Polar Biol (2007) 30:477–486
DOI 10.1007/s00300-006-0206-6

ORIGINAL PAPER

# Biodiversity and structure of the suprabenthic assemblages from South Shetland Islands and Bransfield Strait, Southern Ocean

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Received: 30 March 2006 / Revised: 17 August 2006 / Accepted: 22 August 2006 / Published online: 10 January 2007

**Abstract** During the austral summer 1995, suprabenthic samplings were carried out at 24 stations (depth range 45–649 m) located around Livingston Island, within the caldera of Deception Island and in the Bransfield Strait. At each station, the near-bottom motile fauna was simultaneously collected with a multinet Macer-GIROQ sled in three water layers above the bottom. This study presents original data on the occurrence, diversity, vertical distribution and abundance of suprabenthic taxa in this near-bottom environment. The most speciose taxa were amphipods (at least 140 spp.), followed by isopods (66 spp.), pycnogonids (31 spp.) and mysids (19 spp.). Total abundances ranged between 31 ind./100 $m^2$ (Bransfield Strait, 361 m depth) and 6817 ind./100 $m^2$ (South Livingston Island, 163 m depth). According to stations, the groups numerically dominant and more frequent were amphipods (17 stations) or mysids (seven stations). Four suprabenthic assemblages were discriminated in the study area, apparently more structured by the degree of shelter-exposure and development of sessile epifauna than by water depth or sediment features.

## Introduction

Although the intensity of suprabenthic researches has increased in recent years around the world seas (see review in Mees and Jones 1997), up to now, few studies have been conducted on the structure of Antarctic suprabenthic assemblages (San Vicente et al. 1997; Linse et al. 2002; Lörz and Brandt 2003).

Living in the near-bottom environment, suprabenthos (or hyperbenthos) populations are presumed to contribute significantly to biogenic modification (bioturbation, bioresuspension and particle flux) in the benthic ecosystem (Brandt 1993, 1995; Svavarsson et al. 1993). They are also considered as a food resource from many Antarctic predators: typical suprabenthos groups like mysids, amphipods and isopods are known to be a potential food for many species of seals (Tattersall 1965), penguins (Tattersall 1951), benthic fishes (Olaso 1999; Olaso et al. 2000) and shrimps (Storch et al. 2001).

Suprabenthic assemblages sampled during BENTART-95 cruise around South Shetland Islands and Bransfield Strait were preliminary described by

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San Vicente et al. (1997) at a low taxonomical level (order). During subsequent years, studies on the collected fauna were mainly focused on species identification of pycnogonids (Munilla 2001a, b), cumaceans (Corbera 2000), isopods (Castello 2004), mysids and euphausiids (San Vicente et al. 2006).

The main objectives of the present study are to provide new data on occurrence, geographical and bathymetrical distribution of species, and to describe the structural organisation of the suprabenthic assemblages from the investigated Antarctic area.

## Materials and methods

During cruise BENTART-95 (January–February 1995) on board of the RV *Hesperides*, 24 stations (depth range 45–649 m; Table 1, Fig. 1) located around Livingston Island, within the caldera of Deception Island and in the Bransfield Strait were sampled with a modified Macer–GIROQ sled (see full description of this gear in Cartes et al. 1994). This sled is equipped with three superimposed nets (0.5 mm mesh size) that simultaneously sample motile fauna in the 10–50 cm ($N_1$), 55–95 cm ($N_2$) and 100–140 cm ($N_3$) near-bottom water layers. Each net is fixed to an anterior rectangular box (width 80 cm; height 40 cm) and equipped with an opening-closing system activated by contact with the sea-floor (to prevent contamination of suprabenthic samples by organisms from the water column). The sled is towed over the sea bottom for 1–2 minutes at 1.5–2 knots.

The sled nets $N_2$ and $N_3$ were also equipped with a flowmeter fixed behind the opening-closing system of their respective boxes for measurement of haul length. Unfortunately, during BENTART samplings, these flowmeters did not operate correctly for unknown reason and such measurements were not used in this study. Bottom haul length was therefore estimated from GPS-derived position of the research vessel at the beginning and at the end of each tow, by means of the following formula (Brandt and Barthel 1995; Linse et al. 2002; Lörz and Brandt 2003):

**Table 1** Geographical location and depth of the BENTART-95 suprabenthic sampling stations around the South Shetland Island and in the Bransfield Strait (Antarctic Peninsula). Haul lengths calculated from GPS-derived position of the research vessel at the beginning and at the end of each tow (Brandt and Barthel 1995)

