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Macrozooplankton Communities from Weddell Sea Surface Waters, Antarctica

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INTRODUCTION

In the southern and central Weddell Sea plankton sampling is possible only during the summer season (December - March), when parts of the sea ice melt and ice free polynyas occur along the shelf-ice edge. In contrast to the waters off the Antarctic Peninsula, information on distribution and abundance of macrozooplankton from the Weddell Sea is very sparce, due to its difficult accessibility.

Only a few distribution studies have been published so far, which concentrated on euphausiids (Fevolden 1979, 1980; Siegel 1982) and chaetognaths (Bollmann 1934). Hempel *et al.* (1983) reported on the geographical distribution of euphausiids, hyperiid amphipods and fish larvae, and recently several investigations were made on the early life stages of the Antarctic Silverfish *Pleuragramma antarcticum* emphasizing its key position in the cold water ecosystem of the Weddell Sea shelf (Keller 1983; Hubold, 1984, 1985).

In austral summer 1982/83 a zooplankton sampling programe was undertaken in various parts of the Weddell Sea in order to extend our knowledge of the zooplankton distribution in this region.

The present study provides a list of macrozooplankton taxa, of which several are described for the first time from this region. Geographical distribution and relative abundance of the euphausiid species are shown according to their importance in most parts of the Southern Ocean

Furthermore, hydrographic data and cluster analyses were applied to reveal faunal dissimilarities in different regions of the Weddell Sea.

MATERIAL AND METHODS

During her first Antarctic cruise in austral summer 1982/83 RV "Polarstern" carried out a zooplankton sampling programme in various parts of the Weddell Sea. Two sequences of stations were made in ice free waters, one in the summer polynya along the shelf-ice edge from Atka Bay (8°W) to Gould Bay (43°W); the other across the Weddell Sea partly along the marginal pack ice zone ranging from Cape Norvegia (17°W) to the northwestern part of the Weddell Sea (51°W). Hempel (1983) reports on the cruise track and Drescher *et al.* (1983) give a compilation of the biological stations.

The standard zooplankton net was a *m*ultiple *R*ectangular *M*idwater *T*rawl (RMT 1+8m) described in detail by Roe and Shale (1979). The net consisted of three pairs of 0.32mm (RMT 1) and 4.5mm (RMT 8) mesh nets with net openings of $1m^2$ and $8m^2$, respectively.

Altogether 30 RMT standard hauls were carried out (Fig. 1) as stratified oblique tows with maximum haul depths of approximately 300m.

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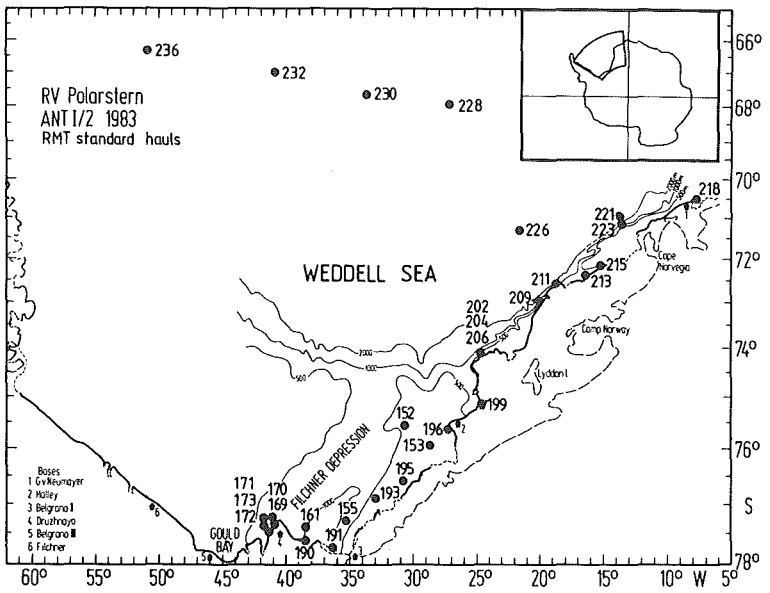
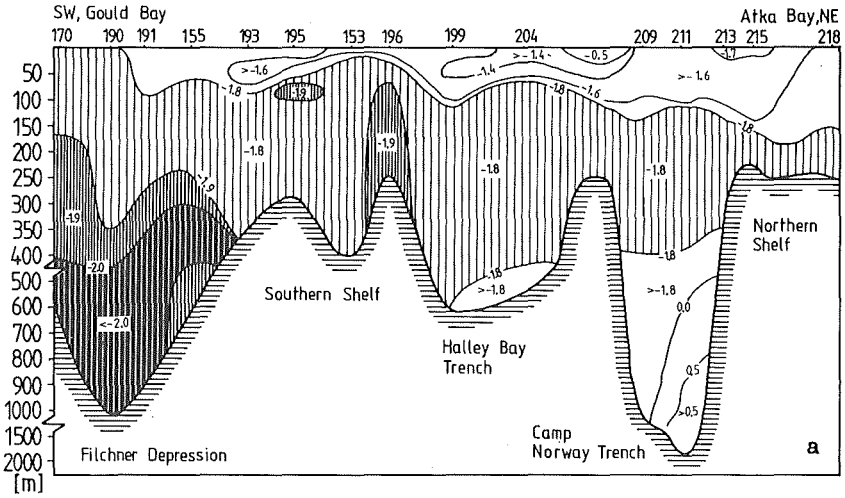


