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Abundance, diversity, and community patterns of Isopoda (Crustacea) in the Weddell Sea and in the Bransfield Strait, Southern Ocean

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Abstract: Abundance, diversity, and distribution of suprabenthic Isopoda caught from a water layer between 0.27 to 0.60 m above the seafloor were analysed. The samples were taken during the ANT XV/3 cruise on RV *Polarstern* by means of an epibenthic sledge along two transects in the southern Weddell Sea (Vestkapp and Halley Bay) and another one east of King George Island. At each of these three bathymetric transects, five to six stations were sampled between 200 and 2000 m. In total, 4258 specimens of isopods were sampled at 14 stations standardized to 1000 m² hauls. 114 species were identified from 49 genera and 23 higher taxa (families and suborders) of Isopoda. Most of them belonged to the suborder Asellota. Dominant families are Munnopsididae (Eurycopinae, Ilyarachninae), Joeropsidae, Munnidae, Paramunnidae, Ischnomesidae and Desmosomatidae. No striking differences were found between areas (Vestkapp, Halley Bay, Kapp Norvegia, and Bransfield Strait). Overall isopod abundances were highest at the shallowest station; species richness was slightly higher above 1000 m depth.

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Key words: isopod community analysis, suprabenthos

Introduction

Our recent knowledge on composition and distribution of suprabenthic communities of the Antarctic is negligible. The first publication on suprafaunal assemblages (San Vincente *et al*. 1997) dealt with results on the composition and depth distribution of species from the South Shetland Islands and the Bransfield Strait. Linse *et al.* (2002) analysed the general composition and distribution of suprabenthic fauna (the upper net of the epibenthic sledge, 1–1.33 m above the seafloor) in the south-eastern Weddell Sea and off King George Island for higher taxa. The present investigation is focused on the lower net of the epibenthic sledge, which collected most Isopoda and allows a cluster analyses of the isopod community due to the higher number of specimens sampled.

Brandt *et al.* (1997) reported on the abundance and diversity of peracarid taxa from a transect in the Beagle Channel, Patagonia. Siegel & Mühlenhardt-Siegel (1988) described the composition of mysids caught by a Beyer's sled in the area of the Antarctic Peninsula.

During recent years, however, more studies of suprabenthic communities were performed in the north-east Atlantic, where some comprehensive studies were undertaken in the Norwegian Sea (e.g. Fosså & Brattegard 1990, Buhl-Jensen & Fosså 1991), in the Bay of Biscay (e.g. Cornet *et al.* 1983, Sorbe 1989, Elizalde *et al.* 1991, Dauvin & Sorbe 1995) and on the Portuguese continental margin (Cunha *et al.* 1997). First investigations on the deep-sea suprabenthos were made in the Arctic Ocean by Brandt & Barthel (1995), Brandt *et al.* (1996, 1997a, 1997b, 1997c) and Sirenko *et al*. (1996). All of these studies focussed mainly on shallow areas.

The present publication is based on material taken by means of an epibenthic sledge (EBS) constructed after Brandt & Barthel (1995) during the EASIZ (Ecology of the Antarctic Sea Ice Zone) II Programme of RV *Polarstern* ANT XV/3 expedition to the Weddell Sea and the area of the Antarctic Peninsula, from February to March 1998. One of the objectives was a preliminary investigation of isopod composition and community patterns at different depth levels and in different geographic areas in order to analyse whether these factors influence composition, abundance and diversity of supra- and epibenthic Isopoda.

Material and methods

Study area

Three depth transects were taken in the West Antarctic (Table I). Two were in the eastern Weddell Sea (south-west of Vestkapp and off Halley Bay) and one off King George Island (South Shetland Islands) in the Bransfield Strait. The area south-west of Vestkapp features a narrow shelf and a steep slope. The shelf stations are mainly characterized by biogenic structures such as sponge-spicule mats, hydrozoan and bryozoan shell rubble, drop stones or coarse sand. On the slope, the sediment is mainly composed of clay and silt, while the sediment of the stations between 1500 m and 2000 m is fine mud. The surface water of this area was

Table I. Station list of RV *Polarstern* expedition ANT XV/3 to the eastern Weddell Sea and King George Island (South Shetland Islands).

