Macrobenthos biodiversity along the Livingstone Island transect, from Drake Passage to the Antarctic Peninsula: First global taxonomic results of the 'Bentart-95' survey

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Introduction

As pointed out by Arntz *et al.* (1999), although our current knowledge about biodiversity seems to indicate that there is no common pattern for species richness in the different ecosystems, or for taxonomic groups, in the Southern Ocean, the fact is that not much data, much less comparable data, is available regarding diversity and evenness in the Antarctic.

This paper presents data on the macrobenthos biodiversity along a transect placed at the longitude of Livingstone Island, from the Drake Passage to the Antarctic Peninsula, with depths ranging from 40 to 850 m. Quantitative –or semiquantitative—data were collected during the 'Bentart-95' survey at 31 stations using three different sampling methods: Agassiz trawl for epibenthic fauna, epibenthic sledge for suprabenthic crustaceans, and Van Veen grab for infauna. In addition, qualitative sampling was carried out using rock-dredge and scuba-diving techniques. The samples were sieved using three mesh sizes (5, 1 and 0.5 mm, for Van Veen, and 10, 5 and 1 mm for Agassiz). In this study only specimens retained on a 1.0 mm (Van Veen) or 10 mm mesh (Agassiz) have been used.

The material has been studied during the last 8 years, and although the taxonomical determination of some taxa remains unfinished, we present the first global results on biodiversity from the 'Bentart-95' cruise.

Results

The biodiversity of 37 major taxa, which were mainly collected with Agassiz trawl, suprabethic sledge and Van Veen grab, has been analysed.

A total of 47,293 specimens have been studied, belonging to Algae (Rodophyta, Phaeophyta, Chlorophyta and Chrysophyta), Porifera (Hexactinellida and Demospongiae), Hydrozoa, Anthozoa (Stolonifera, Alcyonacea, Gorgonacea, Pennatulacea, Actiniaria and Scleractinia), Bryozoa, Echiurida, Nemertini, Mollusca (Opistobranchia, Gastropoda Prosobranchia, Bivalvia, Scaphopoda and Solenogastra), Polychaeta, Crustacea (Isopoda, Mysidacea, Amphipoda, Cumacea, Tanaidacea, Euphausiacea, Decapoda, Leptostraca, Copepoda and Ostracoda), Pycnogonida, Echinodermata (Ophiuroidea and Asteroidea), Ascidiacea and Pisces.

The total number of species determined thus far is 871; however, it should be taken into account that not all of the taxonomic work is finished yet, and these values will surely increase.

Different measures of diversity have been calculated by main taxa and station for each sampling method and for the total. These measures included species number, numerical abundances, and the indices of Margaleff species richness (d), Shannon-Wiener diversity (H') and Pielou's evenness (J').

Taxonomical diversity

Among the 871 taxa determined, 390 species corresponded to epifauna collected by Agassiz trawl, 306 species were mainly peracarid crustacea taken by the suprabenthic sledge, and only 144 were infaunal species caught with a Van Veen grab. The rock- dredge collected a total of 112 epifaunal species.

Considering the total area, Margalef species richness was maximum for the suprabenthos (85.59), whilst presenting mid-range values for epibenthic fauna (34.72) and the lowest figures for the infaunal benthos (11.40) (Table I).

By taxonomical group, the highest diversity corresponded to Amphipoda (125 sp.), followed by the Bryozoa (98 sp.), Polychaeta (89 sp.), Isopoda (80 sp.), Pycnogonida (60 sp.), and Hydrozoa and Porifera (both with 51 sp.) (Figure 1). These taxa also offered the highest richness (Margalef index), calculated based on total numerical abundances by station for the more effective sampler: Bryozoa (16.92), Amphipoda (12.87) and Isopoda (11.11); these were followed by Hydrozoa (8.26), Polychaeta (7.26), Pycnogonida (6.59) and Demospongiae (5.56). The lowest richness corresponded to Echiurida, Solenogastra, and Decapoda. For colonial groups, these figures must be considered with caution, since it is difficult to estimate their numerical abundances. These results are in accordance with the traditional species-rich and species-poor taxa concept in the Antarctic Sea.

At individual levels, the highest abundances were found amongst the infaunal polychaetes of the Maldanidae family, *Maldane sarsi antarctica* (>100,000 ind.), followed at a great distance by *Asychis amphiglypta* (>25,000) and by the Sternaspidae, *Sternaspis scutata* (>16,000). The epifauna of the South Shetlands zone seemed dominated—as shown previously by Sáiz-Salinas *et al.* (1997), Arnaud *et al.* (1998), Piepenburg *et al.* (2002) and others—by brittle-stars, mainly *Ophionotus victoriae* (10,000 ind.); the ascidians, *Molgula pedunculata, Ascidia challengeri* and *Aplidium sp.* (7,000 ind.) and pycnogonids. In the suprabenthic communities—as in the work of San Vicente *et al.* (1998)—amphipods and mysids dominated; the main species among the amphipods were *Djerboa furcipes* (3,414 ind.) and *Rhachotropis antarctica*, and among the mysids, *Antarctomysis maxima* and *Mysidetes poston* (>2,000 ind.). These abundances were to be expected, given the dominance of soft sediments throughout nearly all of the South Shetlands and Bransfield area.

