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Soft bottom sublittoral amphipod fauna of Admiralty Bay, King George Island, Antarctic

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Key words: Antarctic, amphipod distribution, species richness,

Abstract

The present analysis is based on 140 quantitative samples collected from depths of 20 to 500 m in the central basin of Admiralty Bay and its inner shallow area, Ezcurra Inlet. One hundred and twenty species were identified, of which 47 species were new for Admiralty Bay. Mean density of crustaceans decreased with depth. Highest species richness was observed at depths of 50 - 100 m. Historical data and present investigations revealed distinct differences in the amphipod assemblages at different depths. In the subtidal zone, *Gondogeneia antarctica* was the dominant species; in the shallow sublittoral (down to ca 50 m) *Prostebbingia gracilis* and *Hippomedon kergueleni* played an important role. Below 50 m, the importance of phoxocephalid species increased.

INTRODUCTION

Amphipod crustaceans belong to the most diverse groups of Antarctic zoobenthos. Until now more than 800 species of Amphipoda were noted south of the Subtropical Front. In the Antarctic *sensu stricto*, south of the Antarctic Convergence, over 500 species were recorded (De Broyer et al. 2007). However, the number of amphipods recorded in Antarctic waters is still growing; according to the preliminary results of the ANDEEP I-III cruises, almost 200 species are still waiting to be described (Brandt et al. 2007). Additionally, new taxonomic revisions employing traditional and molecular techniques give new information on the taxonomy and phylogeny of different families and also on the species richness of this group in the Antarctic (d'Udekem d'Acoz 2008, 2009; Krapp-Schickel 2009; Havermans et al. 2010).

Amphipods comprise different trophic groups, playing a significant role as a food source for other animals (Dauby et al. 2001, 2003). Despite their diversity and the important role they play in Southern Ocean benthic communities, studies on Antarctic assemblages are scarce. Usually, Amphipoda have been treated as a part of the whole zoobenthos, or studies examined only the shallow sublittoral (Lowry 1975, Beckley & Branch 1992, Gambi et al. 1994, Cattaneo-Vietti et al. 2000, Arntz et al. 2006).

The Antarctic region has been divided into smaller sub-regions by several authors. The most commonly used division is by Hedgpeth (1970), with small modifications applied by different authors. The South Shetland Islands belong to the West Antarctic and are recognised as being rich in amphipod species, with 294 species previously recorded from this region (De Broyer et al. 2007).

Admiralty Bay is a fjord-like embayment of King George Island in the South Shetland Islands archipelago. The first studies carried out in this bay

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were completed at the beginning of the twentieth century. They gave the first lists of amphipod species (Chevreux 1913, Barnard 1932). More thorough studies began when the Polish *Arctowski* and Brazilian *Commandante Ferraz* Antarctic stations opened in 1978 and 1984 respectively. Scientists from other nations also carried out relevant research in the area, mainly Belgians, Germans and Americans. In 1996, scientific activity in this fjord led to a proposal that it should be established as Antarctic Specially Managed Area No. 1 (ASMA No. 1). This proposal was officially accepted in 2006. A summary of more than 30 years of activity of scientists from many countries studying marine benthos in Admiralty Bay is presented by Siciński et al. (2010).

Previously published faunistic data about Amphipoda in Admiralty Bay allowed for preparation of a list of 112 benthic crustacean species (Arnaud et al. 1986; Wakabara et al. 1990; Jażdżewski et al. 1991a, b; Jażdżewski et al. 1995; Munn et al. 1999; Valério-Berardo & Piera 2006; De Broyer et al. 2007; d'Udekem d'Acoz 2008, 2009). Amphipod assemblages were analysed only at small depth ranges. The crustacean communities in the narrow subtidal zone (Jazdzewski et al. 2000) and the shallow sublittoral (down to 30 m) have been studied (Jażdżewski et al. 1991b). General remarks on benthic amphipod assemblages down to 150 m (Jażdżewski et al. 1991a), necrophagous amphipods of Admiralty Bay (Presler 1986), and their role as bird food (Jażdżewski 1981, Jażdżewski & Konopacka 1999) have also been studied. The aim of this study was to examine the diversity and distribution patterns of Amphipoda over the whole depth range in Admiralty Bay.