Station	Date	Time	Region	Position				Depth	Haul	Ind	S	Sediment
				S beg. (lat)	S end	W beg. (long)	W end	(m)	(m)			
48-89	04/02/1998	10:24	swVK	73°27.26	73°27.27	22°45.67	22°46.52	1645	452	708	23	no sediment in net
48-107	06/02/1998	08:24	swVK	73°34.77	73°34.92	22°38.29	22°38.89	938	420	575	36	fine gravel
48-111	06/02/1998	14:12	swVK	73°38.32	73°38.43	22°11.61	22°12.23	397	382	486	26	sponge spines, coarse gravel, sand
48-130	08/02/1998	14:40	swVK	73°23.99	73°23.83	22°08.24	22°08.65	1983	367	99	11	coarse sand, fine silt, mucous
48-133	09/02/1998	10:19	HB	74°31.72	74°31.87	27°12.80	27°13.18	2119	335	99	7	very fine, clay and silt
48-142	10/02/1998	10:28	HB	74°36.13	74°36.30	27°16.13	27°15.50	1574	442	584	21	fine sand
48-145	10/02/1998	17:15	HB	74°38.04	74°37.96	27°10.97	27°10.40	1054	317	99	14	coarse sand, sponges spines
48-171	12/02/1998	17:56	HB	75°26.74	75°26.91	26°39.92	26°39.42	231	392	496	28	small pebbles, sponges
48-272	26/02/1998	16:09	KN	71°28.76	71°29.01	15°10.37	15°10.28	2077	466	74	16	foraminifera, coarse sand with clay
48-310	16/03/1998	13:30	BS	62°15.72	62°15.83	58°22.96	58°23.27	204	336	1294	24	fine clay
48-311	16/03/1998	14:30	BS	62°16.37	62°16.39	58°23.77	58°24.11	413	295	396	27	no sediment in net
48-316	16/03/1998	19:19	BS	62°16.38	62°16.38	58°16.58	58°16.82	742	207	328	21	very fine clay
48-320	17/03/1998	07:09	BS	62°22.64	62°22.60	58°41.70	58°42.06	1064	243	268	16	very fine clay
48-323	17/03/1998	13:16	BS	62°25.30	62°25.37	58°42.25	58°42.45	1488	215	238	9	very fine clay

swVK = south-west of Vestkapp, HB = Halley Bay, BS = Bransfield Strait off King George Island, Ind = individuals, KN = Kapp Norvegia, S = species

characterized by a less salty and warm water that reached down to 150 m (Gerdes & Bohlmann 1999). The discontinuity layer between the cold Eastern Shelf Water (ESW) and the Warm Deep Water (WDW) (for characteristics see Grobe 1986) occurred around 800 m (Gerdes & Bohlmann 1999). The currents in the eastern Weddell Sea flow from Kapp Norvegia towards the Vestkapp area southwards to Halley Bay (Fahrbach *et al.* 1994), average current velocities differ with location and depth (Fahrbach *et al.* 1992, 1994).

At Halley Bay, the shelf is wider and the slope less steep. The sediment at the shallower stations is composed of drop stones, pebbles and coarse sand. The deeper stations are characterized by finer sediment, in which fine sand, clay and silt dominated. Here, the discontinuity layer between ESW and WDW lies at about 600 m (Gerdes & Bohlmann 1999).

The third transect was located east of King George Island from Admiralty Bay into the Bransfield Strait, where very fine clay from the input of the many glaciers dominated. Pruszak (1980) reported a constant flow of cold water from the Bransfield Strait along the bottom into the Admiralty Bay current system. Local upwelling is probably caused by prevailing winds.

The general sedimentology of the Weddell Sea was published by Grobe (1986) and Voß (1988). Descriptions of the sediment retrieved from the EBS samples at the stations are provided in Table I. Besides these data, further sediment characteristics are based on Agassiz trawl catches, video observations (Gerdes & Bohlmann 1999), and the interface inspection of box corers.

