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Distribution patterns of macrozoobenthos: a comparison between the Magellan region and the Weddell Sea (Antarctica)*

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SUMMARY: The Joint Chilean-German-Italian Magellan "Victor Hensen" Campaign in October/November 1994 and the "Polarstern" expedition ANT XIII/4 (May 1996) yielded 207 quantitative multibox corer samples from 11 stations in the Paso Ancho (Magellan Straits), 10 stations in the Beagle Channel, and 15 stations of the shelf and continental slope off the eastern entrance of the Beagle Channel. Mean abundance values in the Magellan Region varied from 1591 Ind. m^{-2} in the Paso Ancho to 3643 Ind. m^{-2} in the Beagle Channel and 3983 Ind. m^{-2} on the shelf; the corresponding biomass values were 96.8 g, 301.6 g, and 119.0 g wet weight m^{-2}, respectively. In terms of org. C the corresponding values are 4.8, 11.4, and 4.6 g m^{-2}. Abundance (3806 Ind. m^{-2}) and biomass (222.6 g wet weight m^{-2} or 7.3 g C) data from the eastern Weddell Sea shelf ("Polarstern" expeditions ANT VI/3, 1987/88 and ANT VII/4, 1989) are in the same range. The composition of the fauna, however, reveals distinct differences.

Key words: Macrobenthos, community structure, southern Chile, Antarctic.

RESUMEN: PATRONES DE DISTRIBUCIÓN DEL MACROZOOBENTOS: UNA COMPARACIÓN ENTRE LA REGIÓN DE MAGALLANES Y EL MAR DE WEDDELL (ANTÁRTIDA). – La Campaña Conjunta Magallánica Chilena-Alemana-Italiana, realizada a bordo del RV "Victor Hensen" en octubre-noviembre de 1994 y la expedición "ANT XIII/4" del RV "Polarstern" en mayo de 1996, proporcionaron 207 muestras cuantitativas tomadas con multi box-corer, en 11 estaciones en el Paso Ancho (Estrecho de Magallanes), 10 estaciones en el Canal del Beagle y 15 en la plataforma y pendiente continental de la entrada este del Canal del Beagle. Los valores medios de abundancia en la región de Magallanes varían desde 1591 ind.m^{-2} en el Paso Ancho hasta los 3643 ind.m^{-2} en el Canal del Beagle y los 3983 ind.m^{-2} en la plataforma; los valores de biomasa (peso húmedo) correspondientes fueron de 96,8, 301,6 y 119,0 g m^{-2} respectivamente. En términos de carbono orgánico, los valores correspondientes fueron 4,8, 11,4, and 4,6 g m^{-2}. Los datos de abundancia (3806 ind.m^{-2}) y biomasa (222,6 gr.m^{-2}) procedentes de la plataforma este del Mar de Weddell (datos obtenidos de las expediciones ANT VI/3, 1987/88 y ANT VII/4, 1989 a bordo del "Polarstern"), están dentro del mismo rango. La comparación faunística presenta sin embargo, marcadas diferencias.

Palabras clave: Macrobentos, estructura de comunidades, sur de Chile, Antártida.

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INTRODUCTION

The study area of the "Joint Victor Hensen Magellan Campaign" is one of the classic three Subantarctic regions with a strong "Antarctic component" (Hedgpeth, 1969). The South American continent was the last to separate from the Antarctic continent, it is still closest to it, and exchange between both continents is supposed to have lasted longer and to have been more frequent than that between other fragments of Gondwana in the southern hemisphere. A lack of quantitative data from adjacent areas directly on the other side of the Drake Passage, where up to the final separation probably a similar community existed, unfortunately does not allow a comparison of the benthic fauna of these areas. Therefore, the fauna of the eastern Weddell Sea shelf as a high Antarctic environment is compared with our data from the Subantarctic Magellan region.