MATERIALS AND METHODS

Study Area

Admiralty Bay (Fig. 1) is a T-shaped embayment of King George Island, the largest island of the South Shetland Islands archipelago, West Antarctic. The surface of the bay is approximately 120 km^2, with a maximum depth of 550 m. The bay has two north pointing inlets, Mackellar and Martel, and one west pointing, Ezcurra Inlet. The central basin of the bay opens into the Bransfield Strait. Detailed information on the physical, chemical and hydrographical features of this bay has been summarised by Rakusa-Suszczewski (1993) and Siciński et al. (2010).

Methods

Two series of quantitative samples were collected using Van Veen grabs (0.1 m^2). The first series of 103 samples was collected in the central basin of Admiralty Bay and in Ezcurra Inlet during the IXth Polish Antarctic Expedition, 1984 – 86 by J. Siciński. Sampling was done at depths ranging from 20 - 500 m. The second series of 41 samples was collected during the Polish Antarctic IPY Expedition in March 2007 by the author and other members of expedition. Samples were collected in two sectors in Ezcurra Inlet, at a depth of ca 100 m (91 - 145 m) (Fig. 1). All samples were preserved in 4% formaldehyde, sorted, and stored in 75% ethyl alcohol. In total, over 5000 individuals were collected, with 90% identified to species level. Due to taxonomic problems and very small size, only some representatives of the family Stenothoidae were identified to species level; therefore in domination graphs individuals of this family were treated as one group. Caprellid amphipods remained at the family level. Damage of very delicate representatives of *Gammaropsis* resulted in a lack of taxonomically important features, so they remained on a generic level.

RESULTS AND DISCUSSION

One hundred and twenty species were identified, 47 of them recorded for the first time from Admiralty Bay. A further 13 benthic species have been recorded by Brazilian scientists working in Martel and Mackellar inlets (Y. Wakabara & M.T. Valério-Berardo, unpublished data). These results extend the present list of Admiralty Bay benthic amphipods to 172 species belonging to 42 families (Siciński et al. 2010). The full list of Admiralty Bay benthic amphipod species is presented on the ABBED database web page (www.abbed.uni.lodz.pl). When pelagic species of Amphipoda are taken into account, the list contains 177 species. In neighbouring Maxwell Bay and Fildes Strait, which were extensively studied by Rauschert (1991), 101 species were recorded. Interestingly, as many as 36 of these species have not yet been found in Admiralty Bay, so further extension of this list can be expected. With 177 species previously recorded, this basin is one of the most amphipod species-rich basins in the Antarctic. Other well-studied areas are large basins: Davis Sea (100 species of Amphipoda), Ross Sea (128 species) and Weddell Sea (214 species). In the South Georgia region, also renowned for its diversity, 184 amphipod species were recorded (De

