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Maria WŁODARSKA-KOWALCZUK[1], Maria SZYMELFENIG[2] and Lech KOTWICKI[3]

[1] Institute of Oceanology PAS
Powstańców Warszawy 55
81-712 Sopot, POLAND
e-mail: maria@iopan.gda.pl

[2] Institute of Oceanography, University of Gdańsk
Piłsudskiego 46
81-378 Gdynia, POLAND
e-mail: ocenas@univ.gda.pl

[3] Institute of Ecology PAS
Dziekanów Leśny,
05-092 Łomianki, POLAND
e-mail: lechk@iopan.gda.pl

Macro- and meiobenthic fauna of the Yoldiabukta glacial bay (Isfjorden, Spitsbergen)

ABSTRACT: Macrofauna and meiobenthic fauna were studied in Yoldiabukta, a glacial bay off west Spitsbergen. Macrofauna was sampled in the sublittoral (10–95 m), while meiofauna was sampled both in the sublittoral and littoral. The total abundance and biomass of meiobenthos were low in the littoral and its taxonomic composition was very diverse and did not show any regular pattern. Macrofauna was absent in this zone. In the sublittoral (10–95 m) both macrofauna and meiofauna were abundant. Nematoda and Harpacticoida dominated the meiofauna. The macrofauna formed a community dominated by *Yoldiella fraterna* and its diversity was lowest in the forefields of the glacier.

Key words: Arctica, Spitsbergen, macrofauna, meiofauna, biodiversity.

Introduction

The benthic fauna of Svalbard has been the subject of intensive research since the beginning of this century, which has resulted in a number of taxonomic and qualitative studies of this region's fauna (Knipovitsch 1901, Birula 1906, Hofsten 1915). The results of quantitative macrobenthic studies conducted at several Svalbard sites have been presented over the last few decades (Gulliksen *et al.* 1984, Węsławski *et al.* 1990b, Kendall 1994, Holte *et al.* 1996). Most of these studies have focused on macrozoobenthos. Studies of the Svalbard meiofauna have been much less extensive and limited to the littoral zone (Radziejewska and Stańkowska-Radziun 1979, 1985, Szymelfenig *et al.* 1995, Węsławski *et al.* 1997). The results of taxonomical studies on Nematoda were published by Gerlach (1965 a, b) and on Harpacticoida by Mielke (1974).

Special attention has been paid recently to glacial bays as a specific habitat for benthic fauna. Tidal glaciers play an important role in structuring the faunal communities in Arctic and Sub-arctic regions as they influence the hydrological regimes, sedimentation processes and the primary production of the neighbouring basins, while providing new grounds open to faunal colonisation and succession after glacial retreat. In west Spitsbergen glacier-influenced bays comprise 30% of the total area of the fjords. Glaciers are responsible for 70% of the fresh water input to fjordic waters (Węsławski *et al.* 1995). The Spitsbergen glacial bay macrofauna has been studied by Gromisz (1983), Gulliksen *et al.* (1984), Görlich *et al.* (1987), Holte *et al.* (1996), Włodarska *et al.* (1996), Włodarska-Kowalczuk *et al.* (1998). Yet none of these works has included meiofauna observations.

The present study aims to describe the benthic fauna of Yoldiabukta, one of several glacial bays of Isfjord, the largest fjord on the western coast of Spitsbergen. The study concentrates on both the macrofaunal and meiofaunal fractions of zoobenthos.

Material and methods

The field study was carried out in August 1993 from aboard the r/v *Oceania*. Two replicate macrofauna samples were taken at 7 stations (Fig.1) using a van Veen grab (of a 0.09 m^2 sampling area). The samples were sieved on a 0.5 mm mesh and preserved in a 4% formaldehyde solution. Macrobenthic organisms were identified and counted. Taxa were classified according to their trophic ecology into suspension feeders, deposit feeders, and carnivores. Classification and ordination was applied to species/abundance data. Bray-Curtis (Bray and Curtis 1957) similarities were calculated from double-root transformed data. The group-average method of linkage was used in producing the dendrogram. Multi-Dimensional Scaling was used in the ordination of samples (Kruskal and Wish 1978). Several diversity measures were used: the number of species per station, the Shannon-Wiener diversity index (log e, Shannon and Weaver 1963), the Hurlbert rarefaction index and k-dominance plots. The Hurlbert rarefaction formula (Hurlbert 1971) was used to calculate ES/100 and ES/200 values.

The meiofauna was sampled at 7 sublittoral and 18 littoral stations (Fig. 1). In the littoral zone the meiofauna was sampled with a steel tube 2.25 cm in diameter inserted 5 cm into the sediment. The same procedure was applied to sublittoral sediment samples taken using the van Veen grab. The meiofauna was processed according to the procedure developed by Elmgren and Radziejewska (1989). Volumetric method conversion factors were used to determine the dry weight of meiofauna (Feller and Warwick 1988). The abundance was expressed as the number of individuals and the biomass in mg dry weight per 10 cm^2 of the bottom surface.