Sampling

The material was collected in the Weddell Sea and Bransfield Strait during RV *Polarstern* expedition ANT XV/3 from February to March 1998 (Table I) The samples were taken by means of a two level epibenthic sledge (Rothlisberg & Pearcy 1977), modified after Brattegard & Fosså (1991) and improved by Brandt & Barthel (1995) in order to catch both the suprabenthic and the epibenthic fauna. The sledge carries two sampling boxes both with an opening of 100 cm width and 33 cm height. While the epibenthic or lower sampler extends from 27 to 60 cm above the seafloor, the suprabenthic sampler extends from 100 to 133 cm above the seafloor (Brandt & Barthel 1995). A plankton net is attached to each sampler, of 0.5 mm mesh size for the nets of both samplers and 0.3 mm for the cod ends. The cod end of each is enclosed by a 0.3 mm mesh net. When the sledge touches the seafloor, a shovel fixed to the box door of the epibenthic sampler opens both boxes. The doors are closed mechanically when the sledge leaves the bottom.

The sledge was hauled over the bottom for 10 min at a mean velocity of 1 knot. The haul distances were calculated on the basis of the GPS-derived positions of the ship at the start and end of the haul (distance in m = 1852 x $\sqrt{}$ (Δ lat')² + (cos lat' x Δ long')² Brandt & Barthel 1995). The haul length varied from 207 to 466 m (Table I); for the analysis the data were standardized to 1000 m hauls, equivalent to a bottom area of 1000 m² sampled by the sledge.

Errors or artifacts may have occurred at station 48-107 (938 m depth) where the doors kept open due to a shovel blocking stone on the way up, and at station 48-316 (742 m depth) where the upper part of the cod end's net was damaged and had an 8 cm open slit.

Processing

Once the samples had reached the deck of the vessel, they were washed through a 250 µm screen. The whole samples were fixed in 4% buffered formaldehyde and transferred into 70% ethanol after 48 hours.

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Table II. Isopod family/ subfamily abundances at different stations ordered by depth.

Station	310	171	111	311	316	107	145	320	323	142	89	130	272	133
Depth (m)	204	231	397	413	742	938	1054	1064	1488	1574	1645	1983	2077	2119
Acanthaspidiidae	3	3	0	0	5	14	9	0	0	25	4	0	0	0
Aegidae	48	0	0	0	5	0	0	0	0	0	0	0	0	0
Anthuridea	0	15	8	0	0	52	16	103	0	38	104	0	2	0
Cirolanidae	3	0	0	7	10	5	0	0	0	2	0	0	2	0
Cryptoniscidae	0	3	10	0	0	0	0	0	0	5	7	3	0	3
Desmosomatidae	6	43	95	30	30	23	0	25	0	0	24	8	0	9
Eurycopinae	27	110	127	180	34	74	15	46	0	63	245	52	29	78
Gnathiidae	15	125	89	10	0	2	0	4	0	0	0	0	0	0
Haploniscidae	0	0	0	0	5	0	0	25	42	0	166	0	0	0
Ilyarachninae	39	14	16	10	44	119	0	20	0	0	69	16	12	0
Ischnomesidae	0	0	3	44	0	100	0	0	130	7	7	11	12	3
Janiridae	24	31	0	0	0	10	3	25	0	0	0	0	0	0
Joeropsidae	601	41	13	41	5	0	0	0	0	0	0	0	0	0
Macrostylidae	0	0	0	0	0	10	0	0	0	0	0	0	2	3
Munnidae	241	69	45	16	39	29	6	8	5	4	0	3	0	0
Munnopsinae	0	3	0	6	73	0	0	0	5	0	0	0	0	0
Nannoniscidae	0	8	3	0	0	67	13	0	14	111	51	0	0	0
Paramunnidae	156	18	63	40	58	33	34	12	42	315	13	0	11	0
Santiidae	21	3	0	0	0	0	0	0	0	0	0	0	0	0
Serolidae	0	0	0	3	0	2	0	0	0	0	7	6	4	3
Stenetriidae	104	0	0	0	0	2	0	0	0	9	4	0	0	0
Storthyngurinae	0	0	0	0	0	21	0	0	0	5	7	0	0	0
Valvifera*	6	10	14	9	20	12	3	0	0	0	0	0	0	0

* = mainly Antarcturidae

Community analysis

The distribution and structure of distinct benthic assemblages was examined by multivariate analysis (PRIMER software package after Clarke & Warwick 2001, Kruskal & Wish 1983, Wilkinson & Eckert 1983, Clarke & Ainsworth 1993). Classification and ordination procedures were used to delineate groups of stations with similar faunal composition of Peracarida. The faunistic resemblance between stations was measured by the quantitative Bray-Curtis similarities (Bray & Curtis 1957) of fourth-root transformed abundance data. Non-metric multidimensional scaling (MDS) was applied to resemblance data to order the stations in a two-dimensional plane in a way that they reflect the faunistic similarities.