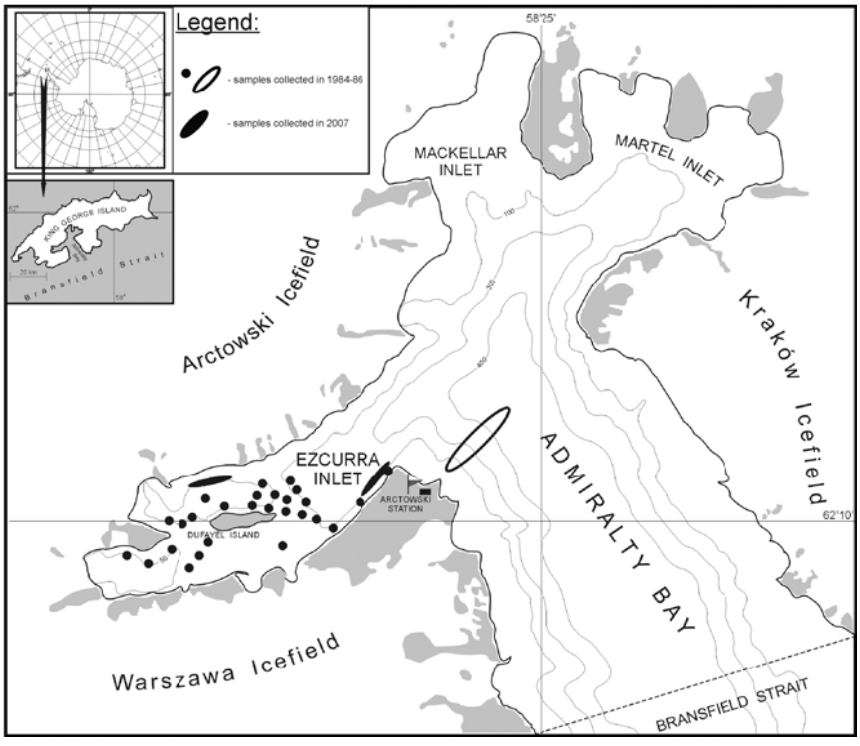

Fig. 1. Study area showing sampling stations.

Broyer et al. 2007; Lörz et al. 2007, 2009; Krapp et al. 2008, d'Udekem d'Acoz 2008, 2009; d'Udekem d'Acoz & Robert 2008; Biswas et al. 2009; Lörz 2009; De Broyer & Danis 2010; Havermans et al. 2010).

When presenting this species richness comparison, it is worth noting that more research stations are located in smaller, semi-enclosed basins, such as fjords or in waters surrounding South Georgia, than in the large, deep and less precisely delimited areas like Weddell or Davis Sea. However, such a comparison is still noteworthy. The South Shetland Islands are known to have a diverse fauna of Isopoda (Brandt et al. 1999), whereas the area north of the Antarctic Peninsula is only moderately species-rich in the case of Mollusca (Linse et al. 2006). The high species richness of amphipod crustaceans observed in Admiralty Bay can be explained in part by the intensive and long lasting studies carried out in this region. However, the history of the Last Glacial Maximum and ice retreat suggests that Bransfield Strait could play the role of a glacial refugium for some marine organisms, allowing marine shelf animals to recolonise the region of the South Shetland Islands very early, possibly because ice retreat after the Last Glacial Maximum started in the North Antarctic Peninsula as early as 18000–14000 yr BP (Ingólfsson et al. 1998, Heroy & Anderson 2007). Furthermore, some authors suggest that Bransfield Strait was free of grounded ice during the Last Glacial Maximum (Anderson et al. 2002).

In the present study, nine of the newly recorded species have not been found since they were described (Table 1, Fig. 2). According to De Broyer and Jazdzewski (1993), 37% of all amphipod species recorded from the Southern Ocean were known only from original material. Due to intensive studies over the last two decades, this number has decreased to 30%, but a high number of poorly known species must still be dealt with (De Broyer et al. 2007). Current records of these nine species confirm their existence and give new data on their distribution. In the case of seven of these species, their present discovery in Admiralty Bay is not surprising because they have been described from the West Antarctic. However, one oedicerotid (*Monoculodes curtipediculus*) and one stenothoid (*Prometopa tuberculata*) were described from locations far from the West Antarctic. Present findings extend their geographical range considerably.

Two representatives of the family Amphilochidae that were found for the first time since their description – *Gitanopsis denticulata* and *G. fucatosquamosa* - were described as being very rare (Rauschert 1994). Here, they were also rare - only

Table 1

Species recorded for the first time since their original description.