Fig. 1 – Map of investigation area and positions of sampling stations.



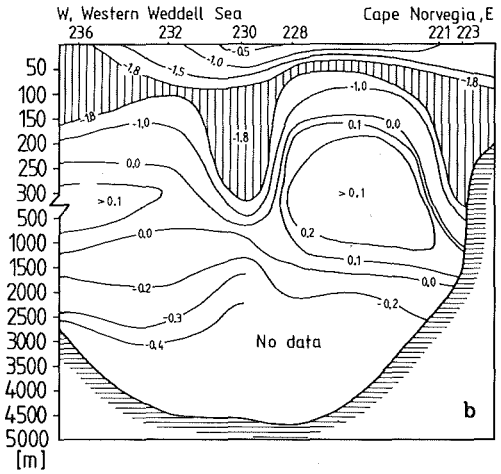


Fig. 2 – Water temperatures and bottom topography along the station sequences. (a) Transect from Gould Bay to Atka Bay. (b) Transect from Cape Norvegia to the western Weddell Sea.

Immediately after each haul the samples were preserved in 4% borax buffered seawater formaldehyde solution.

In this paper only data from RMT 8 samples are considered. They were sorted into the different taxa listed in Table I. The remaining smaller zooplankton, like copepods, ostracods and euphausiid larvae (mesozooplankton), was not sorted and kept as residual sample. Distribution patterns of

TABLE I

Macrozooplankton and Nekton Taxa Identified from Weddell Sea RMT 8 Samples (mesh size 4.5mm) in February 1983. All Hauls Considered were Oblique Tows (300-0 m). + The Values of the Relative Abundance (ind./1000m^3) Represent an Average for the Total of Stations, at which the Taxon was Present.
For Occurrence in Different Communities: + + avery abundant (>10 ind./1000 m^3). + common, (+) only sporadically found, – absent.

Taxon	Occurrence %	Relative Abundance (ind./1000 m^3)		Occurrence in community		
		Maximum	Mean$^+$	A	B	C
Coelenterata						
Pandea rubra	3.3	0.1	0.1	+	–	–
Calycopsis borchgrevinki	43.3	1	0.3	+	+	(+)
Botrynema sp.	43.3	2	0.8	+	(+)	–
Solmundella bitentaculata	6.7	0.1	<0.1	+	–	–
Trachymedusae indet.	70.0	1	0.3	+	+	+
Diphyes antarctica	100.0	20	6	++	+	+
Dimophyes arctica	100.0	17	6	++	+	++
Pyrostephos vanhoeffeni	80.0	18	3	+	++	+
Vogtia serrata	26.7	7	3	+	–	–
Periphylla periphylla	6.7	<0.1	<0.1	+	+	–
Atolla wyvillei	10.0	0.1	0.1	+	–	–
Mollusca						
Echinospira sp.	80.0	23	4	(+)	+	++
Limacina helicina	76.7	156	22	+	+	++
Clione limacina	90.0	3	0.8	+	+	+
Spongiobranchea australis	66.7	0.3	0.1	+	+	+
Clio pyramidata	46.7	6	2	+	+	(+)
Galiteuthis glacialis	33.3	0.4	0.2	+	+	–
Psychroteuthis glacialis	3.3	<0.1	<0.1	+	–	–
Alluroteuthis antarcticus	13.3	<0.1	<0.1	+	+	–
Polychaeta						
Tomopteris carpenteri	30.0	0.2	0.1	+	(+)	+
Tomopteris sp.	36.7	1	0.3	+	+	–
Rhynchonereella bongraini	26.7	0.8	0.3	+	+	–
Vanadis antarctica	26.7	0.4	0.2	+	–	–
Travisiopsis levinseni	20.0	0.2	0.1	+	+	–
Bylgides pelagica	20.0	0.2	0.2	–	+	–
Syllidae indet.	13.3	<0.1	<0.1	–	–	+
Mysidacea						
Antarctomysis sp.	20.0	1	0.4	(+)	+	+
Amphipoda						
Vibilia antarctica	6.7	3	2	+	–	–
Cyllopus lucasii	36.7	2	0.4	+	+	(+)
Cyllopus magellanicus	6.7	0.3	0.2	+	–	+
Hyperia macrocephala	6.7	0.1	<0.1	+	–	+
Hyperia sp.	6.7	<0.1	<0.1	–	+	–
Hyperiella dilatata	70.0	0.7	0.2	+	+	+
Hyperiella macronyx	43.3	0.2	<0.1	+	–	+
Hyperoche medusarum	66.7	0.5	0.1	+	+	+
Primno macropa	40.0	2	0.5	+	+	–
Eusirus antarcticus	13.3	<0.1	<0.1	+	+	–
Eusirus microps	46.7	0.4	0.1	(+)	+	+
Eusirus propeperdentatus	43.3	8	2	–	(+)	+
Epimeriella macronyx	43.3	2	0.6	–	–	+
Orchomene plebs	36.7	0.5	0.1	–	(+)	+
Orchomene rossi	53.3	0.9	0.2	–	+	+
Orchomene sp.	6.7	<0.1	<0.1	–	+	–
Cyphocaris richardi	3.3	<0.1	<0.1	–	+	–
Lysianassidae indet.	23.3	<0.1	<0.1	–	+	+
Euphausiacea						
Euphausia superba	83.3	301	24	++	++	+
Euphausia crystallorophias	80.0	568	51	(+)	++	++
Thysanoessa macrura	76.7	77	6	++	+	+

