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Taxonomic surrogacy in the diversity assessment of the soft-bottom macrofauna along a depth gradient of an Antarctic fjord

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Abstract: The study was aimed at analyzing patterns of abundance and diversity of macrozoobenthic communities along a depth gradient in the Admiralty Bay, a semi-enclosed basin located in a rapidly changing region of the western Antarctic Peninsula. The study concerns primarily the Polychaeta and Amphipoda, the taxonomic richness and diversity of both groups being analyzed at different taxonomic levels (species, genus and family). Such an analysis, which uses a basic surrogacy measure (low taxonomic resolution) can be very useful in future monitoring programs of the Admiralty Bay. The analysis was based on 35 samples collected in the summer seasons of 1984/85 and 1985/86, with a Tvärminne sampler (within the 7–30 m depth range) and an 0.1 m^2 van Veen grab (deeper areas) along a transect with the depth changing from 7 to 502 m. The total macrozoobenthos abundance was found to decrease with depth, from 1581 ± 730 ind./0.1 m^2 within the 7–30 m to as few as 384 ± 145 ind./0.1 m^2 at 400–500 m. The number of phyla per sample was observed to increase along the depth gradient of 7–30 to 200–300 m but was substantially reduced in the deepest sublittoral (400–500 m). The results showed large differences between amphipods and polychaetes in their respective depth-related biodiversity changes. On the other hand, the diversity metrics used (Pielou's evenness, Shannon-Wiener index, number of species per sample, number of genera per sample, number of families per sample) at different taxonomic levels within each group produced similar patterns, demonstrating the usefulness of surrogacy in studies of Antarctic fjords.

Key words: Antarctic, King George Island, Admiralty Bay, ecological gradients, species richness.

Introduction

Depth-related effects and the nature of bottom deposits belong to the most important environmental drivers of the marine benthic community structure (*e.g.*, Perez-Mendoza *et al*. 2003; Olabarria 2006; Dauer *et al*. 2008; Maciolek and Smith 2009). They may influence distribution patterns and diversity of the fauna (Ronowicz *et al*. 2013), modify the trophic structure (Vanaverbeke *et al*. 1997), affect feeding strategies (Nerot *et al*. 2012) and body size of individual taxa (Sharma *et al*. 2011). Factors such as food availability, water transparency and disturbance intensity may follow a depth gradient and, as a result, produce bathymetric zonation of benthic communities (Lee *et al*. 2004; Carney 2005; Seike *et al*. 2013). Distribution patterns and diversity of various taxa and of ecological or trophic groups may differ along a depth gradient (Saiz-Salinas *et al*. 1998; Cartes *et al*. 2003; Olabarria 2005).

Climate warming observed off the West Antarctic Peninsula especially during the last 50 years may influence the composition and diversity of the benthic fauna and their distribution along a depth and/or sediment gradients (Sahade *et al*. 2015). For example, warming may enhance various natural disturbance processes, including ice scour and glacier-derived sedimentation, two major structuring forces shaping benthic communities at shelf depths (*e.g*., Gutt 2001; Smale 2007; Siciński *et al*. 2012; Kędra *et al*. 2013). Ice disturbance occurs mostly in the shallow sublittoral zone, down to 30 m (Nonato *et al*. 2000; Brown *et al*. 2004). Effects of sedimentation may be visible even at a depth of 100 m (Pabis *et al*. 2015), although they are pronounced mostly in the shallows (Gutt 2001; Siciński 2004). The most important factors influencing benthic communities in the deeper sublittoral of the Southern Ocean include food availability and sediment type (Saiz-Salinas *et al*. 1998; Kroger and Rowden 2008).

Admiralty Bay is a good model system for studies on climate change effects in marine benthos. The long history of the relevant benthic research provides a perspective from which it is possible to treat this basin as an important monitoring site for the assessment of climate change effects on the benthic fauna off the West Antarctic Peninsula (Siciński *et al*. 2011). Distribution and diversity of benthic fauna in the basin have already been addressed by a number of studies (*e.g*., Jażdżewski *et al*. 1986; Nonato *et al*. 2000; Petti *et al*. 2006; Filgueiras *et al*. 2007; Pabis *et al*. 2011, 2014). The Bay has also featured in comprehensive environmental studies (*e.g*., Pęcherzewski 1980; Tokarczyk 1986; Lipski 1987; Siciński 2004; Campos *et al*. 2013). All the previous research and data gathered in the Admiralty Bay Benthos Database (ABBED) constitute an ideal benchmark against which to assess changes that are occurring at present and to predict those that may occur in the future. However, the assessment and prediction require continuous monitoring programs and systematic surveys of diversity, involving repeated analyses targeting selected sites. Such an approach is time-consuming, as it requires laborious taxonomic analyses. To some extent at least, this problem has been circumvented in monitoring of anthropogenically disturbed sites (pollution, oil-drilling sites etc.) by the use of surrogacy measures. A useful approach in this context is to lower the resolution of taxonomic identification, as already tested in various studies, particularly with an aim to derive the most ecologically meaningful information. The pros and cons of using surrogacy measures have been discussed by numerous authors (Olsgard and Sommerfield 2000; Bertasi *et al*. 2009; Bevilacqua *et al*. 2012). However, tests in natural systems have been rare (Włodarska-Kowalczuk and Kędra 2007). On the other hand, the approach has been often criticized; some authors (*e.g*., Bertrand *et al*. 2006) have even denied the applicability of surrogacy and found no justification for it.

Polychaetes and amphipods are the most abundant and diverse macrobenthic taxa in the Southern Ocean (De Broyer *et al*. 2011). Both show a high functional diversity and a variety of feeding strategies (Dauby *et al*. 2001; Pagliosa 2005). They are also considered good indicators of changes in the marine environment (Conlan 1994; Olsgard *et al*. 2003; Giangrande *et al*. 2005). Therefore, the aim of this study was to analyze distribution patterns of the macrozoobenthos within a 7–502 m depth range on the soft bottom of the Admiralty Bay, with a particular reference to the abundance, species richness and diversity of the two taxa mentioned. The study addressed problems of taxonomic resolution and applicability of surrogacy measures (genus and family level data) in the biodiversity assessment of the Antarctic infaunal benthic communities.