Family	Species name	Literature data			Own material	
		Type locality	No.of ind.	Depth range (m)	No. of ind.	Depth (m)
Amphilochidae	*Gitanopsis denticulata* Rauschert, 1994	Fildes Strait, King George Island	1	90-110	3	116
	Gitanopsis fucatosquamosa Rauschert, 1994	Maxwell Bay, King George Island	1	45-110	3	145
Astyridae	*Astyra antarctica* Andres, 1997	Elephant Island	2	120-126	1	111
Lysianassidae s.s.	*Orchomenella (Orchomenopsis) denticulata* Rauschert, 1995	Livingston Island	21	10-15	40	53-60
Oedicerotidae	*Monoculodes curtipediculus*, Hendrycks&Conlan, 2003	McMurdo Sound, Ross Sea	>600	20-23	29	ca. 100
	Paroediceroides sinuatus Schellenberg, 1931	South Georgia	5	22-310	29	45-212
Stenothoidae	*Prometopa tuberculata* Schellenebrg, 1926	Gauss Station, Davis Sea	17	385	2	335
Corophiidae	*Anonychocheirus richardsoni* Moore&Myers, 1983	Arthur Harbour, Anvers Island	70	18-50	16	52-100

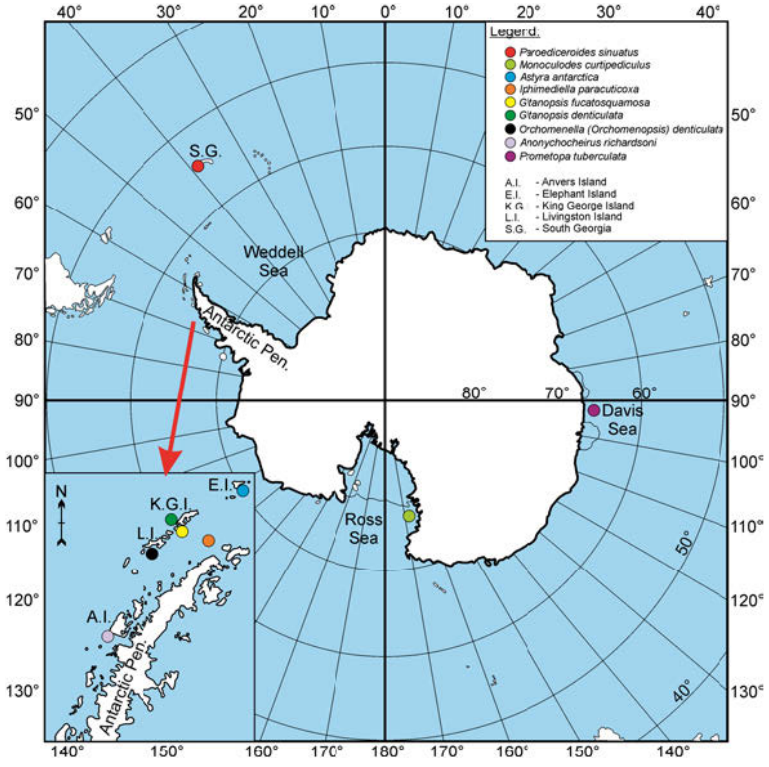

Fig. 2. Type localities of species not hitherto recorded since their original description.

three individuals of each species were found across all samples.

Monoculodes curtipediculus was very common in its type locality, at depths of 20 - 23 m. The original material consisted of more than 600 individuals found in 10 samples (Hendrycks&Conlan 2003). In the present samples, 29 individuals were found in 11 samples, all coming from a depth of ca 100 m. This current discovery renders new data on the bathymetric range of this species; it appears to be not only a shallow sublittoral species.

Prometopa tuberculata has not been recorded since its original description over 80 years ago, although its description is detailed and the species has characteristic features. That could be due to its very small size – adults reach only 3 mm length. Eight other species newly recorded from Admiralty Bay have been reported elsewhere by several authors. However, none were caught in the West Antarctic; thus, the present finding extends their range to this region (Table 2, Fig. 3).