(To be continued)

TABLE I (Continuation)

Macrozooplankton and Nekton Taxa Identified from Weddell Sea RMT 8 Samples (mesh size 4.5 mm) in February 1983. All Hauls Considered were Oblique Tows (300-0 m). + The Values of the Relative Abundance (ind./1000^3) Represent an Average for the Total of Stations, at which the Taxon was Present.
For Occurrence in Different Communities: + + Very Abundant (>10 ind./1000 m^3). + common, (+) only sporadically found, – absent.

Taxon	Occurrence %	Relative Abundance (ind./1000 m^3)		Occurrence in community		
		Maximum	Mean+	A	B	C
Decapoda Larvae						
Notocrangon antarcticus	76.7	3	0.9	(+)	+	+
Chorismus antarcticus	36.7	0.5	0.2	(+)	+	+
Hymenodora gracilis	10.0	0.1	<0.1	+	–	–
Acanthephyra pelagica	26.7	0.5	0.2	+	–	–
Chaetognatha						
Eukrohnia hamata	100.0	34	7	++	++	+
Eukrohnia bathypelagica	33.3	0.4	0.2	+	+	–
Sagitta gazellae	100.0	16	6	++	++	++
Sagitta marri	43.3	3	0.8	+	+	–
Sagitta maxima	6.7	<0.1	<0.1	–	+	–
Tunicata						
Salpa Thompsoni	60.0	385	23	++	+	+
Pisces Larvae						
Pleuragramma antarcticum	80.0	14	2	+	+	++
Aethotaxis mitopteryx	23.3	14	3	–	+	++
Nototheniidae indet.	10.0	<0.1	<0.1	–	+	+
Trematomus spp.	30.0	0.6	0.2	(+)	+	+
Harpagiferidae indet.	10.0	0.1	<0.1	+	–	+
Cryodraco antarcticus	50.0	0.4	0.2	(+)	+	+
Chionodraco sp.	20.0	0.2	0.1	+	+	+
Pagetopsis sp.	56.7	0.7	0.3	–	+	+
Prionodraco evansii	16.7	0.2	0.1	(+)	+	+
Bathylagus antarcticus	33.3	0.1	<0.1	+	+	+
Notolepis coatsi	40.0	4	1	+	+	+
Myctophidae indet.	10.0	<0.1	<0.1	+	–	–
Pisces Adult						
Pleuragramma antarcticum	26.7	1	0.3	–	+	+
Myctophidae indet.	6.7	0.1	<0.1	+	–	–

mesozooplankton from RMT 1 samples will be published elsewere (Boysen-Ennen, in prep.).

CTD recordings were carried out prior to the plankton sampling. Data of water temperature were used to characterize different water masses along the transect profiles (Fig. 2 a, b). A complete analysis of the hydrographic data sets obtained during the cruise will be published separately (Koltermann, pers. comm.).