Material and methods

Study area. — The Admiralty Bay is an about 120 km^2 fjord-like embayment of the King George Island. The Bay consists of a central basin and three inlets (Ezcurra, Martel and McKellar). With its more than 500 m maximum depth, the central basin is the deepest part of the Bay; it opens up to the Bransfield Strait. Almost half of the Bay's shoreline is covered by glaciers and icefalls, particularly numerous in the inlets and along the eastern coast of the central basin (Braun and Grossmann 2002; Siciński *et al*. 2011). The daily mineral suspension supply to the Bay's water during the austral summer has been estimated at about 2000 tons. Suspended matter of glacial origin affects the water column and the bottom mostly in the inner parts of the inlets where the water column's mineral suspended particulates have been estimated at 100 mg/dm^3, the central part of the Bay showing much lower concentrations down to 2.8 mg/dm^3 (Pęcherzewski 1980). In addition, the central basin's water column shows a low turbidity and a high chlorophyll *a* content (Tokarczyk 1986; Lipski 1987). Disturbance processes observed in shallows of the central basin are associated mostly with ice scour (Nonato *et al*. 2000; Pabis *et al*. 2011). The sediment supply is reflected in the nature of bottom deposits in the Bay. The bottom of the inlets is mostly mud-covered, while the central basin's floor shows a higher proportion of sand-covered areas, particularly in the shallow sublittoral. The bottom deposits of this part of the Bay show also a higher content of skeletal fractions (Siciński 2004; Siciński *et al*. 2011; Campos *et al*. 2013).

Sampling. — Material for this study was collected during the austral summers of 1984/85 and 1985/86 from the central basin of the Admiralty Bay. The sampling sites (stations) were arranged along a transect starting from the shallow sublittoral (7 m depth) to the deepest part of the Bay (502 m) off the *H. Arctowski* Polish Polar Station (Fig. 1). The analysis involves a total of 35 samples from 35 stations. Six samples (7–30 m) were collected with a Tvärminne sampler (565 cm^2) (Kangas 1972). The abundance values derived from those samples were referred to 0.1 m^2. The remaining 29 samples (41–502 m) were collected with a van Veen grab (0.1 m^2). All the samples were sieved on an 0.5 mm mesh size sieve and fixed in 4% formaldehyde. Polychaetes and amphipods were identified to the species level. Grain size data were obtained areometrically (Siciński 2004).

Data analysis. — The polychaete and amphipod species richness (the number of species per sample, S) as well as Pielou's evenness (J) and the Shannon-Wiener Index (H′, $\log_e$) were calculated for each sample (Magurran 2004). We also analyzed the data at different taxonomic levels and calculated the mean number of polychaete and amphipod genera and families per sample as well as J and H′ at the genus and family levels. Results of those analyses are discussed against the backdrop of the entire macrobenthic community. The total macrozoobenthos abundance (excluding the colonial taxa, *e.g.*, the Bryozoa and Porifera), the number of phyla per sample, and the composition of higher taxa (the most important classes and orders) were also analyzed along the depth

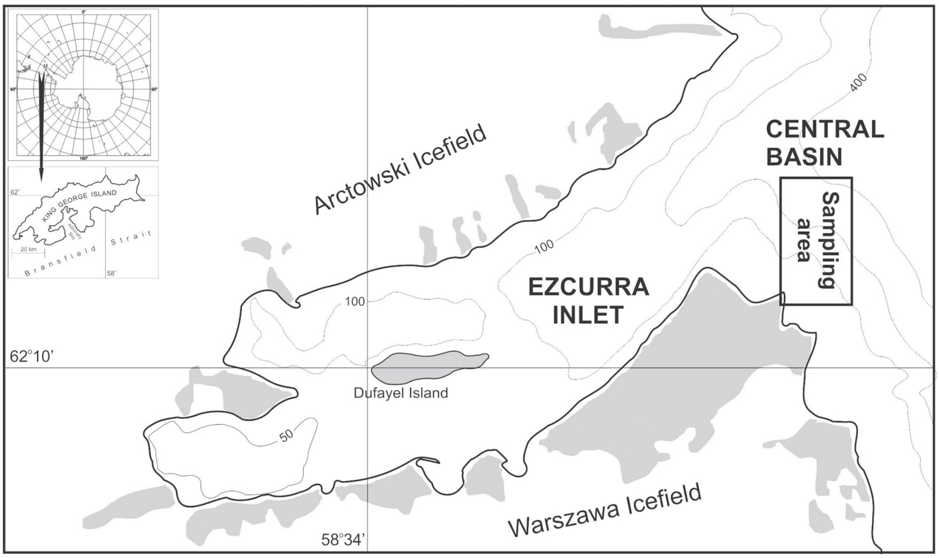

Fig. 1. Location of the sampling area in the Admiralty Bay.

gradient. Mean values with standard deviation (±SD) were calculated for all indices. The samples were split into five groups representing defined depth intervals (7–30 m with six samples; 40–90 m with ten samples; 100–150 m with seven samples; 200–300 m with nine samples; 400–500 m with three samples) to follow changes in abundance, diversity and composition of the benthic fauna along the Admiralty Bay central basin depth gradient. Significance of differences between the groups was tested using the non-parametric Kruskal-Wallis test, Dunn's test was used to identify, post-hoc, the significantly different groups.

Linear regression was used to analyze the relationship between the amphipod and polychaete taxonomic (species-, genus-, family-level) richness, as proposed by Doerries and Van Dover (2003) and Li *et al*. (2006). Correlations between diversity measured at different taxonomic levels allow to assess the extent of usefulness of family- and genus-level data as surrogacy measures on the Antarctic shelf.