| Area | Station | Date | Time | Initial position | | Final Position | | Depth (m) | Length of haul (m) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Latitude (S) | Longitude (W) | Latitude (S) | Longitude (W) | | |
| Deception Island | 17 | 23/01/95 | 21:06 | 62°59.55′ | 60°35.44′ | 62°59.52′ | 60°35.52′ | 107 | 87 |
| Deception Island | 18 | 24/01/95 | 14:38 | 62°57.93′ | 60°40.57′ | 62°57.92′ | 60°40.56′ | 115 | 20 |
| Deception Island | 2 | 16/01/95 | 17:06 | 62°55.98′ | 60°38.92′ | 62°55.99′ | 60°39.00′ | 141 | 70 |
| Deception Island | 11 | 20/01/95 | 16:30 | 62°57.05′ | 60°39.49′ | 62°57.07′ | 60°39.53′ | 167 | 50 |
| Deception Island | 12 | 20/01/95 | 21:48 | 62°57.48′ | 60°38.05′ | 62°57.50′ | 60°38.10′ | 167 | 56 |
| South Livingston Island | 6 | 18/01/95 | 15:58 | 62°43.67′ | 60°26.55′ | 62°43.64′ | 60°26.63′ | 45 | 88 |
| South Livingston Island | 3 | 17/01/95 | 3:07 | 62°37.84′ | 60°22.97′ | 62°37.88′ | 60°22.93′ | 89 | 82 |
| South Livingston Island | 9 | 19/01/95 | 20:08 | 62°39.73′ | 60°39.36′ | 62°39.74′ | 60°39.41′ | 163 | 46 |
| South Livingston Island | 4T1 | 17/01/95 | 13:44 | 62°38.47′ | 60°24.47′ | 62°38.47′ | 60°24.37′ | 176 | 85 |
| South Livingston Island | 4T2 | 17/01/95 | 20:47 | 62°38.74′ | 60°24.92′ | 62°38.76′ | 60°24.97′ | 188 | 56 |
| South Livingston Island | 10 | 19/01/95 | 23:47 | 62°40.41′ | 60°38.41′ | 62°40.44′ | 60°38.36′ | 221 | 70 |
| South Livingston Island | 19 | 25/01/95 | 14:19 | 62°43.74′ | 60°31.29′ | 62°43.73′ | 60°31.31′ | 234 | 25 |
| South Livingston Island | 5 | 18/01/95 | 13:50 | 62°41.12′ | 60°30.96′ | 62°41.08′ | 60°30.91′ | 262 | 85 |
| South Livingston Island | 15 | 22/01/95 | 17:01 | 62°45.40′ | 60°35.77′ | 62°45.33′ | 60°35.83′ | 331 | 139 |
| South Livingston Island | 21 | 28/01/95 | 16:14 | 62°49.49′ | 60°24.98′ | 62°49.51′ | 60°24.97′ | 420 | 38 |
| South Livingston Island | 16 | 24/01/95 | 22:36 | 62°45.67′ | 60°32.26′ | 62°45.62′ | 60°32.35′ | 427 | 120 |
| North Livingston Island | 27 | 02/02/95 | 14:35 | 62°20.59′ | 60°19.13′ | 62°20.60′ | 60°19.30′ | 71 | 147 |
| North Livingston Island | 28 | 02/02/95 | 18:36 | 62°12.03′ | 60°22.50′ | 62°12.03′ | 60°22.67′ | 124 | 147 |
| North Livingston Island | 29 | 03/02/95 | 15:19 | 62°04.99′ | 60°25.73′ | 62°04.96′ | 60°25.70′ | 242 | 61 |
| North Livingston Island | 30 | 04/02/95 | 2:26 | 62°01.45′ | 60°25.75′ | 62°01.44′ | 60°25.80′ | 649 | 47 |
| Bransfield Strait | 23 | 29/01/95 | 21:34 | 63°57.23′ | 60°58.30′ | 63°57.22′ | 60°58.30′ | 104 | 19 |
| Bransfield Strait | 22 | 31/01/95 | 23:27 | 63°03.56′ | 60°39.54′ | 63°03.59′ | 60°39.54″ | 330 | 56 |
| Bransfield Strait | 25T1 | 30/01/95 | 16:34 | 63°56.64′ | 60°41.36′ | 63°56.63′ | 60°41.18′ | 357 | 148 |
| Bransfield Strait | 25T2 | 30/01/95 | 17:50 | 63°56.64′ | 60°41.36′ | 63°56.63′ | 60°41.19′ | 361 | 140 |

Haul lengths calculated from GPS-derived position of the research vessel at the beginning and at the end of each tow (Brandt and Barthel 1995)

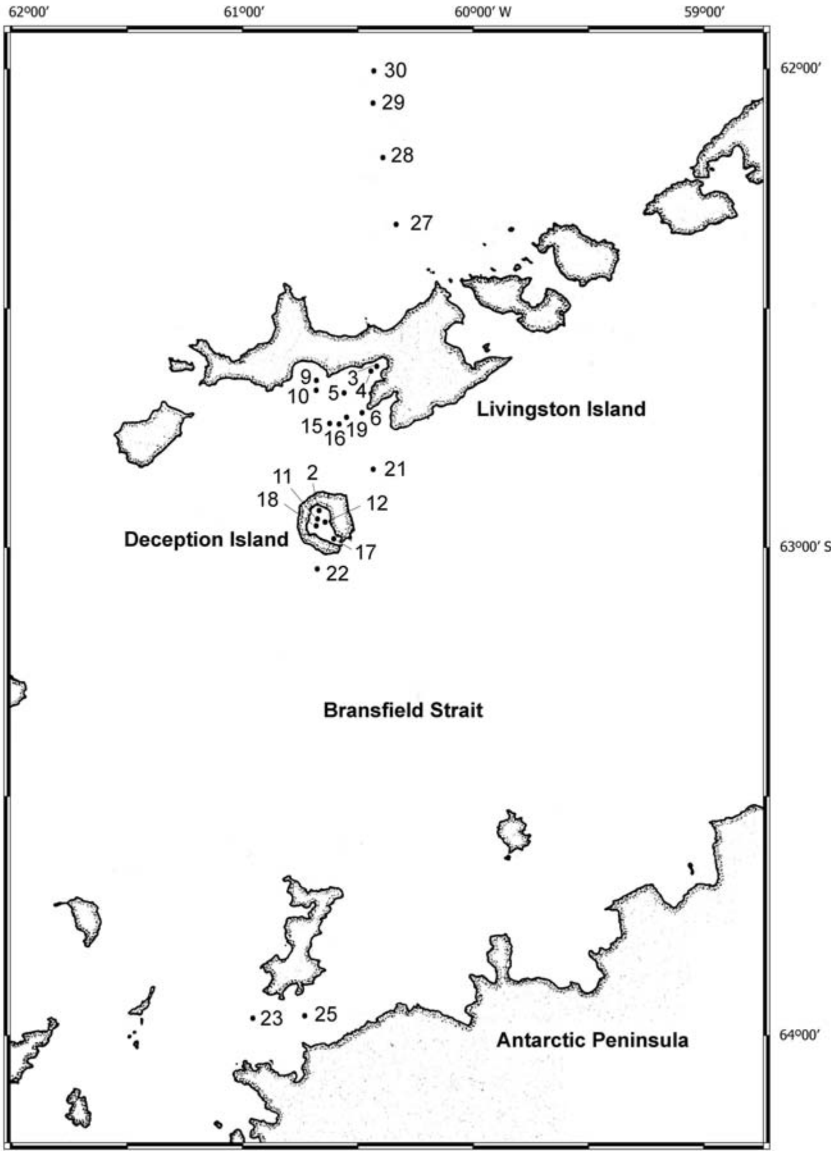

**Fig. 1** Position of the BENTART-95 sampling stations around the South Shetland Island and in the Bransfield Strait (Antarctic Peninsula)