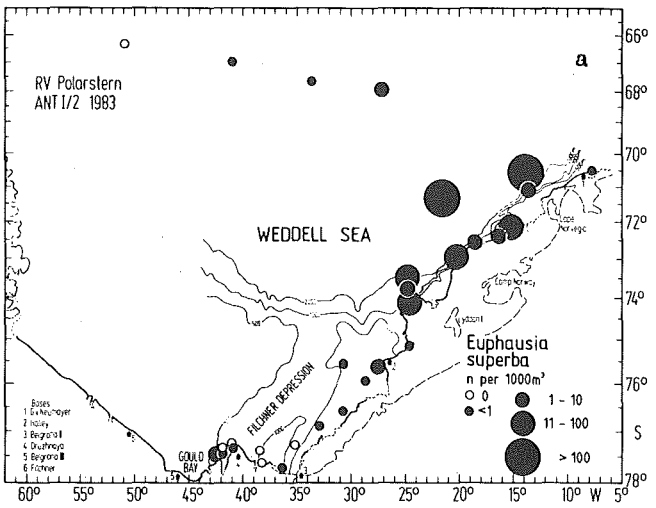
Cluster analyses were applied to investigate similarities between the species compositions. Analyses of the biological data sets were carried out at the computer center of Kiel University (PDP-10, DEC system). They were arranged according to an "n × m" -matrix, with n representing the stations and m the relative abundances (ind./1000 m^3) of the various taxa. Bölter *et al.* (1980) and Bölter and Meyer (1983) developed the computer programmes.

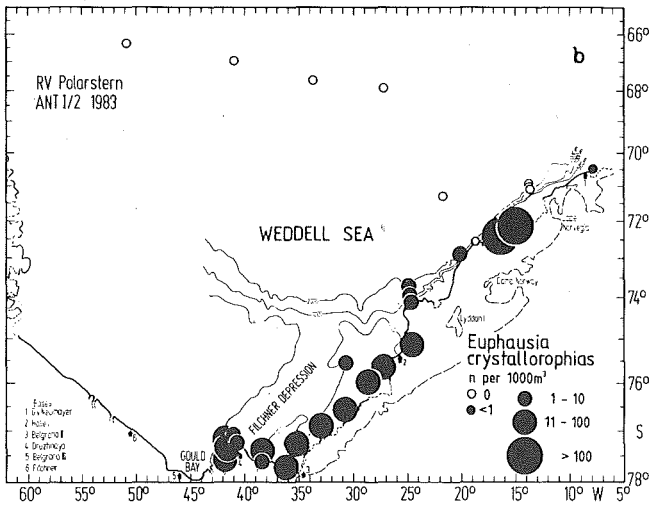
RESULTS

The investigated area and the positions of the 30 sampling stations area shown in Figure 1.

Water temperatures and bottom topography along the station sections are given in Figure 2 a, b. The coldest water temperature was measured in the Filchner Depression below 400m depth (≤ –2.0°C), where the so-called Ice Shelf Water (ISW) is

Fig. 3 – Geographical distribution and relative abundance of euphausiid species encountered, calculated from RMT 8 samples in surface waters (≤300 m). (a) *Euphausia superba*. (b) *Euphausia crystallorophias*. (c) Thysanoessa macrura. →


a
RV Polarstern
ANT I/2 1983
WEDDELL SEA
FILCHNER DEPRESSION
GOULD BAY
Euphausia superba
n per 1000m³
0
<1
1 - 10
11 - 100
> 100
66°
68°
70°
72°
74°
76°
78°
S
60° 55° 50° 45° 40° 35° 30° 25° 20° 15° 10° W 5°