Pattern diversity distribution

The diversity measures by station for each one of the benthic compartments –epibenthos, suprabenthos and infauna, and total—are presented in table I. For comparison, we considered only the 16 stations where the three main sampling methods were used

In the entire South Shetlands benthic ecosystem, total numerical abundances oscillated between 4,300 and 53,000 individuals; the species number from 38 to 195; Margalef's richness index from 10.07 to 19.15; Shannon's diversity index from 0.67 to 3.02; and Pielou's evenness between 0.13 and 0.72. The global index values were: 626 (Sp. nb.), 63.89 (Margalef), 3.24 (Shannon) and 0.50 (Pielou).

As can be seen in table I, there are major differences among stations on all diversity indices in relation to the different benthic subsystem exits, which would indicate that there is no latitudinal cline of biodiversity. Nevertheless, some distribution patterns of diversity stand out:

1) The highest richness zones seem to be located off southern of Livingstone Island, where global values from 100 to 150 species per station were found, mainly at st. 19, which showed high species numbers and specific richness, globally and for suprabenthic and epibenthic subsystems, but also the lowest evenness. In the area closest to the Antarctic Peninsula and in the northern zone of Livingstone Island, high values of diversity were also found.
2) The poorest area, as previous analysis of the main taxa had showed (Sáiz-Salinas *et al.*, 1997; Arnaud *et al.*, 1998; San Vicente *et al.* 1998), was located at inner Deception Island, in Foster Bay, where the diversity indices were lowest.

3) In spite of local differences, and strong dominance of some particular species, similar mean values of evenness (J') were found for the three benthic subsystems (0.42-0.59) (0.5 for total benthic communities); this would seem to indicate that, in general, individual abundances are more or less evenly distributed among the species in the South Shetlands benthos.
4) Preliminary analysis regarding the relationships between diversity measures and environmental parameters indicates that depth is the main factor, significantly affecting distribution patterns.
5) Multivariate analysis is now underway, and these results will be presented in October 2003 at the IBMANT-ANDEEP Symposium.

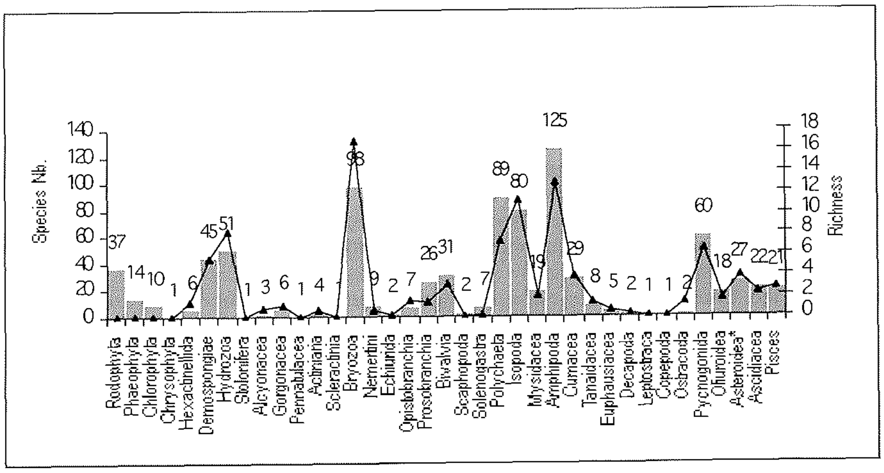

Fig. 1. Species number (histograms) and species richness (Margalef's Index, line) of 37 taxa. Material collected at 31 stations during the 'Bentart-95' Survey. 871 species; 47,267 determined specimens