$$\text{Haul length(m)} = 1852\sqrt{((\Delta\text{lat}')^2 + \cos\text{lat}'\Delta\text{long}')^2}$$

where $\Delta\text{lat}'$ and $\Delta\text{long}'$ are the difference in latitude and longitude between starting and ending points, respectively. During BENTART samplings, haul lengths ranged between 19 and 147 m (Table 1). Density values were calculated from haul lengths and were expressed in two ways, both with respect to the area swept by the sled on the sea floor (ind./100 $m^2$) and to the volume of water filtered by the nets (ind./1,000 $m^3$) for comparison with values taken from the literature.

The material sampled with the sled was sorted on board into main taxonomic groups and then preserved with 10% neutral formalin until laboratory identification to the lowest possible taxon. Small zooplankton components (copepods, ostracods, chaetognaths) and demersal fishes were excluded from this study.

Data were analysed using PRIMER v5 software (Clarke and Gorley 2001). Univariate diversity indices (Shannon-Wiener diversity $H'$-$\log_2$) were calculated from species abundance data. Intersample similarities were calculated using Bray-Curtis coefficients based on ‘‘fourth root’’ transformed relative abundance data (%$N_t$). Intersample similarities were ordinated using non-metric multi-dimensional scaling (MDS). Differences between groups of samples were addressed using ANOSIM test and routine SIMPER (‘‘similarity percentage’’) was used to discriminate species and their percentage contribution to (dis) similarities within and between groups defined by the MDS. K-dominance plots were constructed in order to examine changes in dominance and diversity.

## Results

The overall material collected in the 10–140 cm water layer of the 24 sampling stations contained a total of 24,027 individuals sorted into eigh taxonomic groups (amphipods: 60.2% of total individuals; mysids: 24.8%; cumaceans: 5.1%; isopods: 4.5%; euphausiids: 3.6%; pycnogonids: 0.8%; tanaids: 0.7%; decapods: 0.3%) and belonging to a minimum of 300 species (Table 2). The highest number of species was shown by amphipods with 140 species (46.7% of total number), followed by isopods (66 spp.), pynogonids (31 spp.), cumaceans (29 spp.), mysids (19 spp.), tanaids (8 spp.), euphausiids (5 spp.) and decapods (2 spp.). 276 species (92.0% of total) were recorded in the lowermost level sampled by the sled ($N_1$) but only 131 and 91 species in the upper levels $N_2$ and $N_3$, respectively.

Abundance, species richness and diversity of the suprabenthic species sampled in the 10–140 cm near-bottom water layer of BENTART-95 sampling stations are available from <http://www.personal.telefonica.terra.es/web/cumacea/PDFs/annex.pdf>. Species richness of all sampling stations (10–140 cm water layer) ranged between eight (station 12) and 77 species (station 30). At all stations, species number showed a decreasing vertical gradient from the sediment-water interface to the water column and a consequent decrease generally occurred between levels $N_1$ and $N_2$. Such a trend was also observed for all major groups (pycnogonids and peracarids).

Total abundance values (10–140 cm water layer) ranged between 31 and 6,817 ind./100 m$^2$ (station 25T2 from Bransfield Strait and station 9 from South Livingston, respectively) (Table 3). At most stations, amphipods were dominant (37.1–94.8% of total abundance) except at stations 18, 2, 11 and 12 of Deception Island and stations 5 and 15 of South Livingston Island where mysids ranked first (57.8–92.2%). The major suprabenthic groups showed a clear vertical abundance gradient with a drastic decrease between level $N_1$ and $N_2$, except in the case of euphausiids which were often less abundant in the lowermost level sampled by the sled (Table 2). The highest diversity values were observed at the lowermost level of the sled.

The highest diversity value from the whole 10–140 cm water layer was observed at station 29 from North Livingston (H′ = 5.0) as a result of a more even distribution of taxa abundance and the lowest value was registered at station 27 from North Livingston (H′ = 0.6) due the predominance of the amphipod *Cardenio paurodactylus*. Station 27 where dominance is increased and diversity reduced (Fig. 3) was discarded by subsequently analysis and was not taken into consideration.

Three major groups of stations (A, B and C) can be discriminated in the two-dimensional MDS configuration of the 23 sampling sites (station 27 excluded), based on the relative species abundances of all stations (10–140 cm water layer) (Figs. 2, 3). A fourth group (D) can be also discriminated but with a low average similarity between stations (16.9%). All groups were significantly different (ANOSIM Global $R = 0.63$, $P < 0.001$, all pairwise $P < 0.05$) in terms of community structure. On the 300 species recorded, 46 (15.3%), contribute to up to 1% of dissimilarities between any pairwise of station groups (Table 4). These 46 species represented the 82.7% of total abundance of the 23 sampling sites (10–140 cm water layer).

