, 1845							+						
Amphipoda														
114	*Eusirus propeperdentatus* Andres, 1979			*										
115	*Eusirus microps* Walker, 1906			*										
116	*Cyphocaris richardi* Chevreux, 1905			*										
117	*Vibilia antarctica* Stebbing, 1888													+
118	*Cyllopus lucasii* Bate, 1863			*										
119	*Cyllopus magellanicus* Dana, 1853													+
120	*Cyllopus* spp.											+		
121	*Hyperiella dilatata* Stebbing, 1888													+
122	*Hyperia macrocephala* (Dana, 1853)			*										
123	*Hyperia* spp.											+		
124	*Themisto gaudichaudii* Guerin, 1825			*+								+		+
125	*Primno macropa* Guerin-Meneville, 1836											+		+
126	*Hippomedon kergueleni* (Miers, 1875)													+
127	Gammaridea non det.											+		
128	Isopoda													+
129	Cumacea													+
Euphausiacea														
130	*Euphausia crystallorophias* Holt et Tattersall, 1906	+	+										+	
131	*Euphausia frigida* Hansen, 1911		+				+					+		
	E. frigida – larvae						+	+				+		
132	*Euphausia superba* Dana, 1850	+	+	+								+		+
	E. superba – larvae			+				+				+		+
133	*Euphausia triacantha* Holt et Tattersall, 1906		+				+					+		
134	*Thysanoessa macrura* G.O. Sars, 1883	+	+									+		+
	T. macrura – larvae			+				+				+		+
135	*Thysanoessa vicina* Hansen, 1911											+		
136	Decapoda – larvae													+
Chaetognatha														
137	*Eukrohnia bathyantarctica* David, 1958											+		
138	*Eukrohnia bathypelagica* Alvarino, 1962											+		+
139	*Eukrohnia fowleri* Ritter-Zahony, 1909													+
140	*Eukrohnia hamata* Mobius, 1875			+							+	+		+
141	*Sagitta gazellae* Ritter-Zahony, 1909										+	+		+
142	*Sagitta hexaptera* d'Orbigny, 1843											+		
143	*Sagitta macrocephala* Fowler, 1905											+		
144	*Sagitta marri* David, 1956										+	+		+
145	*Sagitta maxima* Conant, 1896											+		
146	Tentaculata – larvae											+		
147	Echinodermata – larvae						+							+
148	Ascidiacea – larvae						+				+	+		+
Appendiculariae														
149	*Fritillaria borealis* Lohman, 1896							+						+

Table 5 – continued.

No.	Taxa	A	B	C	D	E	F	G	H	I	J	K	L	M
150	*Oikopleura gaussica* Lohmann, 1905							+						+
151	*Oikopleura* spp.							+						+
Salpae														
152	*Ihlea racovitzai* (van Beneden, 1913)						+	+				+		+
153	*Salpa gerlachei* Foxton, 1961							+				+		+
154	*Salpa thompsoni* Foxton, 1961						+	+				+		+
Pisces – larvae														
155	*Notothenia neglecta* Nybelin, 1951								+					
156	*Notothenia rossii* Richardson, 1844								+					
157	*Nototheniops nybelini* (Balushkin, 1976)								+					
158	*Lepidonotothen kempi* Norman, 1937								+					
159	*Lindbergichthys nudifrons* (Lonnberg, 1905)								+					
160	*Trematomus newnesi* Boulenger, 1902								+					
161	*Pagothenia hansoni* (Boulenger, 1902)								+					
162	*Pleuragramma antarcticum* Boulenger, 1902								+					
163	*Harpagifer antarcticus* Nybelin, 1947								+					
164	*Artedidraco* sp. (*skottsbergi* ?)								+					
165	*Parachaenichthys charcoti* (Vaillant, 1906)								+					
166	*Gymnodraco acuticeps* Boulenger, 1902								+					
167	*Psilodraco* sp. (*breviceps* ?)								+					
168	*Champsocephalus gunnari* Lonnberg, 1905								+					
169	*Chaenocephalus aceratus* Lonnberg, 1906								+					
170	*Cryodraco antarcticus* Dollo, 1900								+					
171	*Chinodraco rastrospinosus* DeWitt et Hureau, 1979								+					
172	*Neopagetopsis ionah* Nybelin, 1947								+					
173	*Pagetopsis* sp. (*macropterus* ?)								+					
174	*Protomyctophum* spp.								+					

* Pelagic species found in the stomachs of pygoscelid penguins.

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Streszczenie

W pracy przedstawiono wyniki obserwacji zooplanktonu Zatoki Admiralicji badanego w cyklu rocznym. Materiały zbierano w czterech stanowiskach różniących się reżimem hydrologicznym (Rys. 1). Ogółem stwierdzono 67 taksonów zwierząt zooplanktonowych (Tab. 1). Najliczniej i najczęściej reprezentowane były Copepoda, a wśród nich gatunek *Oithona similis* (Rys. 2, Tab. 2). Stosunkowo licznie i często spotykane były Polychaeta, Ostracoda, Chaetognatha i Amphipoda. Euphausiacea i Salpae występowały głównie w centralnej i ujściowej części Zatoki (Rys. 3). Liczba taksonów oraz ich gęstość generalnie zwiększała się w kierunku ujścia Zatoki do Cieśniny Bransfielda. W zasadzie nie zauważono wyraźnych, sezonowych zmian w ogólnym obrazie zooplanktonu. Stwierdzono natomiast sezonowe pojawy larw Polychaeta, Crustacea i Ascidiacea. Średnia biomasa zooplanktonu wahała się od ok. 7 do ok. 58 g 1000 m^{-3} (Tab. 3). Na podstawie otrzymanych wyników oraz danych literaturowych opracowano skład gatunkowy zooplanktonu Zatoki Admiralicji, w którym reprezentowane są 174 taksony (Tab. 5).