	Dept	Epibenthos (Agassiz trawl)					Suprabentos (Sledge)					Infauna (Van Veen grab)					TOTAL		
Station	(m)	Sp.	Nb	d	H'	J'	Sp.	Nb	d	H'	J'	Sp.	Nb.	d	H'	J'	Sp.	d	H'
D1	40	17	622	3.01	1.70	0.60						22	14567	2.19	2.48	0.80	39	3.84	
D2	146	14	2180	1.91	1.47	0.56	13	1522	1.63	1.22	0.48	16	4900	1.77	2.10	0.76	**38**	4.53	**2.62**
SLI3	92	56	10486	5.58	1.60	0.40	64	962	9.16	3.18	0.76	26	8500	2.76	2.15	0.66	**139**	**14.54**	**2.89**
SLI4	161	68	2700	7.47	1.98	0.47	44	946	6.27	2.16	0.57	21	15357	2.07	1.50	0.49	**127**	**13.31**	**2.42**
SLI5	256	53	10181	6.90	1.88	0.47	26	909	3.67	1.30	0.40	16	16400	1.55	0.73	0.26	**89**	9.10	**1.24**
SLI6	49	68	42216	8.26	2.33	0.55	61	2383	7.72	2.75	0.67	24	8600	2.54	1.81	0.57	**146**	**13.88**	**3.02**
SLI7	80	72	12244	7.50	2.23	0.52						39	33408	3.65	2.61	0.71	111	**10.07**	
SLI8												43	14533	4.38	2.80	0.74	43	4.38	
SLI9	162	42	23072	4.99	2.21	0.59	50	2543	6.25	2.05	0.52	24	12233	2.44	1.69	0.53	**112**	**10.81**	**2.70**
SLI10	220	64	14807	7.76	2.34	0.56	35	299	5.96	2.57	0.72	12	16000	1.14	0.95	0.38	**111**	**10.54**	**1.59**
D11	167	41	1935	6.35	1.72	0.46	15	847	2.08	1.17	0.43	11	1855	1.33	1.96	0.82	**66**	7.63	**2.62**
D12	167	25	2545	3.75	1.41	0.44	10	673	1.38	1.07	0.47	18	4033	2.05	2.38	0.82	**52**	5.74	**2.79**
SLI13												27	11733	2.77	2.27	0.69	27	2.77	
SLI14												19	10667	1.94	2.11	0.72	19	1.94	
SLI15	335	21	2312	2.77	1.93	0.63	36	534	5.57	2.21	0.62	15	6600	1.59	1.46	0.54	**71**	7.65	**2.18**
SLI16	429	52	2075	11.14	1.92	0.49	63	585	9.73	2.85	0.69	26	11759	2.67	2.46	0.76	**130**	**14.41**	**2.70**
D17	106	23	35346	2.46	0.92	0.29	34	3331	4.07	0.87	0.25	15	6333	1.60	2.28	0.84	**70**	6.53	**2.47**
D18	109	14	6858	1.74	1.02	0.39	12	97	2.32	1.65	0.67	19	8805	1.98	2.40	0.82	**42**	4.35	**2.62**
SLI19	214	108	1484	14.80	2.28	0.49	80	1803	10.54	2.81	0.64	20	43800	1.78	0.29	0.10	**195**	**19.15**	**0.67**
SLI20												22	9233	2.30	1.83	0.59	22	2.30	
B21							48	1182	6.64	1.66	0.43	5	2400	0.51	1.48	0.92	53	6.35	
B22A	330	22	53	5.10	1.28	0.41	24	183	4.35	2.18	0.69						46	8.05	
B23	141	89	1140	12.54	2.48	0.55	9	33	3.22	2.09	0.95	28	6033	3.10	2.60	0.78	**123**	**13.96**	**2.99**
B24	234	103	1589	15.65	2.20	0.47						3	2967	0.25	0.96	0.87	106	**12.35**	
B25							27	133	6.46	3.02	0.92						27	5.32	
NLI27	70	42	295	7.33	2.12	0.57	9	2907	1.68	1.37	0.62						51	6.07	
NLI28	125	35	120	6.02	1.90	0.53	26	895	4.08	2.17	0.67						61	8.52	
NLI29	237	70	4690	8.38	2.08	0.49	32	457	6.02	2.82	0.81	20	10467	2.05	1.70	0.57	**118**	**10.46**	**2.33**
NLI30	710	65	12885	10.33	2.44	0.58	48	580	8.42	3.23	0.84						113	**11.67**	
NLI31	850	32	8348	6.16	2.00	0.58											32	3.32	
31		390	200182	34.72	2.52	0.42	306	23804	85.59	3.40	0.59	144	280599	11.40	2.79	0.56	871	63.89	3.24

Table 1. Measures of macrobenthos diversity by station along the Livingstone Island transect (from Drake Passage to the Antarctic Peninsula), for epibenthic species (Agassiz trawl), suprabenthos (sledge), infauna (Van Veen grab), and total. Species number (Sp); Total numerical abundances (Nb); Margaleff's species richness (d); Shannon-Wiener diversity; (H') and Pielou's evenness (J') (D: Deception Is.; SLI: South Livingston Is.; B: Bransfield Strait; NLI: North Livingston Is.)

The Asellota (Peracarida: Isopoda): Successful invaders of the deep sea

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The Isopoda and especially the Asellota are one of the most numerous and important elements of the benthos in all oceans. They are the dominating taxon among crustaceans in the deep sea and display a range of morphologies which is spectacular and bizarre.
However, Antarctic Asellota are little known, and no molecular data are available up to now for phylogenetic studies. First results of ssu rDNA-gene analyses support the monophyly of many typical deep sea families, e.g. the Munnopsidae, Ischnomesidae and Haploniscidae. On the other hand there is no evidence for the monophyly of the Janiridae. In addition the molecular data indicate a multiple colonization of the Antarctic deep sea. This ecosystem has to be