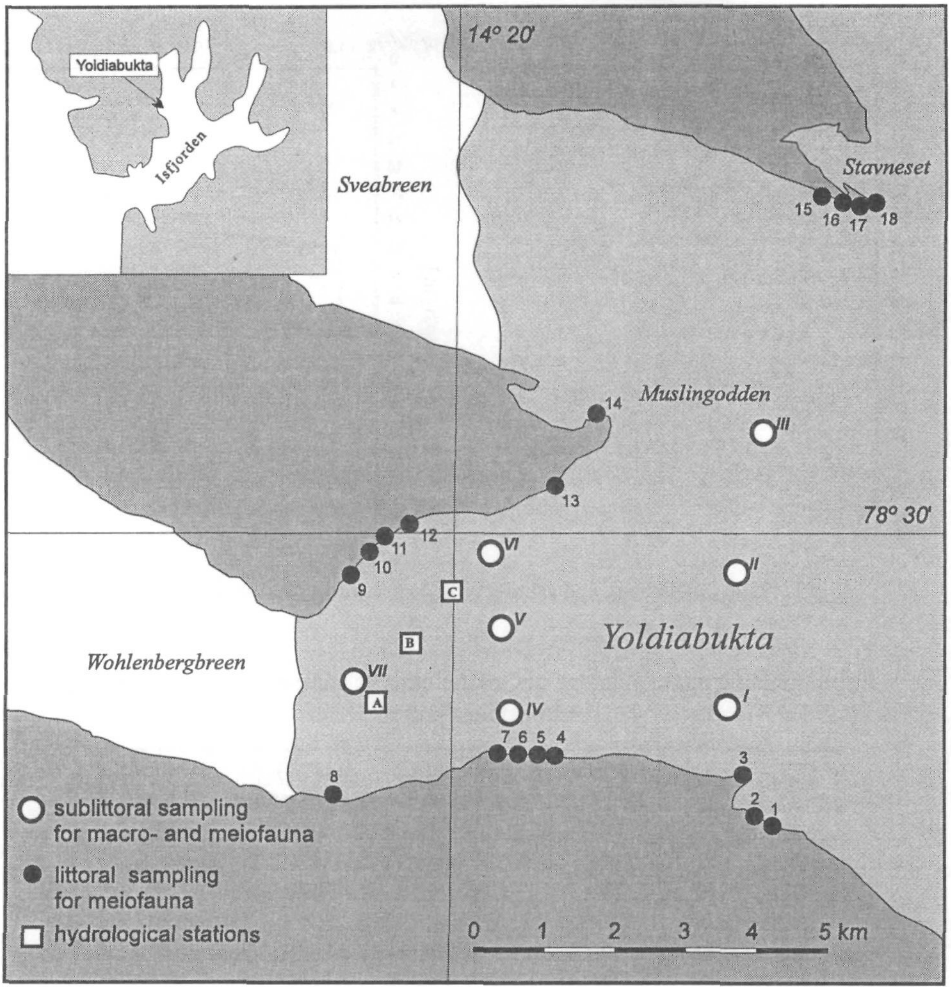

Fig. 1. Locations of the sampling sites.

Study area

Yoldiabukta is one of the open bays in the northern branch of Isfjorden (Nordfjorden). Its width is about 4.5 km. The Wahlenberg glacier front creates the western bank of the bay. It is an active, calving, iceberg producing glacier which surged in 1908 and has markedly retreated since 1968 (Hagen *et al.* 1993).

The sublittoral bottom of the bay is covered with pellits with a small admixture of sands and the presence of dropstones. Organic matter content in the examined sediment ranges from 6.3 to 8.9% (Zajączkowski *unpubl. data*; Table 1). The coasts are moraine beaches in the initial phase after glacier retreat and are covered by sediments consisting mostly of gravel. They were classified as oligotrophic bar-

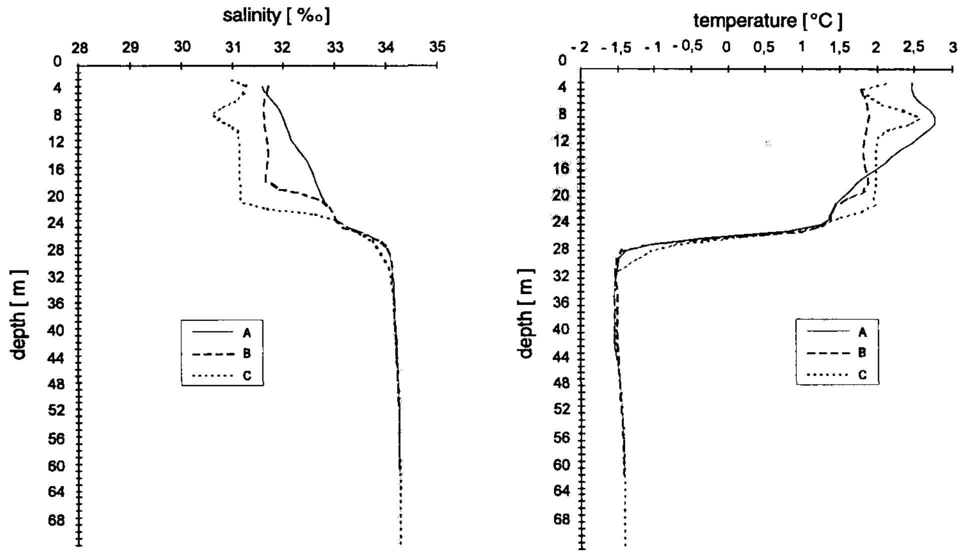

Fig. 2. Water temperature and salinity profiles at hydrological stations A, B, C.

Table 1

Depth, organic matter content, and granulometric composition of sediments; *dropstones present.

station	depth	organic matter [%]	pelit [%] (<0.063 mm)	sand [%] (1–0.063 mm)	gravel [%] (>1 mm)
I	65	8.7	90	8.2	1.8*
II	95	8.9	87.8	9	3.2
III	60	8.4	85.2	10.2	4.6*
IV	10	7.2	86.6	9.2	4.2
V	15	6.3	72.2	11.2	16.6*
VI	20	7.7	73.4	13.6	13*
VII	36	7.2	86.4	11.2	2.4

ren beaches by Węsławski *et al.* (1990a) because the macrofaunal communities lack macrofauna and macrophytes.

Based on T-S diagrams (Lech and Walczowski 1993; Fig. 2) we can determine two basic water masses present in Yoldiabukta in summer:

- The surface water layer is about 20 m thick. It is formed by freshwater runoff derived mainly from melting ice, snow, and rainfall. The characteristics of this water are salinity below 31.7 ppt and an almost constant temperature of around 2°C. The highest temperature, 2.5°C, and the lowest salinity, 30.5 ppt, were recorded at station III at a depth of 7 m.
- Cold, deep winter water is formed by the salt rejection mechanism of ice during the freezing process. From a depth of 26 m to the bottom the temperature and salinity are almost constant at below –1.4°C and about 34.1 ppt.

The hydrological regimes of Yoldiabukta described above are very similar to the summer situation observed in the deep inner parts of Hornsund (Swerpel 1985) and Isfjord (inside Billefjorden, Węsławski *et al.* 1990a). The salinity of the deep water in Yoldiabukta is close to the salinity of the Atlantic water recorded around Svalbard (34.9 ppt; Normann 1986). However, it seems that this water mass does not enter the studied bay.

Mineral suspensions are discharged with glacial meltwater. Włodarska-Kowalczuk *et al.* (1998) reported inorganic suspension concentrations in surface waters ranging from 10.1 to 40.8 mg×dm^{-3} (mean – 25.7 mg×dm^{-3}) in the central part of Yoldiabukta in July 1994.

Results

Macrofauna. — Ninety-five taxa were found and most of them were identified to the species level (Table 2). The fauna was dominated by 55 taxa of annelids, which provided 49% of the total number of individuals. Mollusca were the second most important group and consisted of 21 species and 41% of the number of individuals. Ten species of Crustacea made up 2% of the number of individuals. Five taxa occurred at all stations (*Chaetozone setosa, Lumbrinereis* sp., *Nuculana pernula, Terebellides stroemi, Yoldiella fraterna*). The dominant taxa were *Y. fraterna* (20% of the total abundance), *Lumbrinereis* sp. (10%), *Ch. setosa* (7%) and *Leitoscoloplos* sp. (5.5%).