This paper presents the first abundance and biomass data from the areas at the tip of South America. These data are compared with multibox corer samples from the eastern Weddell Sea shelf. The questions to be answered are:

- how similar are benthic abundance and biomass in high Antarctic and South American waters?
- are there differences in the faunal composition between these two areas?

MATERIAL AND METHODS

Quantitative bottom samples were achieved during the "Joint Chilean-German-Italian Magellan "Victor Hensen" Campaign" in October/November 1994 and during the "Polarstern" expedition ANT XIII/4 in May 1995 by means of the multibox corer (Gerdes, 1990). Eleven stations were situated in the Paso Ancho (Magellan Straits, 8 to 459 m water depth), 10 in the Beagle Channel (38 to 348 m water depth), and 15 stations on the shelf and continental slope off the eastern entrance of the Beagle Channel from 14 to 1162 m water depth (Fig. 1).

Seventy-six single cores from the Paso Ancho area, 64 cores from the Beagle Channel, and 67 cores from the shelf stations provided the matrix for the evaluation of abundance, biomass and composition of the benthic fauna. All samples were sieved over 0.5 mm mesh size directly after

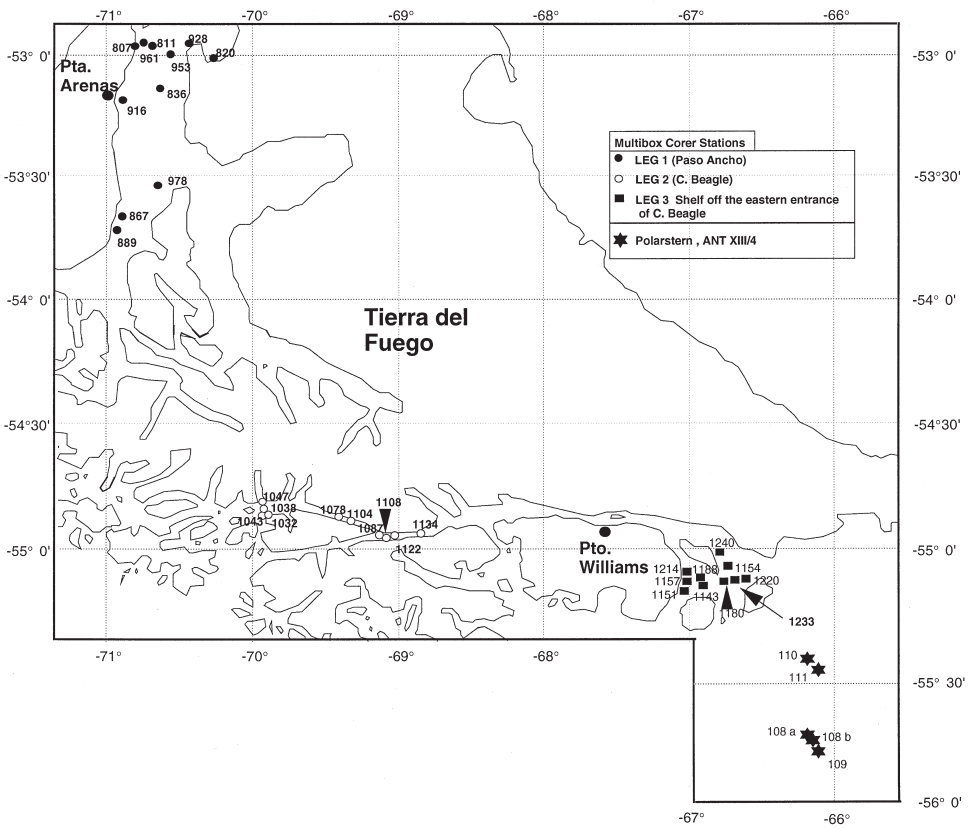

FIG. 1. – South American sampling sites during the "Victor Hensen" Magellan Campaign 1994 and "Polarstern"expedition ANT XIII/4

TABLE 1. – Summarized benthos data of the "Victor Hensen" Magellan Campaign (1994) and data from other quantitative studies in Antarctic and Subantarctic areas.