b
RV Polarstern
ANT I/2 1983
WEDDELL SEA
FILCHNER DEPRESSION
GOULD BAY
Euphausia crystallorophias
n per 1000m³
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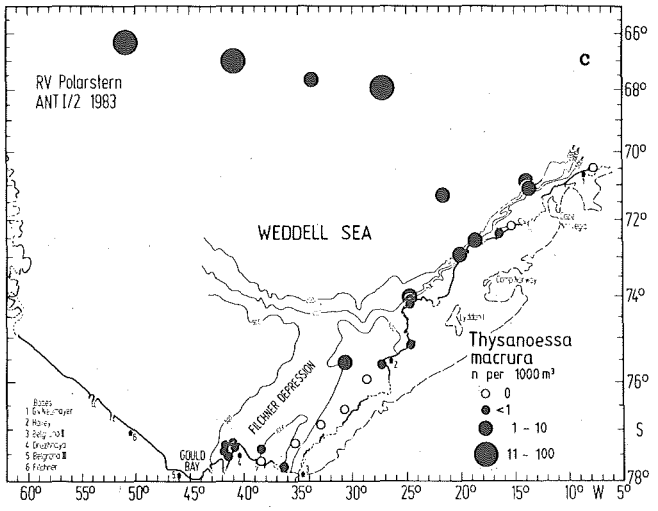
c
RV Polarstern
ANT I/2 1983
WEDDELL SEA
FILCHNER DEPRESSION
GOULD BAY
Thysanoessa macrura
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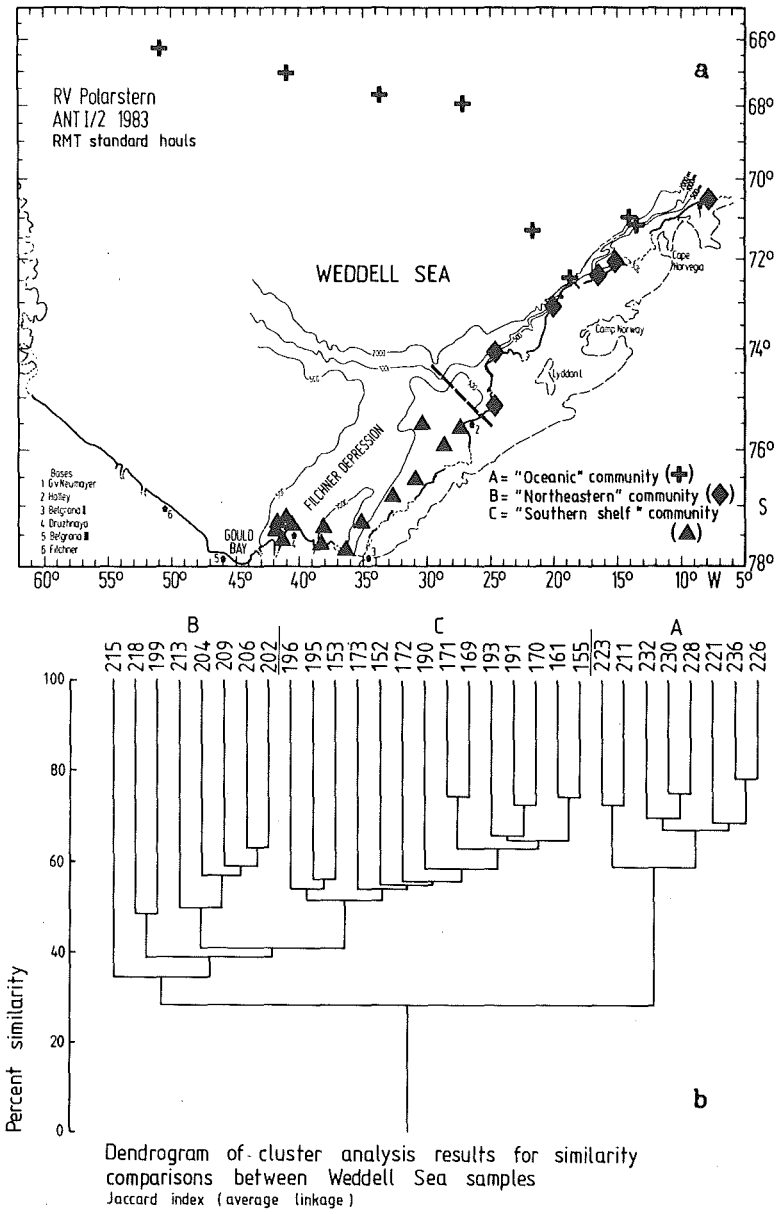

Fig. 4 – (a) Sampling stations related to macrozooplankton communities which were revealed by cluster analysis. (b) Dendrogram of cluster analysis for similarity comparisions between Weddell Sea samples.

produced (Carmack and Foster 1975). The Ice Shelf Water can be followed northward up to Atka Bay (Northern Shelf), where its temperature has risen to -1.8°C. In the northeastern parts a warmer summer layer ($\geq -1.4^{o}C$) covers the cold shelf water. The temperature profile along the section across the Weddell Sea indicates Warm Deep Water (WDW, $\geq 0.1^{o}C$) below 250m covered by a layer of cold winter water ($-1.8^{o}C$). Above the latter there is a warmer summer layer with temperatures up to $-0.5^{o}C$. The water masses beneath 1500m depth are Antarctic Bottom Water (ABW, $\leq 0.0^{o}C$).

A total of 70 macrozooplankton taxa was found, of which 55 were identified to species level, ten to genus level, and five remained as family (Table I). Frequency of occurrence as well as maximum and mean relative abundance of each taxon are present. Only