Total faunal densities varied from 1194 to 2111 ind.×m^{-2} (Table 3). Mean value and standard deviation of 14 replicates were 1558 and 414 ind.×m^{-2}. Detritus feeding organisms, which contributed from 58 to 95% of the total number of individuals, dominated the fauna. The most important detritus feeders were *Y. fraterna, Ch. setosa, Leitoscoloplos* sp., *Maldane sarsi* and *Heteromastus filifornis*. The percentage of suspension feeders ranged from 1 to 9%. The most abundant suspension feeders were *Rhabdaminia* sp, *Arctinula groenlandica* and *Astarte crenata*. Carnivores accounted for 3 to 30% of the fauna and were dominated by *Lumbrinereis* sp.

At the 50% similarity level three groups of samples can be distinguished as follows: A – samples from stations I, II, III and VI; B – samples from stations IV and V; C – station VII (Fig. 3). These three groups have been encircled in the MDS plot (Fig. 4). The replicates of station VII, the closest to the glacier, form a sharply defined group on this plot. The replicates of the other stations, which formed groups A and B on a dendrogram, seem to be much less strongly grouped on MDS plot. Instead, the distribution of stations on the MDS seems to present a slightly marked gradation in community structure across the bay from the areas in the central bay (station V, right side of the plot) to the entrance of the bay (stations I, II, left side of the plot). The weakness of this division is also easily visible when we compare the structure of dominance in the three groups defined (Table 3).

Table 2

Densities of macrofaunal taxa in the sublittoral (ind.m^{-2}, mean values for two replicates taken at each station).

	I	II	III	IV	V	VI	VII
Foraminifera							
Miliolina sp.			6		6		
Rhabdaminia sp.	94	17	33		83		167
Annelida							
Aglaophamus malmgreni Theel, 1879				6			33
Amphitritinae n.det.	11	6	11				
Aricidea sp. A		22		78	50		
Aricidea sp. B		6	6				
Capitella sp	6	11					
Chaetozone setosa Malmgren, 1867	67	206	117	133	78	106	6
Chone duneri Malmgren, 1867					28		
Cirratulidae n.det.					6		
Clymenura polaris (Theel, 1879)	11	6					
Cossura longocirrata Webster et Benedict, 1887	11		6	6	6		
Eteone flava (O.Fabricius, 1780)	6			6			
Eteone longa (O.Fabricius, 1780)	22	11	6				
Eteone sp.					6		
Eteone spetsbergensis Malmgren, 1865						6	
Euchone papillosa (M.Sars, 1851)					6		
Fabriciinae n.det.					17		
Gattyana cirrosa (Pallas, 1766)		6					
Glycera capitata (qrsted, 1843)	6		6				
Harmothoe sarsi Malm, 1874			6				
Heteromastus filiformis (Claparede, 1864)	100	139	61	6		67	
Lanassa nordenskioeldi Malmgren, 1866			6				
Laonice cirrata (M.Sars, 1851)	6					11	
Laphania boecki Malmgren, 1866				22		6	
Leitoscoloplos sp.	161	44	106	72	100	106	
Levinsenia gracilis (Tauber, 1879)	61	39	44				
Lumbrineris sp.	233	117	144	150	239	228	28
Lysippe labiata Malmgren, 1866		6		11	39		
Maldane sarsi Malmgren, 1865	183	94	67	17		17	
Maldane sp. A	28	22	6	6			
Maldane sp. B	17						
Melinna cristata (M.Sars) Mackie et Plijel 1995						6	
Myriochele heeri Malmgren, 1867	6	17	11			6	6
Myriochele oculata Zaks, 1923	11	117	72	22		44	50

Table 2 – *continued.*

	I	II	III	IV	V	VI	VII
Myriochele sp.	33	11	22	6		22	11
Nephtys ciliata (O.F.Müller)	6			22	33		11
Nephtys sp					6		
Nereimyra aphroditoides (O.Fabricius, 1780)	78	11					
Ophelina cylindricaudata (Hansen, 1879)			11				
Orbiniidae n.det.	6						
Paraonis fulgens (Levinsen, 1884)					11		
Pectinaria hyperborea (Malmgren, 1866)	11	50				6	
Pholoe minuta (O.Fabricius, 1780)			6		33	6	
Phyllodoce groenlandica Ørsted, 1843		11	6	6	6		
Polycirrus arcticus M.Sars, 1865		6	39	6		11	11
Polycirrus medusa Grube, 1850	6						
Praxillella gracilis (M.Sars, 1861)			6	6		11	
Prionospio cirrifera Wiren, 1883			6				
Rhodine gracilior Tauber, 1879	6	6				6	
Sabellides borealis M.Sars, 1856			6				22
Scalibregma inflatum Rathke, 1843	17		6				
Spiochaetopterus typicus M.Sars, 1856	6						
Spionidae n.det.		6	6				
Syllis cornuta Rathke, 1843	6	22	6	11		22	
Terebellides stroemi M.Sars, 1835	22	11	28	83	94	17	22
Terebellomorpha n.det.		6	6		17		6
Sipunculida							
Sipunculida n.det.			139	44	133		
Crustacea							
Arrhis phyllonyx (M.Sars, 1858)	6	6		22	17		22
Diastylis goodsiri (Bell, 1855)		11	6				
Diastylis scorpionides (Lepechin, 1780)	6	6		6	6		
Eudorella emarginata (Krøyer, 1846)	11	17	6		6		11
Haploops tubicola Liljeborg, 1855		6	6				
Hyas araneus (Linne, 1758)					6	6	
Melita dentata (Krøyer, 1842)				6	6		
Onisimus spp.				6			
Ostracoda n.det.	6						
Sabinea septemcarinata (Sabine, 1821)		6					
Tanaidacea n.det.			6				
Mollusca							
Arctinula groenlandica (G.B.Sowerby II, 1842)			6	100			94
Astarte crenata (J.E.Gray, 1824)			67	6			