Detailed data about the species composition, distribution of faunal assemblages based on this set of samples was already published by Siciński (2004) and Jażdżewska and Siciński (2017). Here we have used this dataset for the specific analysis of surrogacy measures in diversity assessment along a depth gradient.

Results

Higher taxa: diversity and abundance. — The materials studied yielded a total of 23,555 individuals. The major contributors were the Amphipoda and the Polychaeta, with 6,298 and 5,373 individuals, respectively. Bivalves and oligochaetes were represented by 5,054 and 3,006 specimens, respectively. Other peracarids, *i.e*. cumaceans, isopods and tanaidaceans were represented by a total of almost 800 individuals; echinoderms, dominated (83%) by the Ophiuroidea contributed 869 individuals, whereas gastropods were represented by 588 specimens.

The highest mean macrozoobenthos abundance (1581 ± 730 ind./0.1 m^2) was recorded in the shallowest (7–30 m) sublittoral. The abundance was observed to decrease with depth, down to the lowest mean value (384 ± 145 ind./0.1 m^2) within the 400–500 m depth range (Fig. 2A). The number of phyla per sample (6 ± 1/0.1 m^2) was the lowest within the 7–30 m depth range and was observed to increase along the depth gradient down to 200–300 m, and to decrease again at 400–500 m (Fig. 2B).

The dominance structure and contributions of higher taxa varied along the Admiralty Bay central basin depth gradient. Amphipods were the most abundant macrobenthos component in the shallowest sublittoral, with the highest abundance (1724 ind./0.1 m^2, *i.e*. 29% of the fauna) in the 25 m sample (Fig. 3). The middle sublittoral macrobenthos (40–150 m) was dominated by polychaetes and

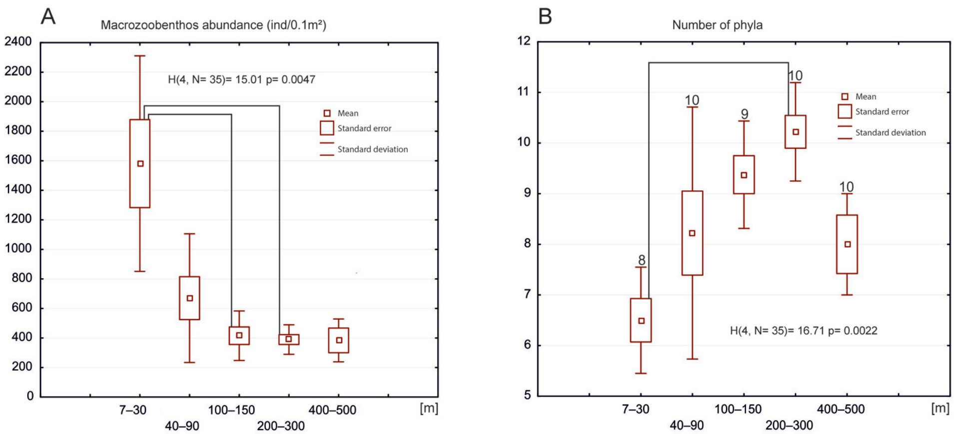

Fig. 2. Mean macrozoobenthos abundance (A) and mean number of phyla per sample (B) along the Admiralty Bay central basin depth gradient. Total number of phyla in each depth range is indicated; results with statistically significant differences are connected with lines.

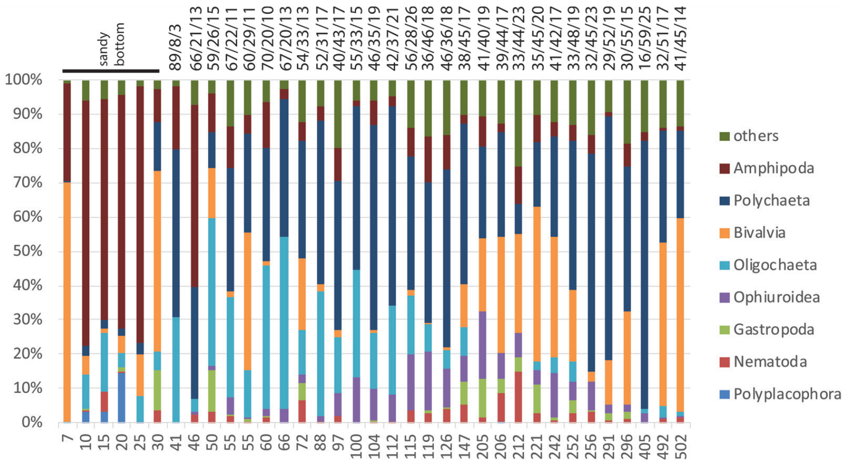

Fig. 3. Major taxa-based macrozoobenthos composition (most important classes and orders) along the depth gradient (data on sediment type in each sample, percent contributions of sand, clay and silt are indicated at the top).

oligochaetes, the former contributing up to 50% of the macrofauna at some stations (*e.g.*, 47% at 88 m). The macrobenthos sampled from the depth interval of 200–500 m was dominated by polychaetes and bivalves, the two taxa together contributing more than 80% of the fauna at some stations (Fig. 3).

Polychaeta and Amphipoda: diversity and abundance. — The materials examined revealed the presence of a total 120 and 104 species of amphipods and polychaetes, respectively. Amphipods were represented by 30 families and 77 genera. Most families were represented by one or two genera. The highest number of genera were found for Lysianassidae, Pontogeneiidae and Stenothoidae (eight genera in each family). Polychaetes were represented by 32 families and 99 genera. The highest number of genera was found in Terebellidae (14 genera), Maldanidae (10 genera) and Polynoidae (8 genera). Majority of families were represented by one to three genera.