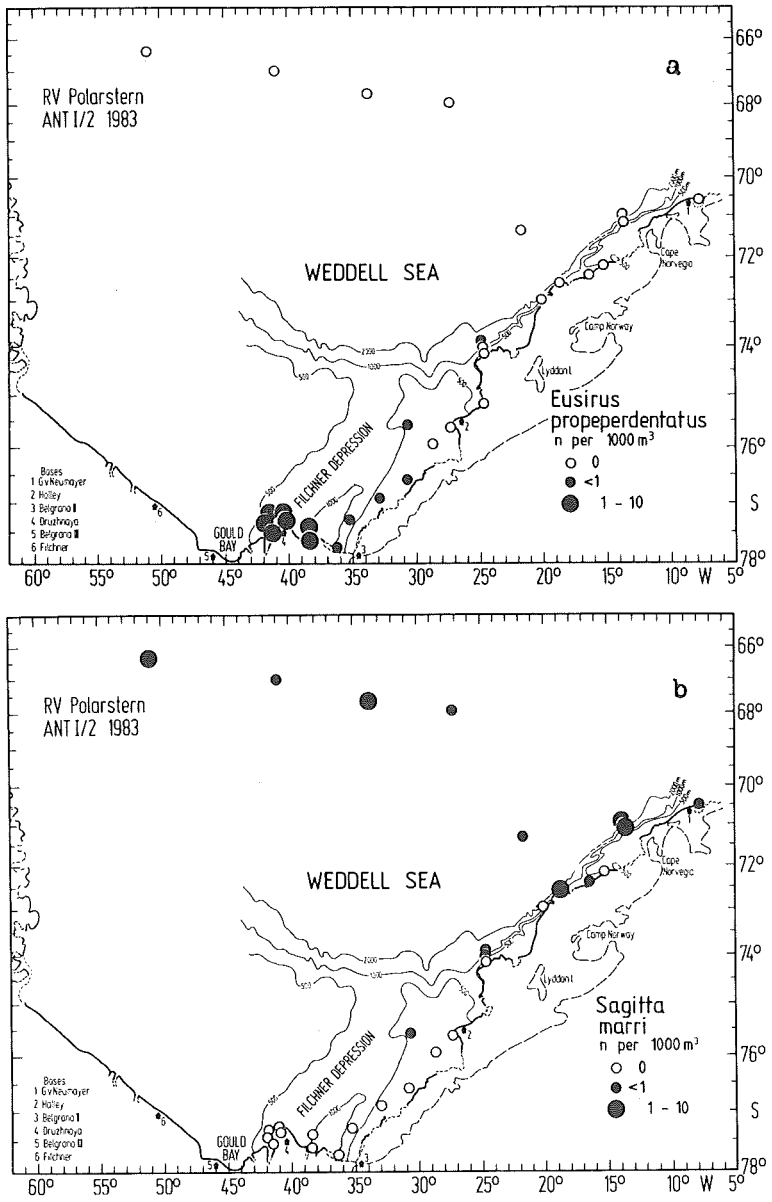

Fig. 5 – Geographical distribution and relative abundance calculated from RMT 8 samples in surface waters (≤ 300 m). (a) *Eusirus propeperdentatus* and (b) *Sagitta marri*.

four species occurred in every sample: the siphonophores *Diphyes antarctica* and *Dimophyes arctica* and the chaetognaths *Eukrohnia hamata* and *Sagitta gazellae*. Amphipods were richest in species (n=18), followed by fish larvae (n=12) and coelenterates (n=11).

The euphausiid *Euphausia crystallorophias* showed the highest abundance. The maximum value (568 ind./1000 m^3) was obtained from the southwest of Cape Norvegia (Station No. 215). Maximum abundances of more than 100 ind./1000 m^3 were also detected for the salp *Salpa thompsoni* (385 ind./1000 m^3 at Station No. 228), the euphausiid *Euphausia superba* (301 ind./1000 m^3 at Station No. 221) and pteropod *Limacina helicina* (156 ind./1000 m^3 at Station No. 169).

Geographical distribution and relative abundance of the euphausiid species are shown in Figure 3 a-c. *Euphausia superba*

was very abundant off the northeastern shelf, which is influenced by the East Wind Drift. In contrast, *Euphausia crystallorophias* occurred almost exclusively at stations on the shelf, especially on its southern part. *Thysanoessa macrura* preferred the oceanic stations far off the continent and was rarely found on the shelf regions.

The dendrogram derived from cluster analyses for similarity comparisons between sample compositions (Fig. 4b) revealed three macrozooplankton communities presented in Figure 4a: an "oceanic community" (A), dominated by gelatinous species and with *Thysanoessa macrura* as the prevailing euphausiid, a "northeastern community" (B), where also the isolated samples of the shallow shelf stations 199, 215 and 218 were included, with either *Euphausia superba* or *Euphausia crystallorophias* as the dominating component and a "southern shelf community" (C), where *Euphausia crystallorophias* dominated and the gammarids *Eusirus propeperdentatus* and *Epimeriella macronyx* occurred.

Table I presents the occurrence of each taxon in the various communities. The geographical distribution and relative abundance of the euphausiids as well as of two typical community inhabitants are given: *Eusirus propeperdentatus* for the "southern shelf community" (Fig. 5a) and the chaetognath *Sagitta marri* for the "oceanic community "(Fig. 5b).

DISCUSSION

For the first time a comprehensive list of macrozooplankton species of the Weddell Sea is available. With the exception of a hitherto not definitely identified gastropod larva (*Echinospira sp.*), wich appears to be a stage new to science, all taxa listed in Table I have been previously reported from the Southern Ocean.