This paper presents data from the same stations published by Linse *et al*. (2002), however, in that publication the supranet (1–1.33 m above the seafloor) was analysed for "higher taxa", no Isopoda were identified to species level.

The term species diversity is used to mean species richness, i.e. the number of species sampled at a station (Hurlbert 1971).

Results

4258 specimens of Isopoda were sampled at 14 stations by means of an EBS standardized to 1000 m² hauls during ANT XV/3. 114 species from 49 genera and 23 families could be identified from this isopod material. Although at each station, a different isopod species dominated, all species belong to the Asellota. Munnopsididae (Eurycopinae, Ilyarachninae), Joeropsidae, Munnidae, Paramunnidae, Ischnomesidae and Desmosomatidae dominated on the whole (Table II). While Joeropsidae were only dominant at the shallowest station 310 (at 204 m), and Munnidae, Desmosomatidae and Gnathiidae were most frequent above 1000 m depth. Paramunnidae were abundant until 1574 m, while Eurycopinae, Ilyarachninae and Ischnomesidae were more frequently sampled also at the deeper stations. Eurycopinae occurred most frequently at the deepest station in 2119 m. Haploniscidae were sampled primarily between 1064 and 1645 m depth. Other families, like families of the suborder Valvifera, and the families Stenetriidae, Serolidae, Santiidae, Janiridae,

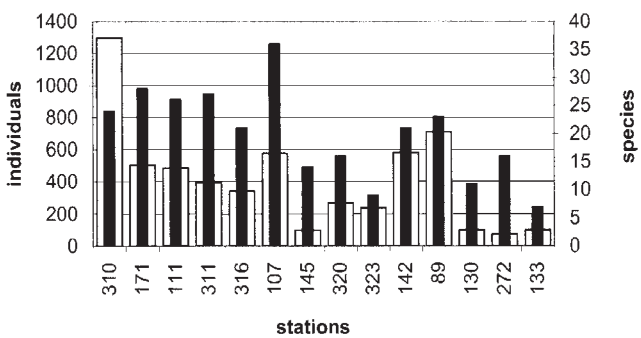

Fig. 1. Numbers of specimens (□) and species (■) of isopods collected with a sledge (EBS model after Brandt & Barthel 1995) the EBS during ANT XV-3. Stations sorted by depth.

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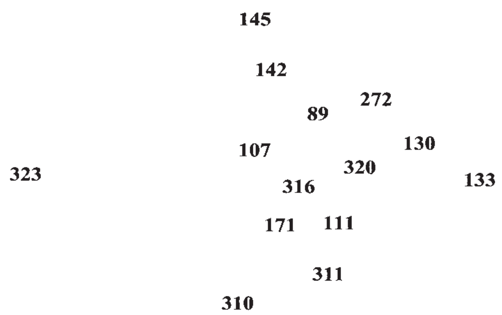

Fig. 2. MDS of similarities of the stations based on isopod composition (stress 0.13).

Acanthaspidiidae, Cirolanidae, had less representation in the samples (Table II).

Some differences were found in general abundance and diversity between the areas Kapp Norvegia, Vestkapp, Halley Bay, and Bransfield Strait. Species of the Aegidae only occurred in the samples from the Bransfield Strait, those of the Macrostylidae and the Storthyngurinae (Munnopsididae) only in the eastern Weddell Sea (Table II). The Nannoniscidae were rarer in the Bransfield Strait, the Santiidae and the Stenetriidae better represented than in the Weddell Sea.