The A assemblage with all stations from the Deception caldera (average similarity: 54.1%) (107–167 m depth) is characterized by five species represented more than 84.0% of cumulated similarity percentage: *Antarctomysis maxima* (23.2%), *Rhacho-*

**Table 2** Abundance and species richness of the main suprabenthic groups in the 10–50 ($N_1$), 55–95 ($N_2$), 100–140 cm ($N_3$) and 10–140 cm ($N_t$) near-bottom water layers sampled by the three nets of the sled during BENTART-95 cruise

| | Total individuals | | | | Total species | | | |
|---|---|---|---|---|---|---|---|---|
| | $N_1$ | $N_2$ | $N_3$ | $N_t$ | $N_1$ | $N_2$ | $N_3$ | $N_t$ |
| Pycnogonida | 156 | 23 | 18 | 197 | 28 | 12 | 8 | 31 |
| Mysidacea | 4978 | 635 | 336 | 5949 | 16 | 12 | 11 | 19 |
| Amphipoda | 13750 | 467 | 239 | 14456 | 126 | 58 | 42 | 140 |
| Cumacea | 1037 | 145 | 54 | 1236 | 29 | 19 | 10 | 29 |
| Isopoda | 1003 | 62 | 26 | 1091 | 62 | 20 | 14 | 66 |
| Tanaidacea | 171 | 8 | 0 | 179 | 8 | 3 | 0 | 8 |
| Euphausiacea | 222 | 388 | 246 | 856 | 5 | 5 | 5 | 5 |
| Decapoda | 44 | 15 | 4 | 63 | 2 | 2 | 1 | 2 |
| Total Suprabenthos | 21361 | 1743 | 923 | 24027 | 276 | 131 | 91 | 300 |

**Table 3** Faunal composition (number of taxa), abundance (ind./100 m$^2$) and diversity (H′, $\log_2$) of the major taxonomical groups sampled in the 10–140 cm near-bottom water layer of BENTART-95 sampling stations

| Zone | Deception Island | | | | | South Livingston Island | | | | | | | | | | | North Livingston Island | | | | Bransfield Strat | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stations | 17 | 18 | 2 | 11 | 12 | 6 | 3 | 9 | 4T1 | 4T2 | 10 | 19 | 5 | 15 | 21 | 16 | 27 | 28 | 29 | 30 | 23 | 22 | 25T1 | 25T2 |
| Depth (m) | 107 | 115 | 141 | 167 | 167 | 45 | 89 | 163 | 176 | 188 | 221 | 234 | 262 | 331 | 420 | 427 | 71 | 124 | 242 | 649 | 104 | 330 | 357 | 361 |
| Number of taxa | | | | | | | | | | | | | | | | | | | | | | | | |
| Pycnogonida | 0 | 0 | 0 | 0 | 0 | 6 | 7 | 5 | 2 | 3 | 1 | 11 | 0 | 1 | 5 | 8 | 0 | 0 | 4 | 10 | 0 | 3 | 4 | 2 |
| Mysidacea | 0 | 2 | 4 | 2 | 2 | 1 | 3 | 5 | 5 | 6 | 5 | 4 | 5 | 9 | 5 | 3 | 3 | 3 | 5 | 3 | 0 | 2 | 4 | 0 |
| Amphipoda | 20 | 7 | 4 | 8 | 4 | 23 | 33 | 18 | 17 | 18 | 11 | 41 | 16 | 21 | 33 | 31 | 8 | 22 | 25 | 32 | 15 | 10 | 19 | 9 |
| Cumacea | 2 | 0 | 0 | 1 | 0 | 6 | 6 | 7 | 8 | 5 | 9 | 5 | 2 | 5 | 7 | 9 | 1 | 12 | 10 | 13 | 1 | 2 | 5 | 2 |
| Isopoda | 5 | 0 | 0 | 0 | 0 | 19 | 11 | 9 | 4 | 2 | 4 | 11 | 1 | 4 | 15 | 7 | 2 | 7 | 11 | 11 | 6 | 2 | 5 | 2 |
| Tanaidacea | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 5 | 0 | 0 | 1 | 0 |
| Euphausiacea | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 1 | 3 | 2 | 0 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 3 | 0 | 2 | 1 | 1 |
| Decapoda | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Total | 28 | 11 | 9 | 13 | 8 | 57 | 61 | 45 | 41 | 37 | 31 | 76 | 27 | 42 | 68 | 62 | 16 | 46 | 57 | 77 | 22 | 21 | 41 | 16 |
| Abundance (ind./100 m$^2$) | | | | | | | | | | | | | | | | | | | | | | | | |
| Pycnogonida | 0 | 0 | 0 | 0 | 0 | 28 | 38 | 19 | 3 | 24 | 4 | 165 | 0 | 2 | 56 | 20 | 0 | 0 | 31 | 90 | 0 | 11 | 9 | 2 |
| Mysidacea | 0 | 344 | 1708 | 1354 | 915 | 3 | 155 | 2617 | 502 | 1248 | 163 | 303 | 1253 | 368 | 237 | 250 | 68 | 63 | 69 | 132 | 0 | 59 | 9 | 0 |
| Amphipoda | 4496 | 147 | 288 | 666 | 192 | 2255 | 862 | 3763 | 679 | 1324 | 193 | 5155 | 68 | 151 | 1359 | 260 | 2117 | 354 | 552 | 1949 | 136 | 311 | 52 | 19 |
| Cumacea | 7 | 0 | 0 | 3 | 0 | 145 | 273 | 342 | 166 | 69 | 131 | 75 | 10 | 14 | 40 | 94 | 4 | 290 | 81 | 153 | 7 | 18 | 8 | 3 |
| Isopoda | 19 | 0 | 0 | 0 | 0 | 802 | 48 | 57 | 18 | 13 | 21 | 244 | 2 | 23 | 306 | 36 | 12 | 25 | 163 | 230 | 48 | 7 | 5 | 5 |
| Tanaidacea | 0 | 0 | 0 | 0 | 0 | 110 | 112 | 0 | 2 | 0 | 0 | 5 | 2 | 0 | 17 | 0 | 0 | 5 | 2 | 34 | 0 | 0 | 1 | 0 |
| Euphausiacea | 219 | 104 | 726 | 30 | 388 | 0 | 0 | 19 | 10 | 13 | 0 | 100 | 2 | 7 | 3 | 8 | 8 | 1 | 4 | 40 | 0 | 7 | 2 | 3 |
| Decapoda | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 4 | 2 | 5 | 55 | 23 | 11 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Total | 4741 | 595 | 2723 | 2082 | 1494 | 3343 | 1487 | 6817 | 1384 | 2694 | 516 | 6101 | 1359 | 576 | 2017 | 668 | 2209 | 739 | 901 | 2629 | 190 | 413 | 89 | 31 |
| H’ ($\log_2$) | | | | | | | | | | | | | | | | | | | | | | | | |
| Pycnogonida | – | | – | – | – | 1.9 | 2.0 | 2.1 | 1.0 | 1.3 | 0.0 | 3.0 | – | 0.0 | 1.3 | 2.6 | – | – | 1.5 | 3.0 | – | 1.4 | 1.5 | 1.0 |
| Mysidacea | – | | 0.5 | 0.3 | 0.2 | 0.0 | 1.5 | 1.6 | 1.0 | 1.4 | 1.5 | 1.3 | 1.4 | 1.9 | 1.3 | 0.6 | 0.5 | 0.9 | 1.9 | 0.7 | – | 0.2 | 1.9 | – |
| Amphipoda | 0.9 | 1.8 | 0.6 | 0.8 | 0.4 | 2.6 | 3.6 | 1.6 | 1.7 | 1.2 | 2.2 | 4.0 | 3.7 | 3.6 | 3.4 | 3.9 | 0.3 | 3.4 | 3.9 | 3.2 | 3.8 | 2.0 | 3.6 | 2.8 |
| Cumacea | 0.7 | – | – | 0.0 | – | 1.5 | 1.9 | 1.3 | 2.0 | 1.1 | 1.3 | 2.2 | 0.6 | 1.8 | 2.7 | 1.7 | 0.0 | 2.2 | 2.8 | 3.4 | 0.0 | 0.8 | 2.0 | 0.9 |
| Isopoda | 1.8 | – | – | – | – | 3.0 | 3.1 | 2.6 | 1.7 | 0.7 | 1.6 | 2.6 | 0.0 | 1.8 | 3.0 | 2.6 | 0.7 | 2.5 | 2.2 | 2.3 | 2.5 | 0.9 | 2.3 | 1.0 |
| Tanaidacea | – | – | – | – | – | 0.2 | 0.0 | – | 0.0 | – | – | 0.0 | 0.0 | - | 0.7 | – | – | 0.0 | 0.0 | 1.7 | – | – | 0.0 | – |
| Euphausiacea | 0.0 | 0.7 | 0.0 | 0.0 | 0.1 | – | – | 0.0 | 1.1 | 0.7 | – | 1.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.5 | 0.0 | 0.0 | 1.3 | – | 0.9 | 0.0 | 0.0 |
| Decapoda | – | – | – | 0.0 | – | – | – | – | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | – | 0.0 | – | – | – | – | – | – | 0.8 | – |
| Total | 1.2 | 2.1 | 1.7 | 1.6 | 1.5 | 3.9 | 4.5 | 2.9 | 3.0 | 2.6 | 3.6 | 4.7 | 2.0 | 3.7 | 4.5 | 4.1 | 0.6 | 4.2 | 5.0 | 4.4 | 4.4 | 2.9 | 4.8 | 3.7 |