Table 2 – *continued.*

	I	II	III	IV	V	VI	VII
Buccinum hydrophanum Hanock, 1846					11		
Ciliatocardium ciliatum (O.Fabricius, 1780)					33		
Cuspidaria subtorta (G.O.Sars, 1878)			11	6			17
Cylichna occulta (Mighels et Adams, 1842)	6		11	11	6	6	
Dacrydium vitreum (Holbøll et Møller, 1842)	28	22	22	6			22
Frigidoalvania janmayeni (Friele, 1878)	6		61			17	
Hiatella arctica (Linne, 1767)					17		
Mya truncata Linne, 1758					6		
Nuculana pernula (Müller, 1779)	33	39	50	56	17	89	17
Nuculoma tenuis (Montagu, 1808)	28		44	56	83	28	111
Onoba mighelsi (Stimpson, 1851)				6			
Portlandia arctica (J.E.Gray, 1824)	6						
Serripes groenlandicus (Bruguiere, 1798)					6		
Thracia myopsis (Møller, 1842)					17	11	
Thyasira dunbari Lubinsky, 1976				11	17		
Thyasira equalis (Verrill et Bush, 1898)			11	11	44		72
Yoldiella fraterna (Verrill et Bush, 1898)	167	122	644	278	156	267	956
Yoldiella frigida (Torell, 1859)		39	67	22	6	17	89
Yoldiella lenticula (Møller, 1842)	89	50	56	6		28	
Echinodermata							
Ophiocten sericeum (Forbes, 1852)						6	
Ophiura robusta (Ayres, 1851)							6
Ophiura sarsi Lütken, 1855			39	33		17	22
Vertebrata							
Lumpenidae n.det.				6	6	6	
Reinhardtius hippoglossoides (Wallbaum, 1792)					6		

Table 3

Domination (percentage in total abundance) of the 6 most abundant species in groups of samples distinguished by cluster analysis.

group A (stations I, II, III, VI)	D [%]	group B (stations IV,V)	D [%]	group C (station VII)	D [%]
Yoldiella fraterna	19.1	*Yoldiella fraterna*	15.3	*Yoldiella fraterna*	52.8
Lumbrineris sp.	11.5	*Lumbrineris* sp.	13.8	*Rhabdaminia* sp.	9.2
Chaetozone setosa	7.9	*Chaetozone setosa*	7.5	*Nuculoma tenuis*	6.1
Leitoscoloplos sp.	6.6	Sipunculida	6.3	*Arctinula groenlandica*	5.2
Heteromastus filiformis	5.8	*Terebellides stroemi*	6.3	*Yoldiella frigida*	4.9
Maldane sarsi	5.8	*Leitoscoloplos* sp.	6.1	*Thyasira equalis*	4.0

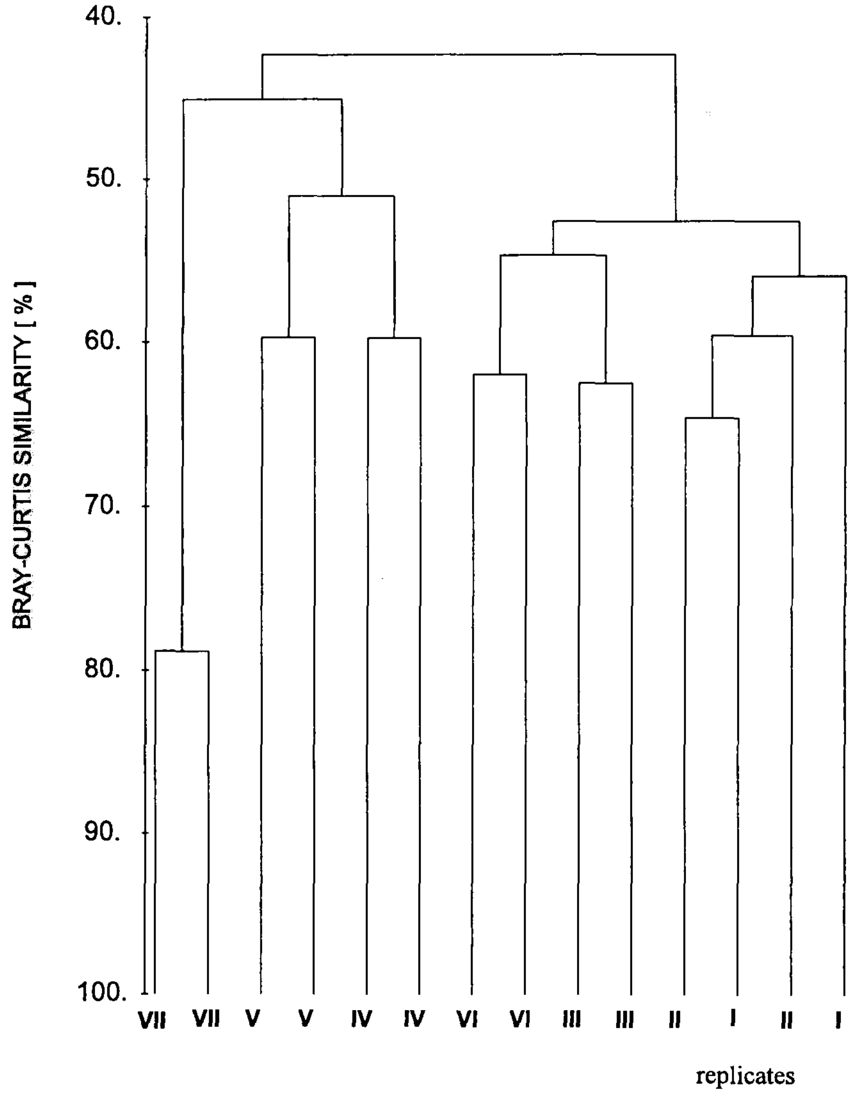

Fig. 3. Dendrogram of macrobenthic stations.

All diversity measures applied showed the station VII fauna to be the least diverse. The number of species, the Shannon-Wiener diversity index, as well as the Hurlbert rarefraction estimates for 100 and 200 individuals were much lower at station VII than at the others (Table 4). Similarly, on the k-dominance plot the curve representing station VII always lies over the other stations' curves, which indicates that the fauna at VII is less diverse (Fig. 5). The curves representing the other stations intersect, thus these stations are not comparable in terms of intrinsic diversity (Lambshead *et al.* 1983).

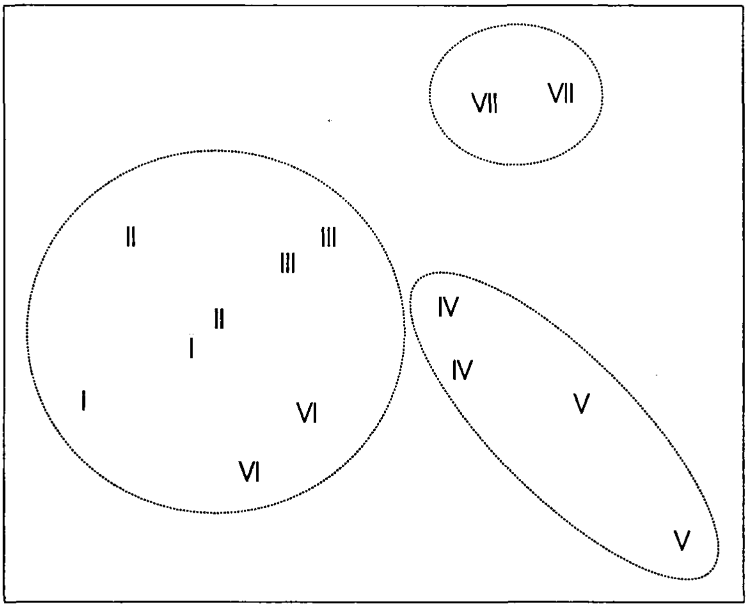

Fig. 4. MDS plot of macrobenthic stations.