Region	Method (No. of samples)	Water Depth (m)	Bottom	Abundance Ind. m^{-2} Min.- Max. (Mean)	Biomass g wet weight m^{-2} Min.-Max. (Mean)	Dominant groups	Authors
Magellan Straits	multibox corer (76)	8-459	high proportion of sand and gravel, partly with clay and mud	409-4727 (1591)	16.8-392.8 (96.8)	bivalves, polychaetes, crustaceans	present study
Beagle Channel	multibox corer (64)	38-348	high proportion of sand and gravel, partly with clay and mud	673-8782 (3643)	10.1-1466.3 (301.6)	bivalves, crustaceans, polychaetes, echinoids	present study
Continent. shelf off the eastern entrance of the Beagle Channel	multibox corer (67)	14-1162	high proportion of sand and gravel, partly with clay and mud	1049-7730 (3983)	1.3-662.8 (119.0)	holothurians, crustaceans, polychaetes, gastropods	present study
Weddell Sea	multibox corer (233)	170-2037	soft bottom with mud, sand, gravel, boulders	131-12846 (3806)	0.12-1673.0 (222.6)	sponges, holothurians, asteroids, polychaetes	Gerdes *et al.*, 1992
King George Isl.	v. Veen grab (54)	60-250	soft	889-2834 (1844)	153-2464 (704)	poychaetes, molluscs, echinoderms, crustaceans	Jazdzewski *et al.*, 1986
South Shetland Isl.	Petersen grab, 0.1 m^2	< 100 >100	soft soft	(3386)[a)] (6028)	(180.0) (164.0)	polychaetes, bivalves, amphipods	Gallardo *et al.*, 1977
Elephant Island	v. Veen grab (25)	100-400	-	140-47620 (12645)	0.2-197.0 (47.0)	polychaetes, molluscs, echinoderms, crustaceans	Mühlenhardt-Siegel, 1988
South Shetland Isl., excluding Elephant Isl.	v. Veen grab (9)	60-850	-	1960-20700 (8742)	14-527.0 (132.5)	polychaetes, molluscs, echinoderms, crustaceans	Mühlenhardt-Siegel, 1988

[a)] 1 mm mesh size

recovering and preserved in 4 % formalin buffered with hexamethylentetramin. For the calculation of abundance, colonial forms such as bryozoans and sponges were only considered as being present.

The organisms were separated into 34 easily distinguishable taxonomic groups (cf. Fig. 3); final determination to species level by the respective experts may take several years. All specimens of each group were counted and their wet weights were determined after blotting the organisms on filter paper. The wet weight data were converted to g Corg, using conversion factors for major taxonomic groups published by Brey and Gerdes (1999) and further references therein.

Samples from the Weddell Sea, taken by RV "Polarstern" in Austral summers 1987/88 and 1989, were treated in the same manner. These samples were taken at 36 stations along the eastern Weddell Sea shelf between Vahsel Bight and Kapp Norvegia in water depths from 170 to 2037 m (cf. Gerdes *et al.*, 1992).

To detect differences in biomass and abundance between the different sampling sites we used "Box-and-Whisker-Plots"(Blankenberger, 1994).

RESULTS

Abundance and biomass data obtained at the different sampling sites are summarized in Table 1.

For all study areas a high degree of small-scale patchiness (10 - 100 m) became obvious for both the composition of the fauna and organism density and biomass.

Lowest abundance values resulted for the Paso Ancho area in the Magellan Straits, followed by those of the Beagle Channel, the shelf stations off the eastern entrance of the Beagle Channel, and the Weddell Sea shelf. Biomass, too, was found to be lowest in the Paso Ancho area; a slightly higher value resulted from the shelf and slope stations whereas biomass in the Beagle Channel was even higher than in the Weddell Sea.