*tropis antarctica* (22.1%), *Euphausia crystallorophias* (19.4), Lysianassidae unid. (9.9%) and *Mysidetes posthon* (9.9%).

The B assemblage with eight stations from South Livingston (average similarity: 37.0%) (89–427 m depth) and 11 main taxa (61.3% of cumulated similarity percentage): *Mysidetes posthon* (14.0%), *Rhachotropis antarctica* (8.7%), *Antarctomysis maxima* (8.1%), *Leucon costatus* (5.5%), *Monoculodes antarcticus* (5.3%), Lysianassidae unid. (3.7%), *Pseudomma sarsi* (3.7%), Oedicerotidae unid. (3.6%),*Djerboa furcipes* (3.2%), *Vaunthompsonia* sp. (2.9%) and *Ceratoserolis trilobitoides* (2.4%).

Group C includes three stations from North Livingston (124–649 m depth) and another one from Bransfield Strait (station 22, 330 m depth) (average similarity: 29.6%). The main taxa in terms of contribution of the similarity percentage (more than cumulate 60%) were: Gammaridea unid. (11.4%), Lysianassidae unid. (8.5%), *Hemilamprops ultimaspei* (7.4), *Antarctomysis maxima* (7.3%), Stenothoidae unid. (7.2%), *Orchomenella* spA. (5.0%), *Rhachotropis* sp. (3.0%), *Liljeborgia* sp. (2.8%), Synopiidae unid. (2.8%), *Austropallene cornigera* (2.6%) and *Urothoe* spp. (2.4%).

Group D includes a heterogeneous group of three stations from Bransfield Strait (104–361 m depth) and three form South Livingston (45–420 m depth). The corresponding assemblage is characterised by the following dominant taxa (more than 51.0% of cumulated similarity percentage): Amphilochidae unid. (11.3%), Stenothoidae unid. (6.5%), Gammaridea unid. (5.8%), *Leptanthura glacialis* (5.7%), *Nymphon australe* (5.3%), *Vaunthompsonia inermis* (4.9%), *Leucothoe orkneyi* (4.2%), *Neojaera antarctica* (3.0%), *Eusirus bouvieri* (2,6%) and *Melphidippa antarctica* (2.3%).