Table 4

Characteristics of macrofauna in the sublittoral (mean values for two replicates taken at each station). A – Total abundance [ind.m^{-2}], s – percentage of suspenion feeders in total abundance [%], d – percentage of deposit feeders [%], n – number of species per sample, H – Shannon-Wienner index, E(S100), E(S200) – Hurlbert index for 100, 200 individuals.

station	A	s	d	n	H	E(S100)	E(S200)
I	1622	79	0	29	2.84	26.32	34.72
II	1344	73	7	29	2.87	24.27	30.87
III	2111	86	1	35	2.80	26.58	34.38
IV	1367	69	9	29	2.83	26.41	35.61
V	1461	58	11	29	2.90	24.74	32.44
VI	1194	61	19	23	2.51	22.84	30.10
VII	1811	95	1	21	1.89	15.19	19.13

Meiofauna. — Thirteen higher level taxa (two represented by larval stages – Copepoda nauplius and Cirripedia cypris) were recorded in the littoral zone (Table 5). The most common taxa were Harpacticoida (present at 16 stations) and Nematoda (13 stations). Turbellaria, Calanoida and Oligochaeta were less frequent, occurring at nine, seven, and five stations, respectively. Ostracoda and Halacaridae were observed at three stations, while Tardigrada, Isopoda, Amphi-

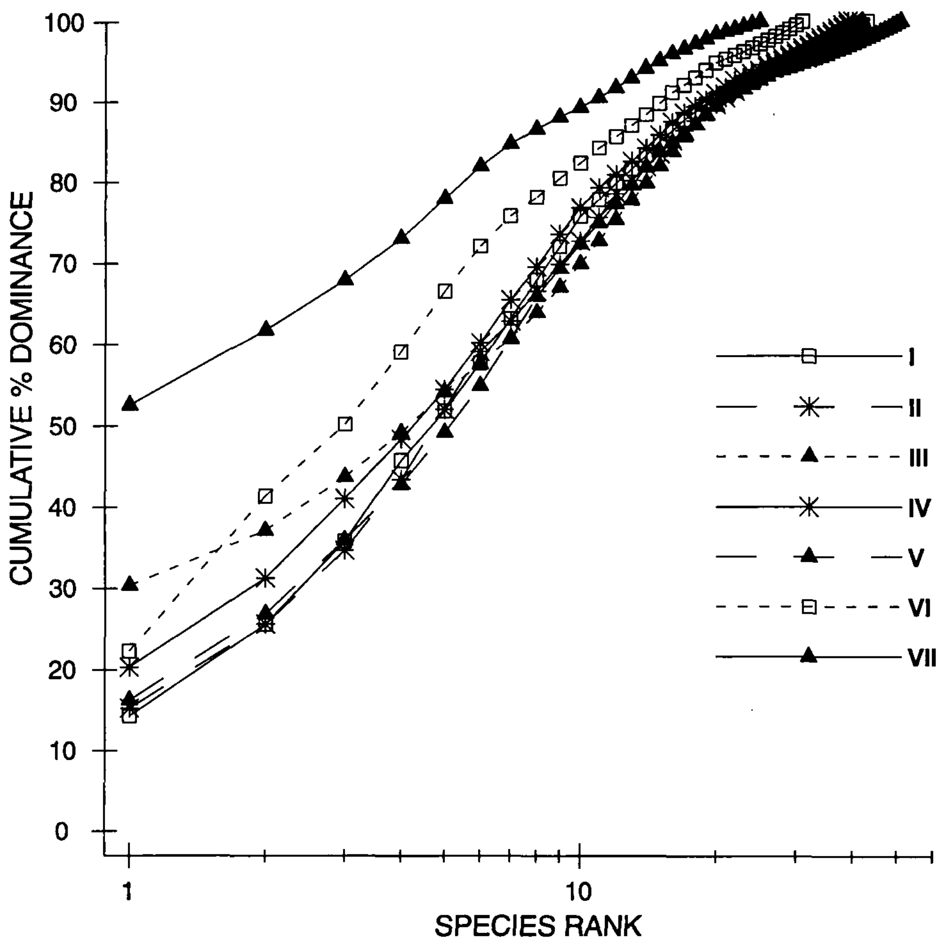

Fig. 5. K-dominance plots for macrobenthic stations.

poda, and Collembola were noted at one station only. The number of taxa at particular stations ranged from two to nine. The most diverse fauna, nine taxa and two larval stages, were recorded at station 8.

Both the total abundance and the total biomass were very low in the littoral zone (Table 5, Figs 6, 7). The maximum total meiobenthic abundance was 132 ind.×10 cm^{-2} and the biomass was 0.29 mg dw×10 cm^{-2}. The maximum abundance of Nematoda was 67 ind.×10 cm^{-2} with a biomass of 0.021 mg dw×10 cm^{-2}. The maximum values observed for Harpacticoida were 13 ind.×10 cm^{-2} and 0.036 mg dw×10 cm^{-2}. Percentages of Nematoda in the total abundance ranged from zero to 80%, but they were over 50% at only three stations, while percentages of the total biomass did not exceed 5% at most stations. Cirripedia larvae made up from 15 to 60% of the total abundance and from 20 to 90% of the total biomass whenever they