The cluster analysis was applied as a useful technique to identify biotic patterns of data sets from biological surveys (Field *et al.* 1982). Recently Miller (1985) successfully applied this method by analysing macroplankton compositions of two sub-Antarctic islands (Gough Island and Prince Edward Island).

In the present study the cluster analysis revealed three "macrozooplankton provinces", each with characteristic communities (Fig. 4a).

On the basis of the euphausiid distribution I will introduce the different communities and discuss, how they are related to those known from waters off the Antarctic Peninsula.

Six euphausiid species have a circumpolar distribution south of the Antarctic Convergence: *Euphausia superba, E. frigida, E. triacantha, E. crystallorophias, Thysanoessa macrura* and *T. vicina* (Dzik and Jazdzewski 1978). Only three of them were encountered in the Weddell Sea: *E. superba, E. crystallorophias* and *T. macrura*. Each represents a different community. *T. macrura* characterizes the "oceanic community" (A), related to the stations in the central Weddell Sea and to those from the deeper parts of the continental slope off the northeastern shelf. These stations are either influenced by the East Wind Drift or situated in the warmer surface waters within the Weddell gyre. *T. macrura* was most abundant at these stations, other typical members of this community were gelatinous species like *Salpa thompsoni, Atolla wyvillei, Vogtia serrata* and *Sagitta marri*. These species are typical inhabitants of the Warm Deep Water, which does not occur on the shelf regions. They can undertake diurnal migrations from the Warm Deep Water during daytime to the upper surface layers at night. The "oceanic community" is largely identical with that known from the oceanic waters off the Antarctic Peninsula. In a study of the Ross Sea Marr (1962) emphasized that *E. superba* is very abundant in the deep water off the slope region. In the present study the maximum krill concentration (301 ind./1000 m^3) was also found off the slope region (Fig. 3a). However, krill is not a typical inhabitant of the "oceanic community".

Rich krill samples ($\geq$ 10 ind./1000 m^3) were detected in the "northeastern community". In this community *E. superba* was a main component, occurring also at stations on the narrow northern shelf, which was also reported by Siegel (1982). Fevolden (1980) suggests an active interchange between the cold shelf water and the Warm Deep Water in this area, which would explain the occurrence of *E. superba* on the shelf. At stations with water depths less than 300 m *E.*

crystallorophias was more abudant than *E. superba*. No typical "Leitformen" can be reported from this community, it appears to be a mixture of the "oceanic" and the "southern shelf" communities. The "northeastern community" is largely influenced by the East Wind Drift. Its main water transport flows along the shelf-ice into a southwesterly direction. When the water masses reach the slope of the southern shelf (north of Halley Bay, at approximately 75°S), the main branch is deflected to the northwest, where it enters the great Weddell gyre. South of Halley Bay only a narrrow coastal current continues in a southerly direction (Gill 1973). At the divergence of those currents there is a distinct frontier, which separates the "northeastern community" from the "southern shelf community" (Fig. 4a). This frontier was also identified during phytoplankton community analyses in austral summer 1982/83 (v. Bröckel 1985).

The "southern shelf community" was characterized by neritic species. *E. crystallorophias* was the dominant euphausiid, which has been known to be restricted to the high-Antartic shelf regions (Rakusa-Suszczewski and Stepnik 1980). Ohter typical inhabitants were the gammarids *Eusirus propeperdentatus* and *Epimeriella macronyx* the latter being an indicator species of this community. Among the fish larvae *Pleuragramma antarcticum* and *Aethotaxis mitopteryx* dominated, and adult *P. antarcticum* occurred in the surface layers. Coelenterate species were sparse. Most of the prevailing species of this community are known to live close to the bottom on the shelf regions of the Antarctic Peninsula. However, on the southern shelf of the Weddell Sea they characterize the pelagic ecosystem.

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SUMMARY

In austral summer 1982/83 macrozooplankton was sampled from surface waters (haul depth ≤ 300 m) in different regions of the Weddell Sea. The samples were taken during the first German Antarctic expedition onboard the RV "Polarstern" by a Rectangular Midwater Trawl (RMT 1+8), mesh size 4.5 mm. The RMT 8 was employed because of its large net opening of approximately 8 m^2, which considerably reduces net avoidance effects.

Seventy taxa were identified. First results on species composition as well as relative abundance and geographical distribution of key species are presented.

Cluster analysis revealed three provinces, characterized by different macrozooplankton communities: an "oceanic community" dominated by gelatinous species (e.g. *Salpa thompsoni*), a "northeastern community", where the euphausiids *Euphausia crystallorophias* and *Euphausia superba* were the major constituents, and a "southern shelf community", where *Euphausia crystallorophias* and the pelagic gammarid *Eusirus propeperdentatus* prevailed.