Results from the present study combined with already published surveys of amphipod assemblages in Admiralty Bay (Jażdżewski et al. 1991b, Jażdżewski et al. 2000) show that the density of Amphipoda in the central basin decreased with depth until ca 100 m, and later remained at a low and almost constant level (Fig. 4). The proportion of species surpassing

Table 2

Species not yet recorded in the West Antarctic *sensu stricto*.

Family	Species name	Literature data		No. of ind. in own material	References
		Occurences	Depth range (m)		
Amphilochidae	*Gitanopsis inaequipes* Schellenberg, 1926	Gauss Station (Davis Sea - type loc.), eastern Weddell Sea	245-622	10	Schellenberg 1926, Gutt et al. 2000, De Broyer et al. 2007
Calliopiidae	*Harpinioides drepanocheir* Stebbing, 1888	Kerguelen Islands (type loc.), Prince Edward Islands, eastern Weddell Sea, Bouvet Island	35-232	18	Stebbing 1888; Bellan-Santini and Ledoyer 1974, 1987; Klages 1991; Arntz et al. 2006; De Broyer et al. 2007
	Oradarea megalops (Nicholls, 1938)	Commonwealth Bay (Adélie Coast - type loc.), Davis Sea, eastern Weddell Sea	81-385	13	Nicholls 1938, Gutt et al. 2000, De Broyer et al. 2007
Iphimediidae	*Iphimediella ruffoi* Coleman, 1996	eastern Weddell Sea (type loc.), Prydz Bay, Heard Island	115-264	2	Coleman 1996, De Broyer et al. 2007, Constable et al. 2007
	Parapanoploea longirostris Bellan-Santini, 1972	Géologie Archipelago (Adélie Coast - type loc.), Davis Sea	68-130	8	Bellan-Santini 1972, De Broyer 1983, De Broyer et al. 2007
Pachynus group	*Pachychelium* cf. *nichollsii* Lowry, 1984	Cape Géodésie (type loc.), Commonwealth Bay (Adelie Coast), Bouvet Island	45-720	7	Lowry 1984, Nicholls 1938, Bellan-Santini 1972, Arntz et al. 2006, De Broyer et al. 2007
Oedicerotidae	*Monoculodes curtipediculus* Hendrycks&Conlan 2003	McMurdo Sound, Ross Sea	20-23	29	Hendryks and Conlan 2003, De Broyer et al. 2007
Pardaliscidae	*Halicella parasitica* Schellenberg, 1926	Gauss Station (Davis Sea - type loc.), eastern Weddell Sea, Prydz Bay	170-622	8	Schellenberg 1926, Klages 1991, Gutt et al. 2000, De Broyer et al. 2007, Constable et al. 2007
Stenothoidae	*Prometopa tuberculata* Schellenebrg, 1926	Gauss Station, Davis Sea	385	2	Schellenebrg 1926, De Broyer et al. 2007