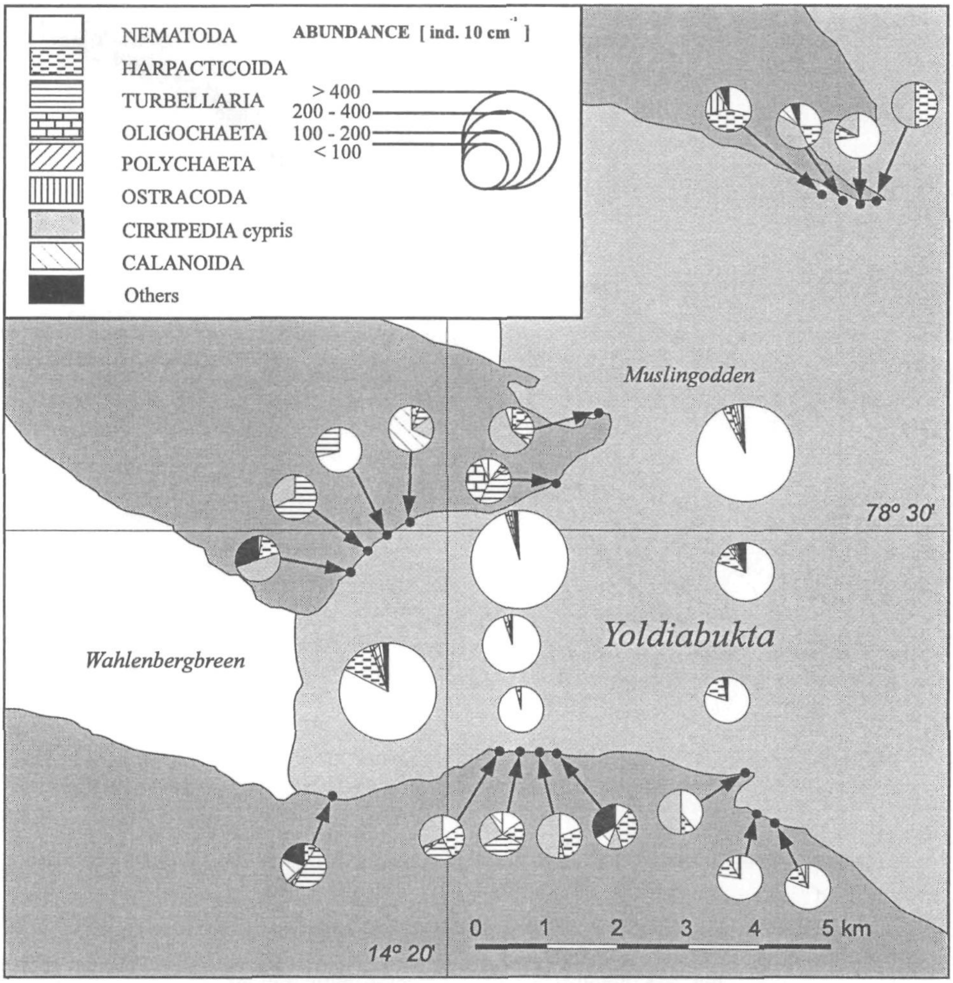

Fig. 6. Total density of meiofauna [ind.×10 cm^{-2}], (represented by the diameter of a circle) and percentages of the main taxa.

occurred. It was impossible to determine the dominating taxa in the littoral meiofauna regarding either abundance or biomass.

Twelve taxa were recorded in the sublittoral (Table 5). Nematoda and Harpacticoida were present at all seven stations. Oligochaeta and Polychaeta occurred at four stations; Turbellaria, Kinoryncha, and Bivalvia at three stations; Halacaridae and Isopoda at two stations. The number of taxa at particular stations ranged from two to eight. The highest number of taxa was observed at stations II and III.

The total abundance in the sublittoral ranged from 47 to 697 ind.×10 cm^{-2} and the total biomass varied from 0.07 to 0.958 mg dw×10cm^{-2} (Table 5, Figs 6, 7). Nematoda dominated both the abundance (79–96%) and the biomass (37–86%).

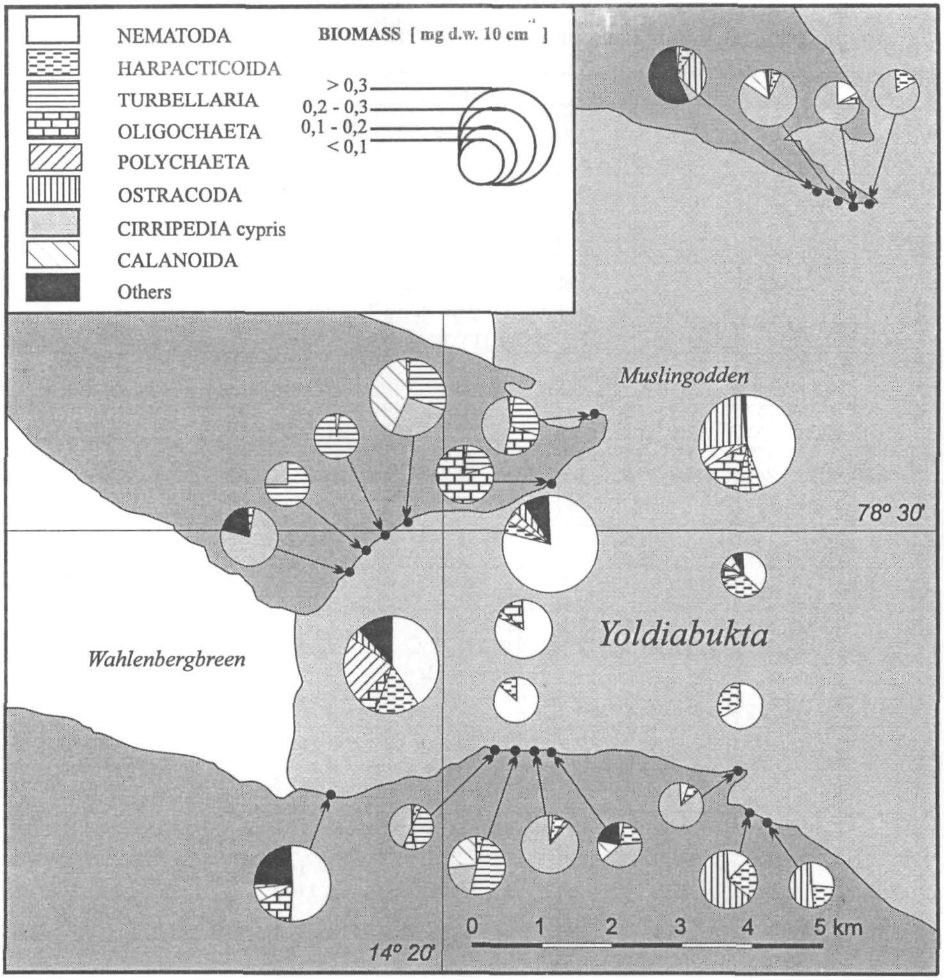

Fig. 7. Total biomass of meiofauna [mg dw ×10 cm^{-2}], (represented by the diameter of a circle) and percentages of main taxa.

The maximum abundance of this taxon was 668 ind.10 cm^{-2} (station VI) and its maximum biomass was 0.384 mg dw×10 cm^{-2} (station VII). The second important group were Harpacticoida, which made up 1.4–18.4% of the total abundance (maximum abundance – 72 ind.×10 cm^{-2} at station VII) and 3.6 – 34.7% of the total biomass (maximum biomass – 0.143 mg dw×10 cm^{-2} at station VII). Significant percentages of the total biomass at stations II, III, and VII were made up by single, large specimens of less abundant groups: Ostracoda, Polychaeta, Oligochaeta, and Isopoda.