In the Admiralty Bay central basin, the depth gradient-related patterns of diversity and abundance of the two groups were completely different. Sediment characteristics also changed between shallow sublittoral and deeper areas (Table 1). The mean amphipod abundance was at its highest (793 ± 541 ind./0.1 m^2) on the sandy bottom within the 7–30 m depth range and dropped sharply (to 74 ± 83 ind./0.1 m^2) within the 40–90 m range (Fig. 4A).

Table 1

Sediment characteristics in the investigated depth zones (mean values with standard deviation) So – sorting coefficient, Sk – skewness, Md – median grain size. For depth range 7–30 m no sediment details were available.

Sediment characteristics	40–90 m	100–150 m	200–300 m	400–500 m
Skeletal fraction [%]	16.2 ± 12.4	21.3 ± 12.3	13.8 ± 11.8	3.0 ± 2.6
1–0.5	2.1 ± 1.3	5.1 ± 2.1	4.7 ± 3.1	1.0 ± 0.00
0.5–0.25	3.2 ± 3.3	3.7 ± 1.2	4.0 ± 1.5	1.3 ± 0.5
0.25–0.1	39.2 ± 13.1	21.7 ± 2.9	15.7 ± 2.1	14.0 ± 6.08
0.1–0.05	24.8 ± 7.7	20.5 ± 4.9	15.8 ± 1.6	22.3 ± 8.9
0.05–0.02	10.0 ± 2.7	15.8 ± 3.04	21.1 ± 4.1	20.0 ± 3.4
0.02–0.006	7.5 ± 3.3	13.0 ± 3.4	16.4 ± 1.9	20.0 ± 6.2
0.006–0.002	4.1 ± 2.0	8.3 ± 1.3	10.1 ± 1.4	9.0 ± 3.0
< 0.002	8.8 ± 2.6	11.6 ± 1.4	11.8 ± 2.2	12.3 ± 3.2
Sand [%]	64.8 ± 10.9	44.8 ± 7.4	34.7 ± 4.5	29.6 ± 12.6
Clay [%]	23.3 ± 7.5	37.8 ± 6.2	46.1 ± 4.7	51.6 ± 7.0
Silt [%]	11.7 ± 3.9	17.6 ± 1.8	19.1 ± 2.6	18.6 ± 5.6
Md	3.4 ± 0.4	4.2 ± 0.3	4.8 ± 0.2	4.9 ± 0.9
So	1.2 ± 0.09	1.4 ±0.06	1.4 ± 0.08	1.3 ± 0.06
Sk	1.2 ± 0.1	1.1 ± 0.1	0.9 ± 0.07	1.1 ± 0.1

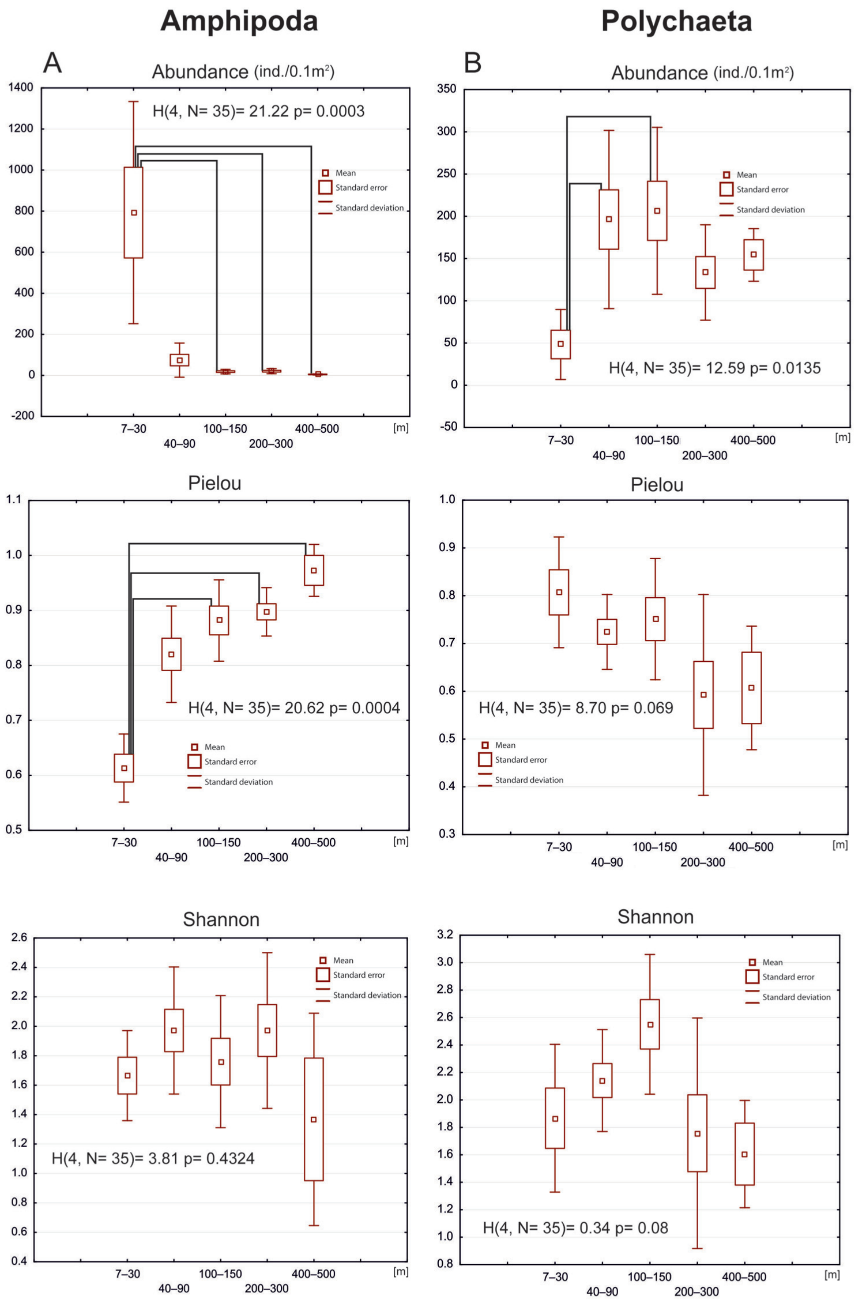

Fig. 4. Mean abundance, Pielou's evenness and Shannon-Wiener diversity (calculated on species-level data) for amphipods (A) and polychaetes (B) along the Admiralty Bay central basin depth gradient; results with statistically significant differences are connected with lines.