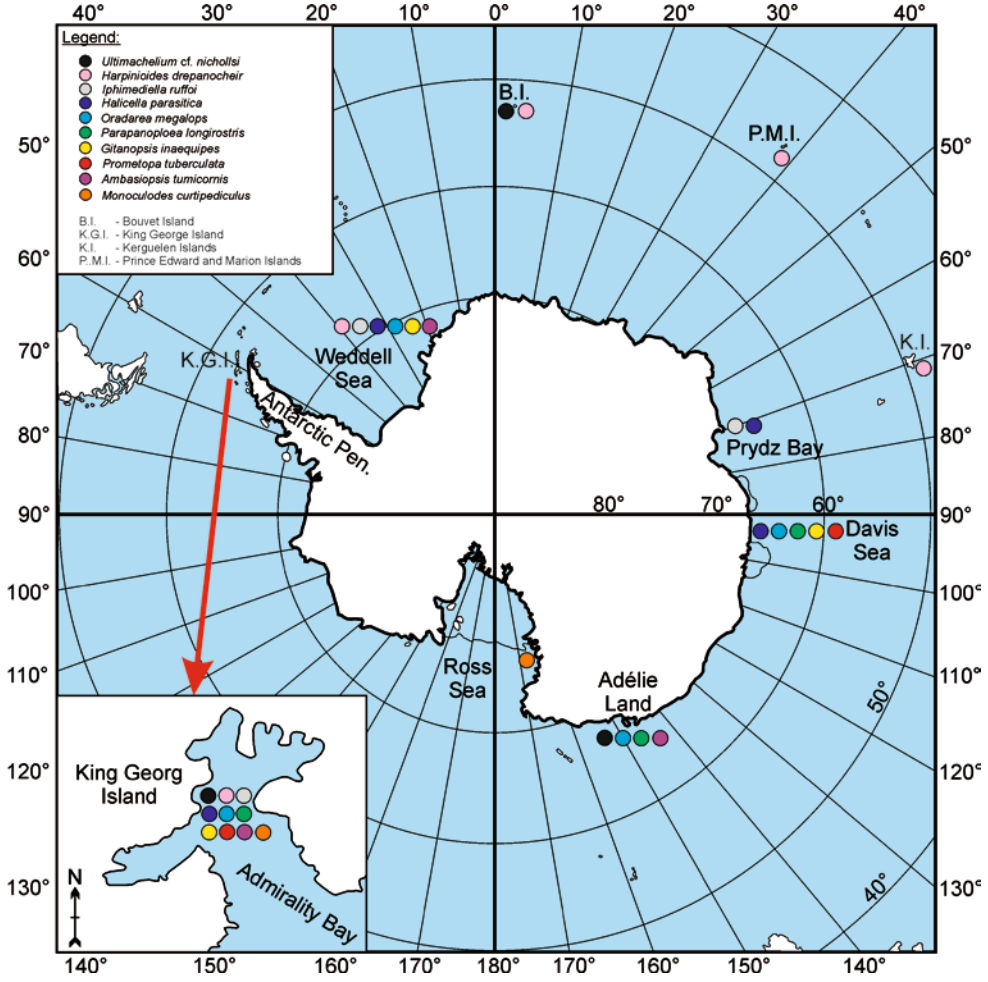

Fig. 3. Distribution of the species known until now from outside West Antarctic sensu stricto (literature and present data combined).

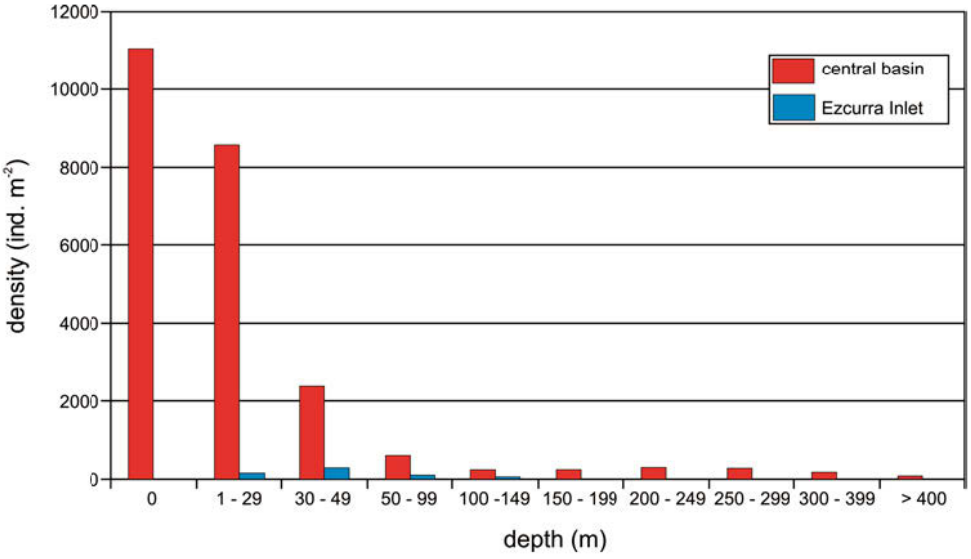

Fig. 4. Mean density of Amphipoda at varying depth ranges (Jażdżewski et al. 1991b, 2000 and present data combined). Depth range studied: central basin – 0 - 500 m, Ezcurra Inlet – 20 - 150 m.