REFERENCES

BÖLTER, M., MEYER, M. & PROBST, B., (1980), A statistical scheme for structural analysis in marine ecosystems. *Ecol. Modell.*, **9**: 143-151.

BÖLTER, M. & MEYER, M., (1983), The Sandy Beach Area of Kiel Fjord and Kiel Bight (Western Baltic Sea) - A Structural Analysis of a Shallow Water Ecosystem. *In:* MCLACHLAN, A. & ERASMUS, T. (Eds.): Sandy Beaches as Ecosystems. Junk Publishers, The Hague, 263-270.

BOLLMANN, A., (1934), Die Chätognathen der Deutschen Antarktischen Expedition auf der "Deutschland" (1911/12). *Int. Revue d. ges. Hydrob. u. Hydrogr.*, **30**: 251-305.

BRÖCKEL, K. v., (1985), Primary Production Data from the South-Eastern Weddell Sea. *Polar Biol.*, **4**: 75-80.

CARMACK, E.C. & FOSTER, T.D., (1975), Circulation and distribution of oceanographic properties near the Filchner Ice Shelf. *Deep-Sea Res.*, **22**: 77-90.

DRESCHER, H.E., HUBOLD, G., PIATKOWSKI, U., PLÖTZ, J. & VOSS, J., (1983), Das Biologische Programm der Antarktis-I-Expedition mit FS "Polarstern". *Ber. Polarforsch.*, **12**: 1-34.

DZIK, J. & JAZDZEWSKI, K., (1978), The euphausiid species of the Antarctic region. *Pol. Arch. Hydrobiol.*, **25**: 589-605.

FEVOLDEN, S.E., (1979), Investigations on Krill (Euphausiacea) sampled during the Norwegian Antarctic Research Expedition 1976/77. *Sarsia*, **64**: 189-198.

FEVOLDEN, S.E., (1980), Krill off Bouvetöya and in the Southern Weddell Sea with a Description of Larval Stages of *Euphausia crystallorophias*. *Sarsia*, **65**: 149 -162.

FIELD, J.G., CLARKE, K.R. & WARWICK, R.M., (1982), A practical Strategy for analysing multispecies distribution patterns. *Mar. Ecol. Prog.* Ser., **8**: 37-52.

GILL, A.E., (1973), Circulation and botton water production in the Weddell Sea. *Deep-Sea Res.*, **20**: 111-140.

HEMPEL, G., (1983), Die Expedition ANTARKTIS-I mit FS "POLARSTERN" 1982/83. *Ber. Polarforsch.*, **14**: 1-141.

HEMPEL, I., HUBOLD, G., KACZMARUK, B., KELLER, R. & WEIGMANN-HAASS, R., (1983), Distribution of some groups of zooplankton in the inner Weddell Sea in summer 1979/80. *Ber. Polarforsch.*, **9**: 1-36.

HUBOLD, G., (1984), Spatial Distribution of *Pleuragramma artarcticum* (Pisces: Nototheniidae) near the Filchner-

and Larsen Ice Shelves (Weddell Sea/Antarctica). *Polar Biol.*, **3**: 231-236.

HUBOLD, G., (1985), *The early life-history of the high-Antarctic silverfish Pleuragramma antarcticum. In:* SIEGFRIED, W.R., LAWS, R.M., & CONDY, P.R., (Eds.): Antarctic nutrient cycles and food webs. Springer, Berlin, New York, pp. 445-451.

KELLER, R., (1983), Contributions to the early life history of *Pleuragramma antarcticum* Boul. 1902 (Pisces, Nototheniidae) in the Weddell Sea. *Meeresforsch.*, **30**: 10-24.

MARR, J.W.S., (1962), The natural history and geography of the Antarctic Krill (*Euphausia superba* Dana). *Discovery Rep.*, **32**: 33-464.

MILLER, D.G.M., (1985), *Marine Macro-Plankton of Two Sub-Antarctic Islands. In:* SIEGFRIED, W.R., LAWS, R.M. & CONDY, P.R. (Eds.): Antarctic nutrient cycles and food webs. Springer, Berlin, New York, pp. 355-361.

RAKUSA-SUSZCZEWSKI, S. & STEPNIK, R., (1980), Three species of Krill from Admirality Bay (King George, Shouth Shetlands) in summer 1978/79. *Pol. Arch. Hydrobiol.*, **27**: 273-284.

ROE, H.S.J. & SHALE, D.M., (1979), A New Multiple Midwater Trawl (RMT 1+8M) and Some Modifications to the Institute of Oceanographic Sciences' RMT 1+8. *Mar. Biol.*, **50**: 283-288.

SIEGEL, V., (1983), Investigations on Krill (*Euphausia superba*) in the southern Weddell Sea. *Meeresforsch.*, **29**: 244-252.