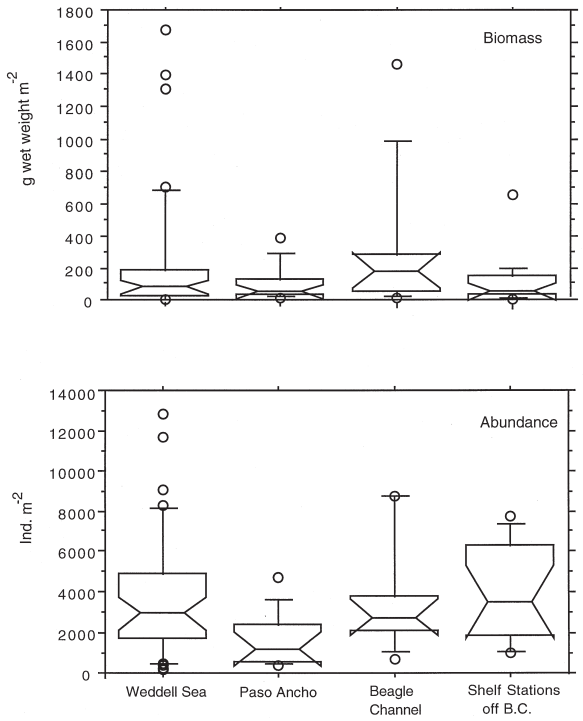

FIG. 2. – Box-Whisker-Plots of biomass (wet weight) and abundance values from 72 stations, situated in the different study areas. Biomasses do not differ significantly (Kruskal-Wallis test: p = 0.3248), whereas the mean abundance in Paso Ancho differs from that of the other areas (p= 0.0496), indicated by a much lower mean rank

With the exception of the Paso Ancho abundance, neither biomass nor the other abundance values were significantly different (Fig. 2).

Concerning the composition of the fauna, in all study areas polychaetes dominated in terms of abundance, followed by molluscs, which, however, achieved higher values in South American waters, and arthropods, which were more abundant along the Weddell Sea shelf than in any of the South American subareas (Fig. 3 a). Echinoderms were less abundant with higher values found only along the Weddell Sea shelf. The composition in terms of biomass shows the overwhelming importance of sponges in the Weddell Sea, which contribute more than 51 % to total macrofauna biomass. In the Patagonian area sponges contributed considerably to total biomass only in the Paso Ancho (about 10 %), and they were almost absent in the Beagle Channel and at the shelf stations (Fig. 3 b.) Molluscs, on the other hand, were much more important in South American waters, especially in the Beagle Channel, where they made up almost 75 % of total benthic wet weight with bivalves being the most important group, whereas gastropods were more important at the shelf stations. In the Weddell Sea the molluscs,