The polychaetes showed an opposite trend: the mean abundance was at its lowest (48 ± 41 ind./0.1 m^2) within the 7–30 m depth range, the maximum mean abundance (206 ± 99 ind./0.1 m^2) being recorded at 100–150 m (Fig. 4B).

The amphipod species richness was observed to decrease along the depth gradient (Fig. 5A). The highest mean number of species per sample (16 ± 5/0.1 m^2) was recorded within 7–30 m, the lowest mean (5 ± 3/0.1 m^2) being found within 400–500 m. The pattern was different in polychaetes. Generally, the mean polychaete species richness was higher than that of amphipods. The highest polychaete species richness was observed in the middle sublittoral (30 ± 8/0.1 m^2 within 100–150 m). The lowest mean numbers of species per sample, 14 ± 2/0.1 m^2 and 11 ± 5/0.1 m^2, were found at the deepest (400–500 m) and at the shallowest (7–30 m) stations, respectively (Fig. 5B).

Pielou index for amphipods was the lowest (0.61 ± 0.62) within 7–30 m, and increased with depth (Fig. 4A). The pattern was again opposite in polychaetes, with the highest values (0.81 ± 0.12) within 7–30 m and the lowest (0.59 ± 0.21) within 200–300 m (Fig. 4B).

The amphipod diversity showed no clear pattern regarding the depth gradient. The mean Shannon-Wiener index reached the maximum (1.97 ± 0.53) within 200–300 m, the minimum (1.37 ± 0.72) being recorded within 400–500 m (Fig. 4A). The mean Shannon-Wiener index value for polychaetes (1.60 ± 0.39) was the lowest within 400–500 m, the maximum mean (2.55 ± 0.51) being recorded within 100–150 m (Fig. 4B).

In both, polychaetes and amphipods the general pattern of taxonomic richness at the genus and family level fully corresponds with that visible at the species level (Figs 5, 6). The regression analysis showed the strong relationship between amphipod species richness and the taxonomic richness at the genus and family level, the respective coefficients of determination (R^2) amounting to 0.97 and 0.88 (Fig. 7A). A similar result was produced by the polychaete data: the polychaete species richness showed strong linear relationship with the taxonomic richness at the genus and family level, and the respective coefficients of determination (R^2) amounted to 0.99 and 0.85 (Fig. 7B).

Discussion

Depth-related distribution patterns in diversity and abundance. — Although the classic analysis of distribution patterns and/or changes in diversity and abundance of benthic fauna along depth gradients still remains an important topic in marine biology (*e.g.*, Maciolek and Smith 2009; Mutlu and Ergev 2013; Nephin *et al*. 2014; Enge *et al*. 2016), most of the relevant studies conducted in the Southern Ocean concern shallow areas. For example, Smale (2008) referred to