While abundance of isopods was highest at the shallowest station, an increase occurred at depths around 1500 m (Fig. 1 & Table I). Diversity was generally higher above 1000 m depth, highest at station 107 (938 m depth), but also comparatively high at stations 142 and 89 from Halley Bay and Vestkapp (Fig. 1). Abundance was lowest at Kapp Norvegia, but this was also one of the deepest stations (2077 m) (station 272), although the diversity at this station was as high as at the station at 1064 m depth (station 320). At the deepest station from Halley Bay in 2119 m (station 133) the abundance of isopods was very similar to Kapp Norvegia, the diversity slightly lower than at Halley Bay. In the Bransfield Strait no samples were available from comparable depths. The deepest station in this area was located at 1488 m (station 323). At this station less than 300 specimens were sampled. Although number of specimens were higher and the sample was taken in a lower depth that the above mentioned deep samples in the Weddell Sea, species richness was lower in the Bransfield Strait than in the Weddell Sea.

A cluster analysis of the isopod composition revealed that station 323 (at 1488 m depth) in the Bransfield Strait is most different from all other stations (Fig. 2). In general the shallow stations are more similar to each other (e.g. stations 310 and 311, both from the Bransfield Strait, cluster together as well as stations 111 from Vestkapp and 171 from Halley Bay in the Weddell Sea). Station 316 from the Bransfield Strait (at 742 m) is similar in isopod species composition to the shallow stations 111 and 171 from the eastern Weddell Sea.

The deepest stations, stations 130 (at 1983 m) from Vestkapp, 272 (at 2077 m) from Kapp Norvegia, and station 133 (at 2119 m) from Halley Bay are similar in isopod species composition, station 89 (at 1645 m) from Vestkapp shows the closest resemblance in isopod species composition to station 272 from Kapp Norvegia. Station 145 (at 1054 m) is most similar to station 142 (at 1574 m), both are from Halley Bay.

Discussion

During the last two decades a number of investigations performed with different modified epibenthic sledge types were published from different areas, however, predominantly from the northern hemisphere (e.g. Buhl-Jensen 1986, Brattegard & Fosså 1991, Buhl-Jensen & Fosså 1991, Dauvin *et al.* 1994, 1995, Wang & Dauvin 1994, Brandt 1995, Dauvin & Sorbe 1995, Brandt *et al.* 1996, Cunha *et al.* 1997). EBS analyses from the Southern Ocean are very scarce. Few investigations were done in polar areas of the South Atlantic Ocean (e.g. San Vicente *et al.* 1997, Brandt *et al.* 1997, Arnaud *et al.* 1998, Saiz-Salinas *et al.* 1998, Linse *et al* 2002). These investigations differ in the type of the epibenthic sledge used, in the height of the net above the seafloor, in the geographic area, the sampling year and sampling depth. It is therefore quite difficult to compare most of the data.

San Vicente *et al.* (1997) employed a Macer-GIROQ sledge with an automatic opening-closing system off the South Shetland Islands in depths between 45 and 650 m in January and February 1995, in a comparable season in which the ANT XV-3 samples were taken. The EBS these authors used was equipped with three different nets, ranging from 10–50 cm, 55–95 cm, and 100–140 cm above the seafloor. Most of their samples from the upper net were dominated by mysids, only 37 isopods were found, 98 isopods were sampled in the middle net at a comparable depth above the ground like the EBS used for the present study, the lowest net yielded 1266 specimens of Isopoda at the 24 stations. The abundance of Isopoda in those sledge samples is lower than that of the EBS employed in the Southern Ocean during EASIZ II. Unfortunately no further faunistic details on family or species level of the Isopoda are available from Vicente *et al.* (1997) for discussion.

The general power and advantage of sledges samples over other towed gear and grab samplers for some macrofaunal taxa lies in the higher number of specimens yielded per haul. For example, Lorenti & Mariani (1997) sampled 737 isopod specimens at 24 stations with van Veen grabs, triangle dredges, and a Charcot dredge in the Magellan Strait, while 4258 isopods were sampled during ANT XV-3 at 14 EBS stations. Moreover, the material of the sometimes rather fragile isopod species is much better preserved for future studies in systematics or evolutionary biology.