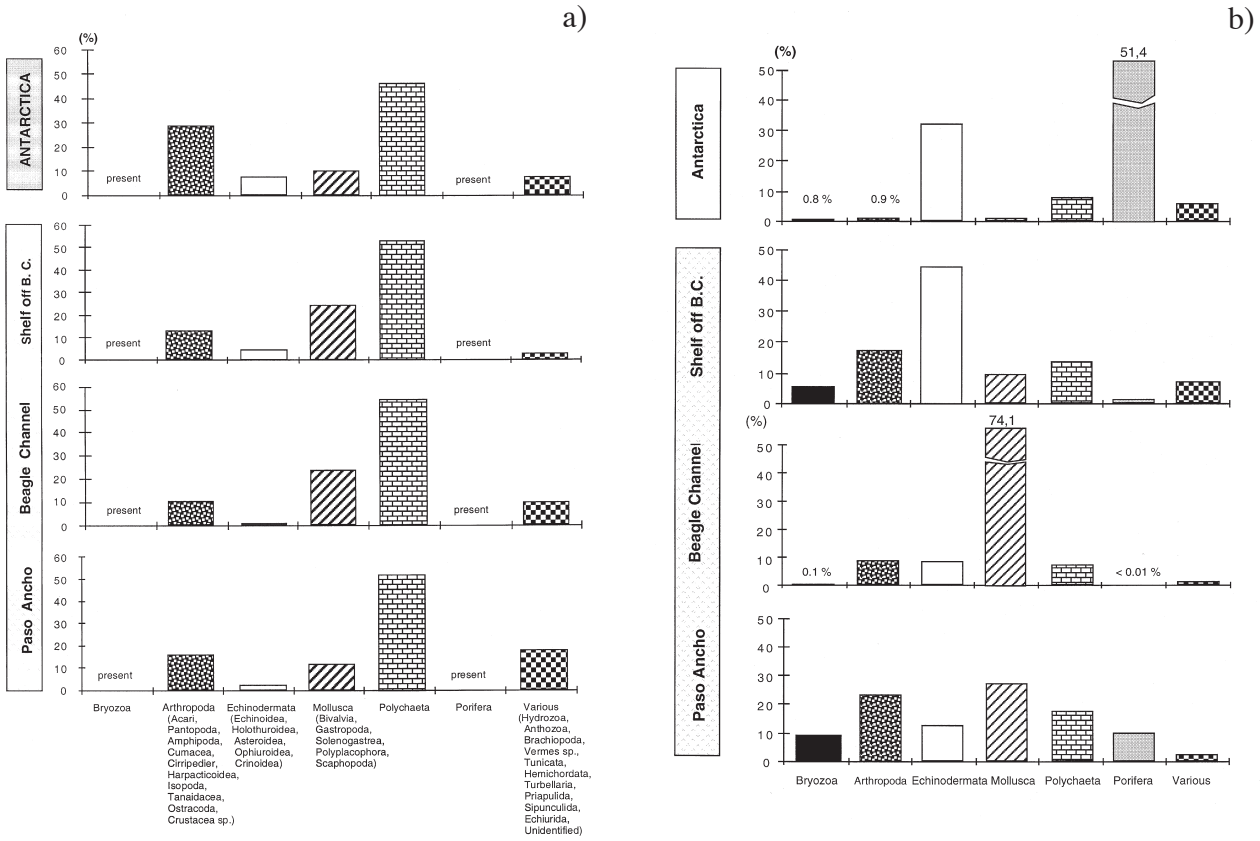

FIG. 3. – Composition of the macrozoobenthos in the different study areas; a) on the basis of the abundance values; b) on the basis of the biomasses

which appear to be much smaller and more fragile than in the other areas, contributed only about 1 % to total biomass. Echinoderms contributed most at the stations on the South American continental shelf and at the Weddell Sea shelf stations. Sea cucumbers were the most dominant (in terms of biomass) echinoderm taxon, contributing to about 37 % of the overall biomass on the South American continental shelf and to about 14 % along the Weddell Sea shelf; in both other South American study areas they were of minor importance. With the exception of one shelf station crinoids were not found in any of the South American study areas. Although being much more abundant along the Weddell Sea shelf, crustaceans contributed considerably more to benthos biomass in the South American study areas, especially due to the reptant decapods, which are known to occur exclusively north of the Drake Passage (with the exception of two rare lithodid crab species). Bryozoans, quite regularly occurring in all study areas, reached highest weight dominance in the Paso Ancho and on the continental shelf east of the Beagle Channel. The group "Various" includes hydrozoans, anthozoans, brachiopods, and small worm taxa such as turbellarians, priapulids, sipunculids, and echiurids, all of which contribute only little to total organism density or biomass.

DISCUSSION

This paper presents data on benthic abundance, biomass, and general composition from different study areas around the tip of the South American continent and from the eastern Weddell Sea shelf representing a high Antarctic regime. We separated our material into 34 major taxonomic groups, because separation to species level is very time consuming in most groups and we wanted to present the quantitative data in a reasonable time. The results are based on multibox corer samples, all treated in the same manner, i.e. they are comparable.