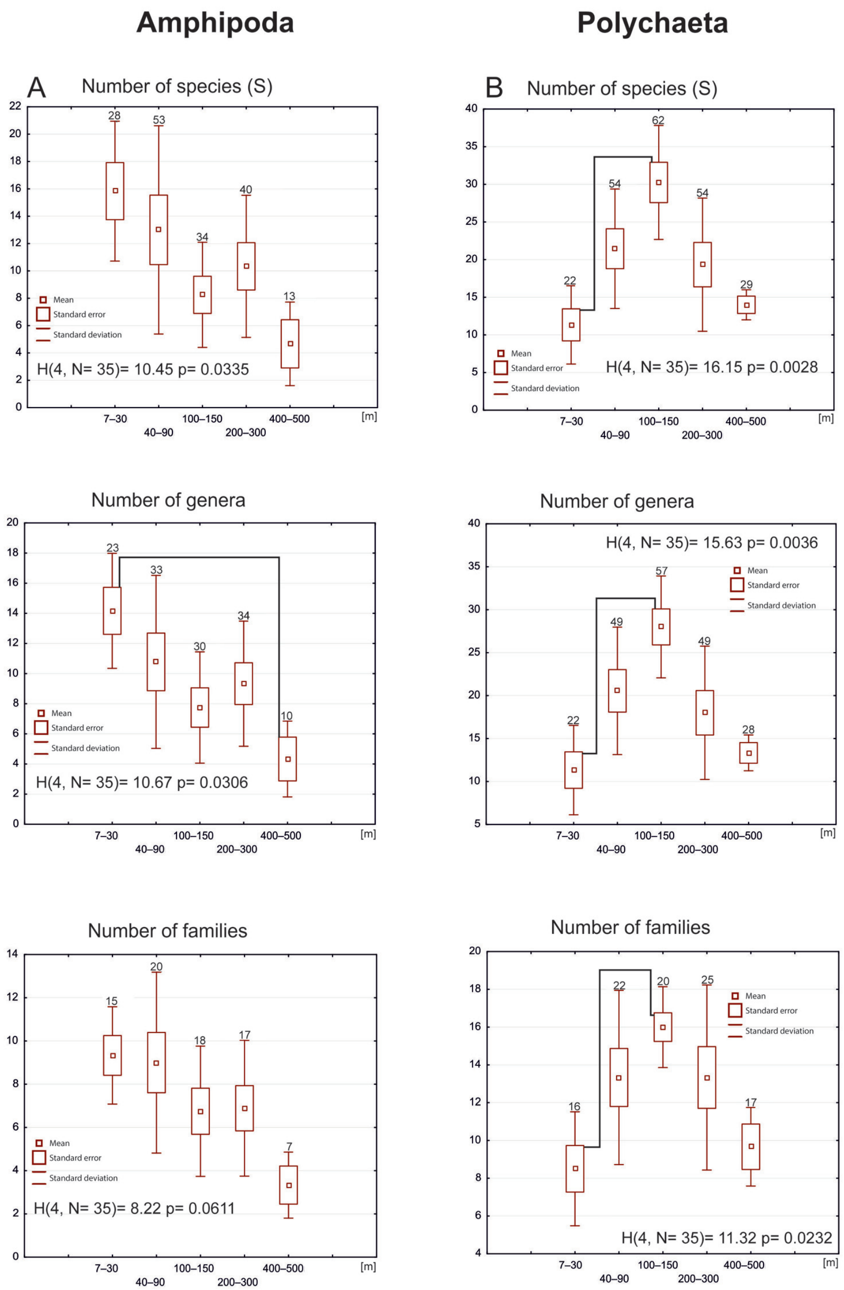

Fig. 5. Mean number of species, genera and families per sample for amphipods (A) and polychaetes (B) along the Admiralty Bay central basin depth gradient. Total number of species, genera and families in each depth range is indicated; results with statistically significant differences are connected with lines.

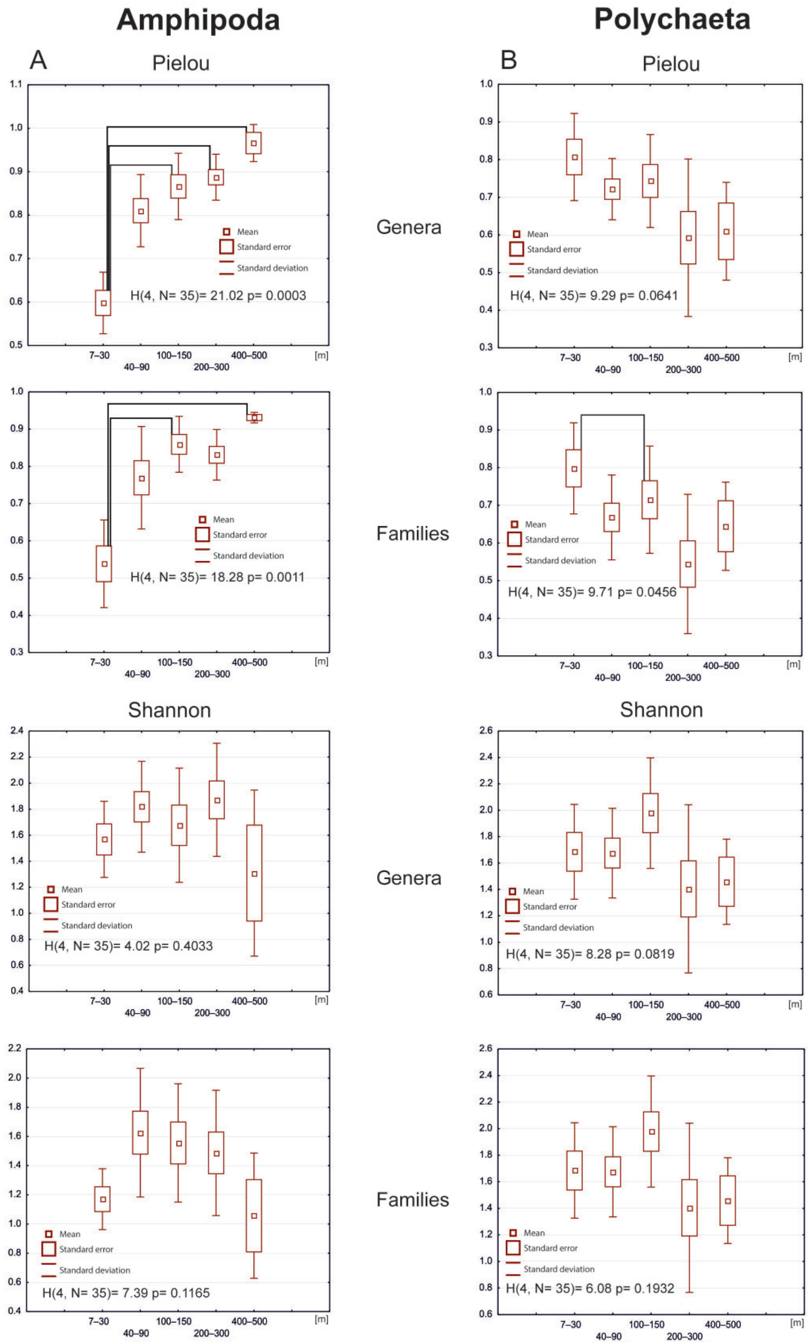

Fig. 6. Mean Pielou's evenness and Shannon-Wiener diversity values calculated on genus- and family-level data for amphipods (A) and polychaetes (B) along the Admiralty Bay central basin depth gradient; results with statistically significant differences are connected with lines.