Linse *et al.* (2002) published data on 24 major taxa of the suprafauna (from the upper net of the EBS, 1 to 1.33 m above the seafloor) taken with the same EBS at the same stations as those samples referred to herewith. The results were presented for a higher taxon level and therefore cannot be compared with the isopod species composition presented in the current paper. Linse *et al.* (2002) reported the highest abundance of Copepoda (the most frequent taxon of their investigation) from south-west of Vestkapp in depths between 938 and 1983. Isopod abundance in their investigation showed no correlation with depth. These authors explained that the high frequency of Copepoda might either be due to local downwelling of surface water (Fahrbach *et al.* 1992) or to internal waves in the water column (Krause unpublished data). In the Weddell Sea, where zooplankton was an important portion of the suprabenthic fauna, mysids occurred with high frequencies where copepods were also the dominant taxon (Linse *et al.* 2002). Linse *et al.* (2002) demonstrated for the suprafauna caught (1 m to 1.33 m above the seafloor) that the samples off Vestkapp showed the highest abundances and species diversity, while in the Bransfield Strait abundances and species diversity were lowest. Isopoda from the epibenthic sampler (lower sampler), revealed no significant differences in diversity and abundance between the Bransfield Strait samples and those from the Weddell Sea, as samples from the Bransfield Strait were taken at slightly shallower depths. However, stations 320 (at 1064 m depth) and 323 (at 1488 m depth) in the Bransfield Strait showed lower abundances and values of species richness than the Weddell Sea samples 142 (at 1574 m depth from Halley Bay) or 89 (at 1645 m depth) from Vestkapp.

Species richness of Isopoda was higher above 1000 m depth, highest at station 107 south-west of Vestkapp at 938 m depth (Fig. 1), and slightly decreased with increasing depth, except for the stations 142 at 1574 m and 89 at 1645 m, where values of isopod abundances and species richness were higher. This might be due to a higher food availability at shallower depths due to deep-water production (c.f. Fahrbach *et al.* 1994). Unfortunately, biological parameters were not measured at these stations, therefore this hypothesis cannot be tested.

On the basis of material from the same expedition ANT XV/3 (EASIZ II), Hilbig (2001) and Piepenburg *et al.* (2002) found similar results. They demonstrated on the basis of box corer samples that both, polychaete and general macrofaunal densities and species richness slightly declined with depth at the stations.

The result of the cluster analysis of the isopod composition is illustrated in the MDS (Fig. 2). It showed that the shallow stations are more similar to each other and so are the deeper stations. One station in the Bransfield Strait at 1488 m (station 323) is most different to all others; station 272 at 2077 m depth from Kapp Norvegia is most similar in isopod composition to station 316 at 742 m depth from the Bransfield Strait.

Differences between stations are probably not only due to depth, but also to the nature of substrate. Table I also illustrates that grain size of the sediment at the different stations does not necessarily depend on depth. For example, the sediment at 2077 m (station 272) is coarse, while at 2119 m (station 133) it consists of fine silt and clay, this might also be a reason why stations are so different in species composition. Unfortunately, we do not know very much about the behaviour and life styles of most janiroidean asellote isopods. Therefore, at present it is impossible to attribute isopod community patterns to differences in sediments composition, although this feature probably influences isopod composition.

Another general problem for the Southern Ocean isopod community analysis is the poor systematic descriptions of many asellote species. For example, the isopod family Munnopsididae has to be revised, many species and genera of the subfamilies have to be redescribed before the new Antarctic material can be identified. For this reason, many specimens of this family could only be attributed to "potential" species (species 1, species 2, species 3, etc.) from the present material. As many of the existing descriptions are useless for identification of the Antarctic material, it is unclear whether these species are new or were previously described from the Southern Ocean.

From the 4258 isopods sampled 114 species are identified. Asellota of the families Munnopsididae (Eurycopinae, Ilyarachninae), Joeropsidae, Munnidae, Paramunnidae, Ischnomesidae, Haploniscidae and Desmosomatidae dominated. These are typical elements of the deep-sea isopod faunas (e.g. Hessler & Thistle 1975, Kussakin 1973). Other families, like families of the Valvifera, Stenetriidae, Serolidae, Santiidae, Janiridae, Acanthaspidiidae, Cirolanidae, occurred at lower frequencies in the samples (Table II).

This is the first study of isopod composition from different areas and bathymetric levels in the Southern Ocean. Besides systematic revisions and descriptions of new species, further investigations of isopod species composition, biotic and also abiotic parameters at different depth levels are necessary in the Southern Ocean in order to understand the functioning of Southern Ocean isopod communities.

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