The individual average weight of Nematoda and Harpacticoida is much lower in the littoral than in the sublittoral (Table 6).

Table 5

Abundance [ind.10 cm^{-2}] and biomass [μg dw 10 cm^{-2}] of meiofauna at stations.

Station	Takson															
	Turbellaria	Kinorhyncha	Nematoda	Polychaeta	Oligochaeta	Bivalvia	Ostracoda	Harpacticoida	Calanoida	Copepda nauplii	Cirripedia cypris	Isopoda	Amphipoda	Tardigrada	Halacaridae	Collembola
abundance [ind.10 cm^{-2}] **biomass [μg dw10 cm^{-2}]**																
SUBLITTORAL																
I			37.5 **60.6**					8.8 **32.3**							1.3 **0.3**	
II	3.8 **5.2**	5.0 **2.4**	157.7 **53.7**	2.5 **1.4**	2.5 **9.6**			20.0 **45.0**	1.3 **13.2**		1.3 **2.9**	2.5 **10.4**				
III	1.3 **27.0**		377.5 **264.0**	5.0 **35.3**	3.8 **79.8**	1.3 **1.3**	6.3 **157.6**	10.0 **21.2**				2.5 **8.5**				
IV			62.5 **60.3**					2.5 **9.5**								
V			180.0 **114.6**		1.3 **18.0**			5.0 **6.2**							1.3 **1.3**	
VI	1.3 **1.7**	10.0 **7.6**	668.7 **237.7**	3.8 **10.6**		1.3 **20.6**	2.5 **13.2**	10.0 **11.5**								
VII		5.0 **1.3**	523.8 **385.0**	11.3 **210.2**	7.5 **67.4**	5.0 **112.9**	10.0 **38.0**	72.5 **143.3**								
LITTORAL																
1			13.3 **5.2**				0.8 **9.8**	**2.5** 3.9								
2			67.5 **20.8**				6.7 **103.0**	13.3 **35.9**						0.8 **0.2**		
3			5.9 **1.5**					1.7 **2.0**			7.5 **19.3**					
4			0.8 **0.4**					2.5 **2.1**	0.8 **1.5**	1.7 **0.4**	0.8 **3.9**				0.8 **1.9**	
5	1.3 **3.2**		6.7 **3.7**					9.2 **9.5**			16.7 **114.2**					
6	6.7 **67.5**		3.3 **1.2**					3.3 **4.8**	1.7 **37.6**		5.0 **27.1**					
7	3.3 **28.7**		2.5 **1.1**		0.8 **6.9**			4.2 **4.6**			5.0 **32.2**					
8	14.2 **65.1**				0.9 **28.6**			2.5 **2.6**	5.0 **107.8**	5.0 **1.3**	0.8 **4.2**				0.8 **1.5**	
9			0.8 **0.3**					5.0 **5.1**			13.3 **96.1**	4.2 **15.3**				4.2 **12.6**
10	1.7 **15.8**										0.8 **5.6**					
11	1.7 **19.0**		4.2 **0.6**													
12	8.3 **83.6**							5.0 **3.9**	54.2 **126.8**		11.7 **74.1**					
13	5.8 **20.3**		1.7 **0.3**		5.8 **79.7**			0.8 **0.9**	0.8 **0.5**							
14	3.3 **37.9**				0.8 **31.4**			2.5 **4.0**	0.8 **0.6**		10.8 **63.2**					
15			7.5 **3.8**				5.0 **54.0**	11.7 **16.6**			0.8 **11.9**		1.7 **112.6**			
16			10.0 **2.7**					6.7 **7.0**	4.1 **20.7**	1.7 **0.4**	15.8 **110.7**				0.8 **0.7**	
17			17.5 **9.4**		0.8 **2.4**			1.7 **2.1**			4.1 **40.8**					
18								0.8 **1.3**			0.8 **5.6**					

Table 6

Mean individual weight [μg d.w.] of selected meiobenthic taxa.

taxon	intertidal	sublittoral
Nematoda	0.38	0.8
Harpacticoida	1.24	2.26
Turbellaria	6.91	6.36
Ostracoda	11.15	10.51
Oligochaeta	19.37	12.29

Discussion

Macrofauna. — A macrofaunal community dominated by the bivalve *Yoldiella fraterna* inhabits the sublittoral in Yoldiabukta. It is common in Arctic and Sub-arctic soft bottom localities to find communities dominated by the Nuculanidae bivalve family. Thorson (1957) described *Yoldia arctica* communities as being characteristic of soft bottoms near river mouths or large glaciers in the high Arctic (Svalbard, East Greenland). Péres (1982) presented the *Yoldia hyperborea* community as a typical, Sub-arctic terrigenous mud shelf-associated community on Icelandic coasts, the White Sea and the Southern Greenland shelf. *Y. hyperborea* dominated communities were observed in the Anadyr River lagoon (Bering Sea; Filatova and Barsanova 1964) as well as in the Skoddebukta glacial bay (Spitsbergen; Włodarska *et al.* 1996). Bivalves of the genus *Portlandia* dominate communities characteristic of Arctic estuarine waters of the Siberian seas (Golikov and Averincev 1977) and in the Canadian Arctic where *Portlandia arctica* associations are noted in the Coronation Fjord and in the McBeth Fjord (Baffin Island; Syvitski *et al.* 1989). Another dominant species, the opportunistic polychaet *Chaetozone setosa*, is also noteworthy as it was identified as a characteristic component of glacier- influenced bottom communities (Holte *et al.* 1996, Włodarska-Kowalczuk *et al.* 1998). The multivariate analysis of species abundances strongly distinguished station VII, the nearest to the glacier front, from the other stations. It seems that it represents the specific faunal association inhabiting the strongly disturbed, glacier-influenced environment. The other stations seem to represent the other association inhabiting the central and outer parts of the bay with a slight gradation of faunal composition which follows the level of glacier influence.