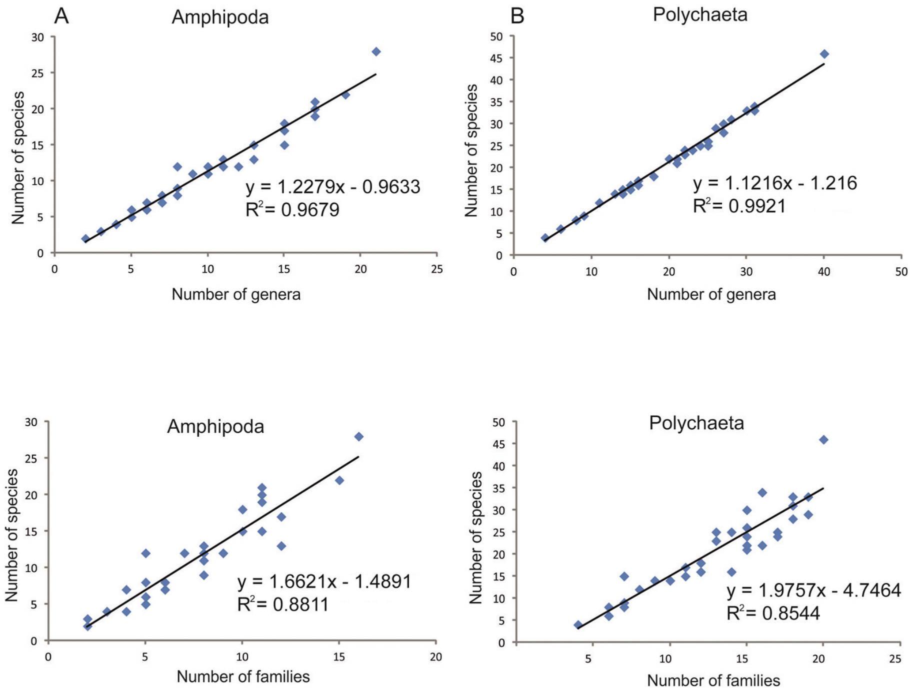

Fig. 7. Linear regression between amphipod (A) and polychaete (B) species richness and their taxonomic richness at the genus and family level.

about 30 published studies devoted to changes in the community structure along a bathymetric gradient of shallow areas on the Antarctic shelf. Moreover, it is often difficult to compare results such as ours, from a small semi-enclosed fjord, with data collected in open shelf systems or spanning wide depth ranges down to the slope depths (Saiz-Salinas *et al*. 1997, 1998; Gutt and Starmans 1998; Aldea *et al*. 2008; Kroger and Rowden 2008; Neal *et al*. 2018). For example, Aldea *et al*.'s (2008) analysis of depth-related distribution patterns of bivalves and molluscs from South Shetlands demonstrated no large depth-related differences along a 0–400 m depth gradient. For polychaetes in the Scotia Sea and the Amundsen Sea, depth was proved a major driver of the community change (Neal *et al*. 2018), although the authors cited admitted that the low sampling effort in shallower shelf areas (200–500 m) prevented any more detailed analysis of that part of the seafloor. On the other hand, a study on the polychaete fauna distribution along a 50–750 m depth gradient in the Ross Sea (Kroger and Rowden 2008) demonstrated relatively small changes in faunal composition between three depth zones sampled (50–250, 250–500 and 500–750 m) and linked them mostly with the chlorophyll *a* content, sediment sorting coefficient and effects of iceberg disturbance. It is also worth mentioning that large changes have been occasionally observed even within a narrow depth range. Smale (2008), who revealed no clear zonation of benthic communities, showed evidence of patchiness in the 5–35 m depth range.

Our results show similarities in patterns of abundance and diversity with those emerging from studies carried out at some Arctic sites. In their study on the macrozoobenthos sampled within 200–3000 m depth in the Kongsfjorden and neighbouring areas of Svalbard Węsławski *et al*. (2003) reported a clear depth-related decline in the abundance and species richness. Similarly, Vanaverbeke *et al*. (1997) recorded a depth-related trend of decreasing densities and numbers of genera in the Laptev Sea meiobenthos, explained as a result of decreasing organic matter supply; however, their depth range sampled (65–3237 m) differed significantly from the depth range of our study.

In this study, the highest abundances of the total macrobenthos were observed at the shallowest stations (< 30 m). The abundances decreased with depth, although there were differences between individual major taxa. Mass occurrences of amphipods in shallow waters of the Admiralty Bay had been previously reported by Jażdżewski *et al*. (1991) and Jażdżewski and Siciński (1993); high abundances of the Polyplacophora in shallower areas of the basin were also observed (Jażdżewski and Siciński 1993). The presence of a clear depth boundary at 30–40 m, associated with changes in sediment type and intensity of iceberg disturbance in the shallow sublittoral, had been previously observed in the Admiralty Bay's central basin (Siciński *et al*. 2011). The highest polychaete diversity was observed at intermediate depths (100–150 m), the lowest being typical for the shallowest stations (7–30 m). On the other hand, Pabis and Siciński (2010) reported the highest diversity of the Admiralty Bay polychaetes to be typical of the deepest stations (260–500 m). This differences in the results may be due to the use of different sampling methods: quantitative point samplers in this study and dredging used by Pabis and Siciński (2010).

Besides depth, the sediment type is often referred to as another major factor influencing the structure of benthic communities (Kaczmarek *et al*. 2005; Włodarska-Kowalczuk 2007; Aldea *et al*. 2008). The distinct change from the sandy bottom in shallower areas to the silt and clay seafloor in the deeper sublittoral affected the distribution of the Admiralty Bay zoobenthos as observed in this study. This is not surprising, as the sediment type effects have already been reported for the basin (Siciński 2004; Pabis and Błażewicz-Paszkowycz 2011; Siciński *et al*. 2011; Jażdżewska and Siciński 2017).

Strong discrepancy between the patterns observed for polychaetes and for amphipods shows also how important is to combine the analysis of these two taxa. Both groups belong to the most speciose non colonial benthic macroinvertebrates in the Southern Ocean (De Broyer *et al*. 2011), therefore it is reasonable to use them in the diversity assessments and studies of ecosystem response to changing environmental conditions. Such approach is also with agreement of the general idea of the polychaete/amphipod ratio (Andrade and Renaud 2011).