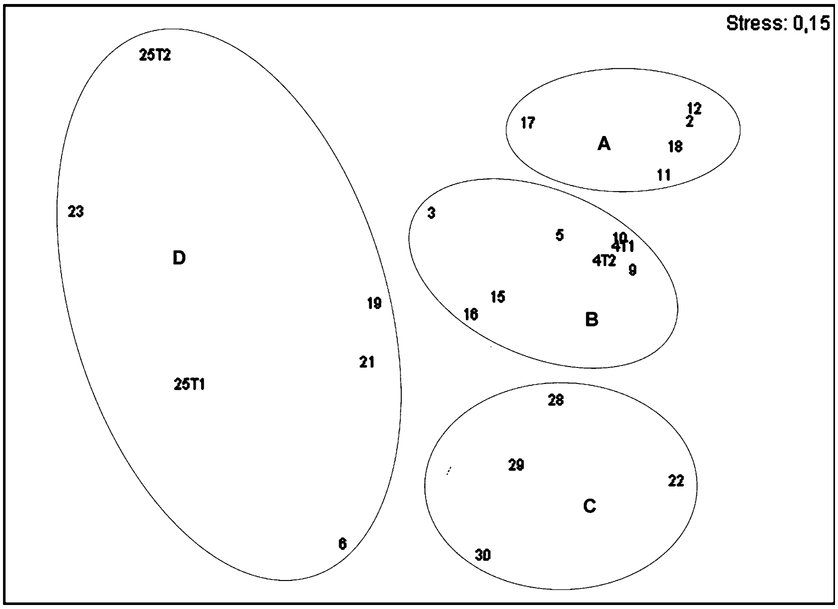

**Fig. 2** Non-metric multidimensional scaling (*MDS*) ordination plot of adjusted Bray-Curtis similarities between BENTART-95 samples calculated from fourth root-transformed relative abundances (%Nt)

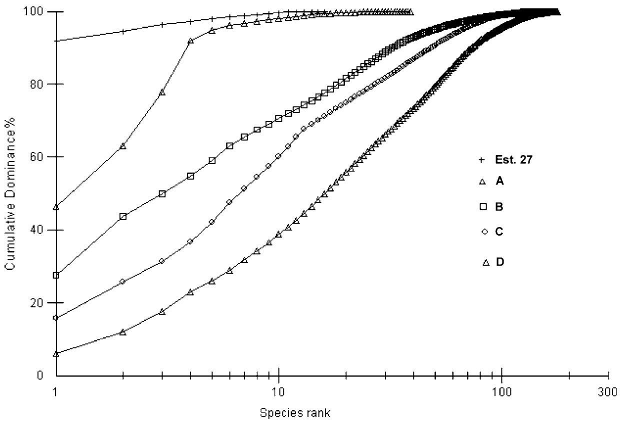

**Fig. 3** K-dominance curves calculated using relative abundance (%Nt) between stations groups of BENTART-95

## Discussion

Suprabenthic crustaceans are common and important macrobenthic animals occurring in variable abundance and diversity from shallow to deep habitats of the world oceans (San Vicente 1996; Sirenko et al. 1996). However, investigations on Southern suprabenthic assemblages are still rare (San Vicente et al. 1997; Linse et al. 2002; Lörz and Brandt 2003). These investigations differ in the type of sledge used, in the height of the nets above the seafloor as well as in the geographic area and sampling depth. As yet mentioned by San Vicente et al. (1997), the BENTART-95 sampling programme also described for the first time the suprabenthic habitat around the South Shetland Island, from coastal to deep areas.

The 24 stations yielded at least 300 species, mainly amphipods (although the identification at species level of this group is still in progress), isopods, pycnogonids, cumaceans and mysids. Peracarid crustaceans represented 85% of the total number of species. The high number of pycnogonid species (31 spp.) registered in the study area contrasts with observations from temperate areas (for instance, only two species at similar depth range in suprabenthic communities from the Bay of Biscay; Sorbe 1984) indicating once more the high diversity of this group in the Southern Ocean (Munilla 2001b).

Furthermore, the most common suprabenthic species are all endemic from the Antarctic, Subantarctic or Magellan regions (Brandt et al. 1998; Thomas and Green 1988; Brandt 1999; Corbera 2000; Munilla 2001b; Castelló 2004; San Vicente et al. 2006).

Suprabenthic species richness showed a clear vertical decreasing gradient from the sediment-water interface to the uppermost levels. Such a near-bottom distribution pattern of the suprabenthic fauna was already described in other marine areas of the world (see Mees and Jones 1997).

The suprabenthic fauna of the study area was numerically dominated by peracarid crustaceans: amphipods, mysids, cumaceans and isopods (decreasing order), representing 95% of the overall collected individuals. These peracarid taxa only represented about 5% of total epifaunal and infaunal abundances respectively collected with Agassiz trawl and Van Veen grab, during the same BENTART-95 sampling program (Ramos 2003; Saiz-Salinas et al. 1997; Arnaud et al. 1998) indicating once more that such gears are

**Table 4** Average dissimilarities between the four major groups of stations discriminated in the two dimensional MDS configuration of the 23 sampling sites (station 27 excluded) and contribution (%) to dissimilarity of species ranked more than 1% in any pair of groups