5% of total amphipod abundance in at least one depth range compared to other species is presented (Fig. 5a). This shows that amphipod fauna was most diverse at depths between 50 - 250 m. At this depth range the proportion of less abundant species in the total number of species exceeded 35%. This group was composed of more than 20 species. An analysis of the dominant species composition (only those exceeding 5%, Fig. 5b) showed that high amphipod abundance in the subtidal zone was formed by only 3 species, with *Gondogeneia antarctica* being clearly dominant (Jażdżewski et al. 2000). In the shallow sublittoral area of Admiralty Bay's central basin, the dominant species were *Hippomedon kergueleni*, *Prostebbingia brevicornis*, *P. gracilis* and *Cheirimedon femoratus* (Jażdżewski et al. 1991b). In the depth range between 30 - 50 m, species characteristic of the shallow water assemblage are still found (*P. brevicornis*, *H. kergueleni*) while the proportion of deeper water species (*Schraderia gracilis*, *Heterophoxus videns*) increases. At a depth of ca 50 m a clear boundary between shallow and deep water amphipod fauna can be observed. Below this depth, the increasing proportion of some species from the family Phoxocephalidae (*Harpiniopsis aciculum, Heterophoxus trichosus, H. videns, Cephalophoxoides kergueleni*) and a large proportion of representatives of family Stenothoidae was evident. Jażdżewski et al. (1991a) also noted that *H. videns* was a relatively abundant species in the middle sublittoral of Admiralty Bay.

Amphipod species richness in the isolated area of Admiralty Bay, Ezcurra Inlet, was much lower than in the central basin. Only 40 species were found in 28 samples from Ezcurra Inlet, compared to 85 species from 33 samples collected from a similar depth in the central basin, equating to 14 amphipod species m^{-2} in Ezcurra Inlet, and 26 species m^{-2} in the central basin. Similar pattern between these two parts of the bay was found for Polychaeta (Siciński 2004), where the difference in species number per square meter was even higher – 10 to 34. The abundance of Amphipoda observed in Ezcurra Inlet was much lower than in the central part of the bay and did not vary much with depth (Fig. 4). Total polychaete abundance has also been noted to be two times lower in Ezcurra Inlet (Siciński 2004). In the case of Amphipoda, mean abundance in Ezcurra Inlet was 20 times lower than in the central basin at the same depth range. This difference in abundance and species richness between these two areas of the bay can be explained in part by the character of the environment in Ezcurra Inlet. This shallow inlet is strongly influenced by subglacial streams causing fast sedimentation rates. Bottom sediments are dominated by clay silt and bottom currents are weak (Siciński 2004). All these features can influence amphipod fauna. However, one has to take into account that at depths between 1 - 29 m, only two samples from Ezcurra Inlet were studied, so caution should be exercised when considering values from this depth range.