The trophic structure of the fauna did not vary between stations. Detritus feeders dominated the fauna, which is connected with the bottom type and sedimentation regimes resulting from the presence of an active glacier. Large amounts of inorganic suspensions decrease the number of suspension-feeding fauna due to the dilution of nutritious suspensions and the clogging of their filtering organs (Moore 1977). However, the suspension-feeding bivalve *Arctinula groenlandica* was abundant even at station VII, which is proximal to the glacier cliff. Aitken and Gilbert (1996), who studied the molluscan fauna of Expedition Fjord (Axel Heiberg Island), found two *Portlandia-Thyasira* associations: an impoverished one consisting only of *Portlandia arctica* and *Thyasira* spp. in a prodeltaic environment (high suspended sediment concentrations, rapid sedimentation rates), and one with significant shares of *Delectopecten (=Arctinula) groenlandicus* and *Yoldiella* spp. in the middle and outer basins (low sedimentation rates). Thus, the results presented suggest that Wahlenberg glacier activity results in moderate levels of inorganic sedimentation in the studied area. The inorganic suspension concentrations in the Yoldiabukta surface waters (mean 25.7 $mg \times dm^{-3}$) reported by Włodarska-Kowalczuk *et al.* (1998) are also much lower than the level of 300–500 $mg \times dm^{-3}$ observed by Elverhoi *et al.* (1983) in the inner basin of Kongsfjorden in the Kongsvegen glacier meltwater plume.

Diversity was the lowest at station VII, which was shown in all diversity measures used. This station is the most proximal to the glacier front. Similar values of diversity indices in this area (up to 1.7 nm from the Wahlenberg glacier front) were reported by Włodarska-Kowalczuk *et al.* (1998) with a 1.26 to 1.64 Shannon index and an 11 to 14 Hurlbert index for 100 individuals. A decrease in faunal diversity along the gradient of glacier or glaciofluvial inflow impact was observed in different localities (Gulliksen *et al.* 1984, Schmidt and Piepenburg 1993, Kendall 1994, Holte *et al.* 1996, Włodarska *et al.* 1996) and was attributed to inorganic sedimentation caused disturbances. According to the Norsk Polarinstitutt (1988) map, the location of station VII was covered by glacier at least up to 1968. Hence, the fauna at this station is the youngest in terms of faunal succession after the glacier retreat. According to Odum (1969), both variety (species diversity) and equitability (dominance diversity) components of diversity increase during succession. It seems that both higher levels of disturbance and a younger bottom in terms of faunal succession are responsible for the lower macrofaunal diversity in the forefields of a retreating active glacier, which can be observed in Yoldiabukta.

Meiofauna. — Typical meiobenthic higher level taxa occurred both in the littoral and sublittoral zones. However, while the sublittoral meiofauna may be regarded as more stabilized, both the qualitative (biomass) and quantitative (abundance) composition of meiofauna in the littoral was more variable and did not show any regular pattern. The dominance of Nematoda and the presence of Harpacticoida is characteristic of sub-tidal meiofauna all over the area. In the littoral zone the inclusion of accidental, water-transported meiobenthos like Cirripedia cypris, Calanoida, or Collembola disturbs the typical quantitative proportions of the main two taxa at many stations. Muddy sediments covering the sublittoral bottom of the bay create favourable conditions for Nematoda. In the littoral the number of Nematoda increased at sites covered by muddy sediments with an admixture of sand (stations 3, 17, 2). Sediments composed only of gravel and little stones, typical of newly-exposed coasts after glacial retreat, do not promote the development of meiobenthic communities. The deposition of mud and organic matter makes this environment more favourable for meiofauna. The other characteristic feature observed in the littoral was the much lower individual biomass of the specimens of the two main taxa, Nematoda and Harpacticoida, as compared to that of the sublittoral.

The total abundance and biomass observed in Yoldiabukta were low, especially in the littoral zone. Similar values of total abundance (max. 167 ind.×10 cm^{-2}) and biomass (max. 0.29 mg dw×10 cm^{-2}) were recorded on the coasts of Bjornoya (Węsławski *et al.* 1997). In the study of the littoral meiofauna of southern Spitsbergen, Szymelfenig *et al.* (1995) observed higher values of average total abundance at 500 ind.×10 cm^{-2} and of average total biomass at 0.34 mg dw×10 cm^{-2}. The total abundance and biomass in Yoldiabukta observed in the present study was also lower than that observed in other polar regions by Galtsova (1971), Galtsova and Platanova (1980), and Feder and Paul (1980). The range of values of total abundance in the littoral zone of Yoldiabukta (0–132 ind.×10 cm^{-2}), as well as the ranges observed by Radziejewska and Stańkowska-Radziun (1979, 1985) in the van Keuleen and Hornsund (West Spitsbergen) fjords (0–4100 ind.×10 cm^{-2}), and by Szymelfenig *et al.* (1995) in southern Spitsbergen (0–14800 ind.×10 cm^{-2}), indicate the high variability of meiofauna among unstable, littoral habitats.

Much lower variability of the total abundance and biomass was observed in the sublittoral of Yoldiabukta. They were also both higher than in the littoral zone (maximum – 668 ind.×10 cm^{-2} and 0.958 mg dw×10 cm^{-2}). However, Herman et al. (1990) recorded a total abundance of up to 2.179 ind.×10 cm^{-2} at similar depths off Greenland, and Carey and Montagna (1982) observed a total abundance of 5.626 – 6.061 ind.×10 cm^{-2} in the Beaufort Sea at a depth of 5.5 m.

Conclusions

Macrofauna is absent in the littoral zone in Yoldiabukta (Węsławski et al. 1990a) while in the sublittoral its total abundance is high as was measured at all stations. The meiofauna abundance is very diverse in the littoral and its taxonomic composition suggests that strong environmental disturbances do not permit this community to stabilize, while in the sublittoral the typical meiofaunal community is well developed. The distance to the glacier front is accompanied by an increase in macrofaunal diversity, while no correlation to macrofaunal abundance or to the abundance or composition of meiofauna was observed.

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Streszczenie

W pracy przedstawiono rozmieszczenie oraz liczebność makrofauny i meiofauny z zatoki przylodowcowej Yoldiabukta w zachodniej części Spitsbergenu (rys. 1). Badania wykonano w sierpniu 1993 r. Materiał na makrofaunę został pobrany ze strefy sublitoralu (10–95 m głębokości), zaś materiał na meiofaunę – zarówno ze strefy sublitoralu, jak i ze strefy brzegowej – litoralu.

W strefie litoralu całkowita liczebność i biomasa meiobentosu byla stosunkowo niska, a skład taksonomiczny na poszczególnych stacjach był zróżnicowany (rys. 6, 7). Makrofauna nie występowała w tej strefie.

W strefie sublitoralu (10–95 m) zarówno makrofauna, jak i meiofauna występowały w dużej liczebności. Nematoda i Harpacticoida (Copepoda) dominowały w liczebności i biomasie meiofauny (tab. 5). W makrofaunie dominującym gatunkiem był małż *Yoldiella fraterna*, a jego liczebność była największa na przedpolu lodowca (tab. 3).