Despite distinct differences in the environmental parameters between both areas, no significant differences exist in abundance and biomass - with the exception of the rather low overall abundance obtained from the Magellan Straits (Paso Ancho). Temperatures in South American waters are comparably high and vary seasonally between 6.5 to 9°C (Artegiani and Pachini, 1991). The salinity in these waters is normally lower than in the Weddell Sea with pronounced seasonal variations especially in the Beagle Channel, in the vicinity of the glaciers, where low values around 27 ‰ S are not exceptional (Antezana *et al.*, 1996). On the Weddell Sea shelf water temperatures are normally rather low and stable (-1.8° ± 0.2°C) with the exception of irregularly occurring intrusions of Warm Deep Water onto the shelf which increase the temperature (Bathmann *et al.*, 1991). The salinity, too, shows little variation with a normal range between 34.6 to 34.9 ‰ S. On the other hand the benthos on the Weddell Sea shelf has to cope with ice coverage, with the seasonal light regime and the short periods of primary production, all of which make the benthic realm less constant than often predicted (cf. Arntz *et al.*, 1994).

Abundance and biomass, however, vary considerably within all subareas. On the Weddell Sea shelf this is presumably due to the existence of rich, three-dimensional suspension feeding communities, based on the occurrence of sponges, hydrozoans and bryozoans and their debris. All these taxa create micro-habitats inhabited by a great variety of benthic species, thus causing local peaks in benthic abundance or biomass. In the waters north of the Drake Passage, such structures are mostly absent, at least at greater depths (cf. Gutt and Schickan, 1996). The *Macrocystis* kelp forests in the shallower parts may provide such community structuring features (Ojeda and Santelices, 1984) to a certain degree; the higher abundance and biomass values at the shallower stations in the Paso Ancho, where such kelp forests occur, seem to support this suggestion (Montiel, 1997).

Highest conformity with respect to organism densities and biomass exists between the South American shelf stations and those in the Weddell Sea. Concerning the composition of the fauna, however, distinct differences occur. For example crinoids, occurring quite regularly along the Weddell Sea shelf, were found only at St. No. 110 (Polarstern Cruise XIII/4) on the shelf south of Isla Nueva. The mollusc fauna, although being comparable to the Antarctic in terms of composition (cf. Linse, 1997), dominates the Magellan benthos (especially in the Paso Ancho and the Beagle Channel) much more in terms of abundance and especially biomass. The low mollusc biomass values in the high Antarctic may be explained by the fact that the majority of species in the Weddell Sea are small (<10 mm) and their shells are extremely thin (cf. Hain, 1990). Reptant decapods such as *Munida subrugosa*, *Peltarion spinosulum* and *Eurypodius spp.* are very common at the South American sampling

sites, especially on the continental shelf, where they account for almost 16 % of total biomass. Along the Weddell Sea shelf their niche may have been occupied by amphipods and isopods (cf. Brandt, 1991), which contribute only little to overall benthic biomass in the Antarctic, even though some of them attain a giant size.

Up to now little information is available directly from the southern slope of the Drake Passage around the tip of the Antarctic Peninsula. In Table 1 some results from investigations performed in these areas are summarized. Even taking into account the different sampling techniques the results reveal highly variable organism densities and biomass values within adjacent localities directly south of the Drake Passage. Especially the abundance maxima reported by Mühlenhardt-Siegel (1988) are higher as compared to the other data in Tab. I, without, however, reaching the outstanding high value (86,514 Ind. m^{-2}) found by Richardson and Hedgpeth (1977) in Arthur Harbour, or the even higher one (155,573 Ind. m^{-2}) of Dayton and Oliver (1977) for east McMurdo Sound. However, variability among biomass values is not nearly as high.

We believe these results sustain our suggestion that despite clear differences in the composition of the benthic fauna no distinct latitudinal gradients exist in organism densities and biomass from the tip of South America to the high Antarctic.

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