| Pair of station groups | AB | AC | AD | BC | BD | CD |
|---|---|---|---|---|---|---|
| Average dissimilarites | 72.54 | 85.71 | 91.05 | 79.02 | 84.88 | 86.14 |
| Pycnogonida | | | | | | |
| *Nymphon australe* | – | – | 1.47 | – | 0.99 | 0.85 |
| *Austropallene cornigera* | – | 1.21 | – | 0.91 | – | 0.62 |
| Mysidacea | | | | | | |
| *Pseudomma armatum* | 2.09 | – | – | 1.15 | 1.1 | – |
| *Pseudomma belgicae* | 1.55 | – | 0.97 | 1.00 | 1.05 | 0.8 |
| *Pseudomma sarsi* | 2.19 | – | – | 1.22 | 1.16 | – |
| *Mysidetes posthon* | 3.07 | 1.98 | 1.77 | 3.14 | 2.68 | – |
| *Mysidetes* sp. A | 1.56 | – | – | 0.93 | 0.85 | – |
| *Antarctomysis maxima* | 3.52 | 2.63 | 4.22 | - | 1.9 | 1.68 |
| Amphipoda | | | | | | |
| *Ampelisca anversensis* | - | 1.38 | – | 1.13 | – | 0.95 |
| Amphilochidae indet. | – | – | 2.2 | - | 1.82 | 1.69 |
| *Gammaropsis georgiana* | – | 1.34 | – | 1.06 | – | 0.91 |
| *Djerboa furcipes* | 2.77 | 1.45 | 1.4 | 1.34 | 1.27 | – |
| *Eusirus bouvieri* | – | – | 1.06 | – | 0.84 | 0.73 |
| *Rhachotropis antarctica* | 1.77 | 2.74 | 2.96 | 1.8 | 1.95 | 0.63 |
| *Rhachotropis* sp. | – | 1.95 | – | 1.38 | – | 1.22 |
| *Schraderia gracilis* | – | – | 1.1 | – | 0.8 | 0.69 |
| *Leucothoe orkneyi* | – | – | 1.41 | – | 1.07 | 0.96 |
| *Liljeborgia* sp. | – | 1.26 | – | 0.93 | – | 0.82 |
| *Orchomenella* spA. | – | 2.08 | – | 1.51 | – | 1.44 |
| Lysianassidae indet. | – | 1.5 | 1.37 | 1.3 | 1.01 | 1.55 |
| *Melphidippa antarctica* | – | – | 1.07 | – | 0.8 | 0.71 |
| Melphidippidae indet. | – | 1.33 | – | – | – | – |
| *Monoculodes antarcticus* | – | – | 1.17 | 0.96 | 1.21 | 0.61 |
| Oedicerotidae indet. | 1.67 | – | – | 0.89 | 0.87 | 0.8 |
| *Harpinia* sp. | – | 1.37 | – | 1.13 | – | 0.99 |
| *Pseudharpinia* sp.? | – | 1.31 | – | 1.05 | – | 0.9 |
| Phoxocephalidae indet. | 1.57 | – | 1.2 | 0.87 | 1.17 | 0.91 |
| *Antatelson walkeri* | – | – | 1.23 | – | 0.92 | 0.83 |
| Stenothoidae indet. | 1.53 | 2.11 | 1.72 | 1.07 | 1.21 | 0.97 |
| Synopiidae indet. | – | 1.38 | – | 0.93 | – | 0.82 |
| *Urothoe* spp. | – | 1.12 | – | 0.91 | – | 0.65 |
| Gammaridea indetAB. | 1.57 | 3.04 | 1.13 | 2.00 | 1.01 | 1.99 |
| Gammaridea indet. | 1.76 | 1.57 | 1.43 | – | 1.18 | 1.2 |
| Cumacea | | | | | | |
| *Vaunthompsonia inermis* | – | | 1.49 | 0.84 | 1.00 | 0.79 |
| *Vaunthompsonia meridionalis* | 1.47 | 1.15 | – | 1.26 | 0.85 | 0.69 |
| *Vaunthompsonia* (manca) | 1.7 | – | – | 1.09 | 0.99 | – |
| *Leucon (Crym.) costatus* | 3.04 | – | – | 1.47 | 1.64 | – |
| *Diastylis inornata* | – | 1.13 | – | 0.91 | – | 0.79 |
| *Hemilamprops ultimaspei* | – | 2.36 | – | 1.69 | – | 1.39 |
| Isopoda | | | | | | |
| *Leptanthura glacialis* | – | – | 1.7 | – | 1.26 | 1.06 |
| *Ianthopsis multispinosa* | – | – | 1.02 | – | 0.72 | 0.64 |
| *Neojaera antarctica* | – | – | 1.3 | – | 0.98 | 0.89 |
| *Ceratoserolis trilobitoides* | 1.49 | – | – | 0.86 | 0.77 | – |
| Euphausiacea | | | | | | |
| *Euphausia crystallorophias* | 4.13 | 3.61 | 3.5 | – | – | – |
| *Thysanoessa sp.* | – | – | 1.15 | – | 0.88 | 0.88 |
| Decapoda | | | | | | |
| *Notocrangon antarticus* | 1.57 | – | – | 0.91 | 0.84 | – |

**Table 5** Comparison of mean abundances (ind./1,000 $m^3$) for five peracarid taxa sampled during EASIZ II (summer), EASIZ III (autumn) and BENTART 95 (summer) cruises

| Author | Linse et al. (2002) | Lörz and Brandt (2003) | San Vicente et al. (1997, 2006) | | | |
|---|---|---|---|---|---|---|
| Programme | EASIZ II | EASIZ III | BENTART 95 | | | |
| Water layer above bottom (cm) | 100–133 | 100–133 | 10–50 | 55–95 | 100–140 | 10–140 |
| Mysidacea | 1034 | 6 | 8264 | 1054 | 558 | 1097 |
| Amphipoda | 1052 | 389 | 22826 | 775 | 397 | 2666 |
| Cumacea | 1458 | 107 | 1721 | 241 | 90 | 228 |
| Tanaidacea | 92 | 58 | 284 | 13 | 0 | 33 |
| Isopoda | 678 | 94 | 1665 | 103 | 43 | 201 |

not adequate for the sampling of near-bottom motile species (Elizalde et al. 1993).

Suprabenthic abundances showed a clear decreasing gradient in both diversity and abundance from the near sediment-water interface to the uppermost water column levels. This vertical gradient was observed in almost all taxa except in the case of euphausiids which avoid the close contact with the bottom. Such a near-bottom distribution pattern is a typical feature of suprabenthic communities of most marine areas (Mees 1994).