Surrogacy measures. — The depth- and sediment-related patterns in the Admiralty Bay macrozoobenthic community structure discussed above provide a good basis for testing the surrogacy measure approach in the Antarctic fjords. The Admiralty Bay may be treated as a model fjordic system in the Southern Ocean. The Census of the Antarctic Marine Life output indicated the bay as a good monitoring site for various climate change-related alterations in the benthic community structure (Siciński *et al*. 2011). Therefore, an attempt to explore the potential applicability of a lower taxonomic resolution might prove very important for future studies in the basin. Species level-based biodiversity assessments are often time-consuming and require the taxonomic expertise (Musco *et al*. 2011). In this context, it is worth mentioning that many species level data-based Antarctic studies were published 4–15 years after the sampling programs were completed (*e.g*., Kroger and Rowden 2008; Parapar *et al*. 2011; Pabis *et al*. 2015; Neal *et al*. 2018). And yet, monitoring of the on-going changes requires repeated sampling events and generates large amounts of data in a relatively short period of time. A system of surrogacy measures has been discussed in the literature for many years; it is most often used in the monitoring studies of various human-related disturbance processes (Olsgard and Sommerfield 2000; Bertasi *et al*. 2009; Bevilacqua *et al*. 2012). Some attention has been paid to the idea of taxonomic sufficiency, based on the assumption that organisms should only be identified to a taxonomic resolution level sufficient to satisfy the objective of a study (Ellis 1985; Bertrand *et al*. 2006). However, it is often difficult to ascertain whether patterns observed at a higher taxonomic level paint a really meaningful picture. The results may vary depending on the region, season, major ecological factors or a sampling method used. The higher taxon approach is suggested mainly for monitoring studies of impacted areas when large, repeatedly collected sets of samples are available (Olsgard *et al*. 1998; Dauvin *et al*. 2003), although the approach has also been successfully tested in naturally disturbed marine basins such as Arctic fjords or at non-disturbed sites. For example, the approach has been applied to the Kongsfjorden macrofauna assemblages (Włodarska-Kowalczuk and Kędra 2007), the Puget Sound nearshore communities (Dethier and Schoch 2006), and the macrofauna of the Santa Giusta lagoon (Western Mediterranean) (Tataranni *et al*. 2009). In their analysis of the Kongsfjorden macrobenthic communities, Włodarska-Kowalczuk and Kędra (2007) reported even that little information was lost when organisms were identified to the order level, and recommended the family level as a reliable measure of benthic response to environmental gradients. Conversely, Musco *et al*. (2011) suggested that taxonomic sufficiency needs to be treated with caution as it may cause loss of information, particularly at the family level and when data are transformed. The approach may also be not sufficient enough when differences among assemblages are not robust (Musco *et al*. 2009). In the Southern Ocean, the surrogacy approach has been so far tested only on the Admiralty Bay amphipod fauna by Jażdżewska and Siciński (2017). The results of that study suggested that the higher taxon level (genus or family) should not be used as a surrogate of the species-level identification, but the authors referred to deal with the problem only with respect to the similarity analysis (Bray-Curtis-based clustering). The present study was focused on the richness and diversity assessment, and demonstrated the usefulness of taxonomic surrogates. Generally, our diversity assessment produced almost an identical pattern for species-, genus- and family-level data, both for polychaetes and amphipods. Such close similarities are in agreement with the results of Włodarska-Kowalczuk and Kędra (2007).

Results of our study and the study of Jażdżewska and Siciński (2017) showed important problems associated with use of higher taxonomic level data in the analysis of Antarctic benthic communities. Different types of analysis, diversity indices or statistical and multivariate methods can react in different way to the raw data used. Based on the results of those two studies it is difficult to present a clear interpretation of pros and cons of the surrogacy approach in the Antarctic fjords. It seems that use of generic or family level data is strongly affecting the analysis of community composition, however it could be useful in the biodiversity assessments conducted along the clear environmental gradients. It seems to be obvious that analysis of species level data is generally more reliable. On the other hand we have to take into account also some practical aspects of such studies. The discussion about influence of climate change on Antarctic benthos is among the most important topics of the current polar science (Ingels *et al*. 2012). At the same time the number of studies describing long term temporal changes in the Antarctic benthic communities is very scarce and – what is more important – gaps between the sampling periods are too large to detect gradual changes in diversity (Moon *et al*. 2015; Sahade *et al*. 2015; Meden *et al*. 2017). All those studies dealt only with megaepifaunal communities and concerned taxa that are relatively easy to identify, even from seafloor images. At the same time, there are no data regarding changes that might have taken place in the infaunal benthic communities, including taxa like polychaetes and amphipods that numerically dominate on the Antarctic shelf. Both groups belong also to most speciose taxa in the Southern Ocean (De Broyer *et al*. 2011). Time consuming species level identification of such soft bottom datasets precludes the assessment of ongoing changes and the discussion of possible reaction scenarios in a reasonable period of time. There is a need for repeated studies conducted simultaneously at different soft-bottom stations in various locations. Only sampling conducted every year may show complexity of faunal dynamics in the Antarctic shelf and its relationship with dynamic environmental processes associated with global environmental changes. Our study suggests that such approach based on higher taxa identification is possible and can generate valuable results in a short period of time. Although it is important that such results need to be treated with caution, our study does provide a baseline for further research. Nevertheless, it is worth remembering that various climate related changes in disturbance processes might also affect the composition of fauna. It is well known that assemblages characterized by similar diversity might have different species composition (*e.g*., Siciński 2004; Pabis and Siciński 2010). On the other hand disturbances processes typical for polar regions, including increased sedimentation, silting of bottom sediments or higher level of ice scour are generally strongly correlated with changes in species richness and diversity (*e.g*., Włodarska-Kowalczuk and Kędra 2007). Therefore, despite the possible loss of information in the analysis of faunal composition, such approach may still be very useful in case of long term studies of ecosystem response to changes in environmental conditions. It seems very important that a similar approach should be tested on different datasets (depth, sedimentation, ice disturbance gradients) based on a larger sampling effort.

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