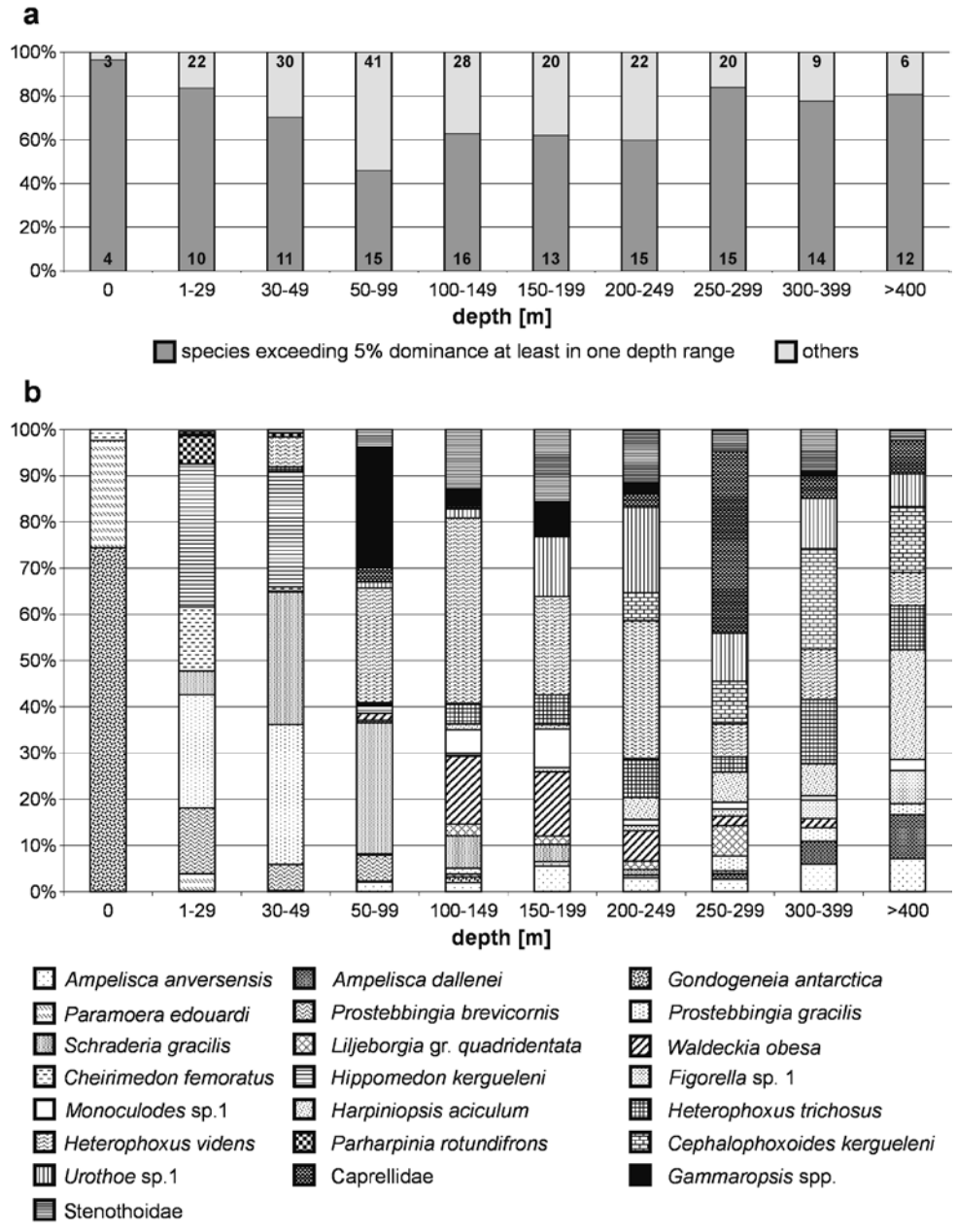

Fig. 5. a) The proportion of dominant species (exceeding 5% in at least one depth range) and others. Numbers show how many species constitute each percent; b) the share of amphipod species that exceeded 5% of dominance at different depth ranges. (Jażdżewski et al. 1991b, 2000 and present data combined).

Fifteen years ago the amphipod species richness of Antarctic Admiralty Bay and an Arctic fjord, Hornsund, was compared. The results showed 97 versus 53 benthic species, respectively (Jażdżewski et al. 1995). At present, new data from both fjords show that the difference remains similar - 172 benthic species in 42 families from Admiralty Bay, and 68 benthic species in 22 families from Hornsund (J.M. Węsławski and J. Legeżyńska pers. comm.). Amphipod fauna of both fjords have been studied with similar intensity over the last decades, so results are comparable. These differences can be explained by the much longer isolated evolution of the Antarctic, a higher diversity of habitats in Admiralty Bay (a lot of dropstones occur on the bottom), and by differences in the depth of these basins – the maximum depth of Hornsund is 250 m (Jażdżewski et al. 1995).

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