Table 5 shows a comparison of abundance values of the major suprabenthic taxa from Weddell Sea/Antarctic Peninsula (Linse et al. 2002; Lörz and Brandt 2003) and BENTART-95 study area. The abundance values from similar near-bottom water layer show high variability in faunal composition and relative importance of the major groups. Surprisingly, tanaids are well represented in the 100–133 cm near-bottom water layer, both in Linse et al. (2002) and Lörz and Brandt (2003) studies, whereas they are absent at that level in our study. Furthermore, cumaceans are numerically dominant at the 100–133 cm layer in Linse et al. (2002) study, whereas their contribution were notably lower at that level in our study. Due to the known endobenthic behaviour of most species in these groups it seems probable that some sediment contamination occurred during samplings of the above mentioned studies.

According to Table 5, the highest abundances were always recorded in the 10–50 cm water layer above bottom. Therefore, accurate estimations of suprabenthic abundance need to sample the water layer as close as possible to the bottom, where motile fauna concentred.

Environmental features that affect suprabenthic fauna seem to change gradually from sheltered to exposed areas and four main suprabenthic assemblages were detected in the study area.

Within the Deception Caldera, the near-bottom environment is drastically conditioned by episodic volcanic activity, and the last historical eruption that occurred in 1970 (Rey Salgado et al. 1994) probably destroyed almost all the benthic fauna (Quintana 1986; Gallardo 1992). The Caldera is a closed bay with both sandy and muddy bottoms characterized by low diversity, abundance and biomass of endobenthic taxa, by the dominance of epibenthic echinoderms (*Ophionotus victoriae* and *Sterechinus neumayeri*) in moderate and deep waters, but by suspension-feeders (mainly Ascidiacea) in shallow waters, and by the absence of dense three-dimensional suspension-feeders assemblages that characterise other Antarctic coastal areas (Arntz et al. 1994). Therefore, benthic macrohabitats in the Deception Caldera are quite different than other zones located elsewhere around Livingston Island (Arnaud et al. 1998; Saiz-Salinas et al. 1997). As also mentioned by for epibenthic and infaunal assemblages, the suprabenthic community within the caldera shows original features: absence of pycnogonids and tanaids, low abundance of cumaceans, low diversity values and dominance of three species (*Antarctomysis maxima*, *Rhachotropis antarctica* and *Euphausia chrystallorophias*). Acidic conditions in surficial sediments and the absence of competition with other epibenthic three-dimensionally structured communities could be the main structuring factors of the caldera suprabenthic assemblage.

The South Livingston suprabenthic assemblage was found on muddy bottoms inhabited by Ophuiroidea and a scarcity of sessile epifauna (Arnaud et al. 1998) or mainly inhabited by infaunal deposit-feeding polychaetes (Saiz Salinas et al. 1997). This suprabenthic assemblage shows higher species richness and diversity than the previous one and was characterized by the dominance of some mysid, cumacean and amphipod populations. C assemblage was found in un-sheltered area of the north Livingston Island and off Deception Island (station 22) at variable depths (124–649 m) and sediments (gravel, gravel and mud, mud), characterized by the predominance of Echinodermata (Arnaud et al. 1998). This assemblage showed lower abundance and higher diversity than the two previous ones. It was dominated by amphipods, thus confirming the importance of this taxa in the neritic Antarctic benthos as already mentioned by different authors (Jazdzewski et al. 1991).

D assemblage was found in a heterogeneous group of stations from the Bransfield Strait and south Livingston Island on variable bottoms (gravel, mud) and depths (45–420 m). The epifauna of the Bransfield Strait was characterized by the dominance of Ophuiroidea and Asteroidea but with a rich variety of three-dimensional suspension-feeder communities (Hexactinellida, Demospongia, Bryozoa ands Ascidiacea) suggesting the existence of near-bottom currents (Arnaud et al. 1998). Station 6 (South Livinsgton) shows a three-dimensional community too, dominated by suspension-feeder, mainly Ascidicea and some Bryozoa and Demospongia.. This suprabenthic assemblage shows equivalent diversity than the previous one. The relative contribution of some species of pycnogonids (*Nymphon australe*), isopods (*Leptanthura glacialis*, *Neojaera antarctica*) and amphipods (*Eusirus*) indicated also contamination of suprabenthic sledge samples with species representative from the epibenthic level.

Factors such as current direction and speed, sediment structure and the diversity of the epibenthic habitat are probably responsible of the suprabenthic organism distribution (Lörz and Brandt 2003; De Broyer et al. 2001). In the South Shetland Islands and Bransfield Strait, two main factors should be noted: the degree of shelter-exposure within habitats and the structure of the epibenthos. At shallow depths the macroepibenthos is mainly represented by suspension-feeders that constitute three-dimensional habitat whereas at deeper depths it is represented by a great variety of trophic groups (carnivores, detritivores, necrophages, suspension-feeders) (Arnaud et al. 1998). Such diversity on spatial benthos microhabitats could also be an important factor affecting suprabenthic assemblages.

The bentho-pelagic coupling is a relatively new interesting area in Antarctic research (Arntz et al. 2005). Suprabenthos live in the benthic boundary layer and therefore plays an important role in bentho-pelagic food webs (Mauchline 1980; Brandt 1995). These small organisms are highly consumed by a great diversity of Antarctic predators and contribute to the recycling of particulate organic matter to higher trophic levels of the Antarctic marine ecosystem.

**Acknowledgments** The BENTART cruises were carried out under the auspices of two Spanish Council of Scientific and Technical Research (CICYT) Antarctic Programmes (no. ANT 93-0996 and no. ANT 94-1161-E). The completion of the work in Spain was achieved under contract no. ANT 95-1011 of the Spanish CICYT. The crew and officers of R.V. "Hesperides", Alfredo Igelmo and José Castro played a vital part in the materialization of this project. To all of them we express our gratitude.

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