Benthic Productivity of the Magellan Region as compared with the Antarctic Shelf

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Abstract

The Magellan region at the southern tip of South America constitutes the southernmost outpost of Atlantic as well as Pacific shelf and coastal ecosystems. This region may be the beachhead of a forthcoming invasion of Antarctic ecosystems by northerly species which will profit from the climate change driven warming of Antarctic waters. Thus, the current state of Magellan coastal and shelf ecosystems and the way they differ from their Antarctic counterparts is of general interest. Previous comparisons of benthic community biomass and productivity between Magellan and Antarctic shelf areas indicated lower biomass but higher production in the Magellan area. The main objective of the present study is to extend this comparison in terms of spatial coverage (56 stations in the Magellan region and 232 stations in the Antarctic, Fig. 1), and to examine the role of major environmental parameters for benthic distribution patterns at either side of the Antarctic circumpolar current.

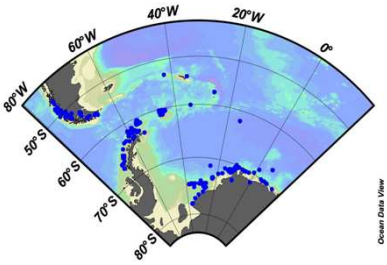


Fig. 1. Distribution map of benthic stations (N=288).

Table 1. Information on the feeding guilds and motility for each taxonomic group.

Taxa	Food Source	Feeding mode	Motility
Porifera	Epibenthic	Suspension-/Filter feeder	sessile
Hydrozoa	Epibenthic	Suspension-/Filter feeder	sessile
Anthozoa	Surface	Predator	sessile
Bryozoa	Epibenthic	Suspension-/Filter feeder	sessile
Brachiopoda	Epibenthic	Suspension-/Filter feeder	sessile
Sipuncula	Surface	Detritus feeder	motile
Turbellaria	Surface	Predator	motile
Nemertinea	Subsurface	Predator	motile
Priapulida	Subsurface	Predator	motile
Polyplacophora	Surface	Grazer/Browsing	motile
Aplacophora	Subsurface	Deposit feeder	motile
Bivalvia	Epibenthic	Suspension-/Filter feeder	motile
Gastropoda	Surface/Subsurface	Grazer	motile
Scaphopoda	Subsurface	Predator	motile
Polychaeta	Surface/Subsurface	Deposit feeder/Detritus feeder	motile
Oligochaeta	Surface/Subsurface	Deposit feeder/Detritus feeder	motile
Echiurida	Surface	Detritus feeder	motile
Acari	Surface	Predator	motile
Pantopoda	Surface	Predator	motile
Amphipoda	Surface/Subsurface	Scavenger/Deposit feeder/Detritus Feeder/Suspension feeder	motile
Cumacea	Epibenthic	Suspension-/Filter feeder	motile
Harpacticoidea	Epibenthic	Suspension-/Filter feeder	motile
Cirripedia	Epibenthic	Suspension-/Filter feeder	sessil
Isopoda	Surface	Detritus feeder	motile
Tanaidacea	Surface	Detritus feeder	motile
Ostracoda	Surface	Suspension-/Filter feeder	motile
Crustacea spp.	Surface	Suspension-/Filter feeder	motile
Echinoidea	Surface	Grazer	motile
Holothuroidea	Epibenthic	Suspension-/Filter feeder	motile
Asteroidea	Surface	Predator	motile
Ophiuroidea	Surface	Scavenger/Detritus feeder/Deposit feeder/Predator	motile
Crinoidea	Epibenthic	Suspension-/Filter feeder	sessil
Hemichordata	Surface	Deposit feeder	motile
Tunicata	Epibenthic	Suspension-/Filter feeder	sessil
Others	Subsurface	Predator	motile

Methods: Data collection

The data sets analyzed corresponds with quantitative samples (multi box corer) were collected in different expeditions and campaigns:

- Joint Chilean-German-Italian Magellan Campaign, RV'Victor Hensen` 1994 (Strait of Magellan and Beagle Channel).
- Cimar-Fiordo II Expedition, RV'Vidal Gormaz' 1996 (South Patagonian Icefield).
- Puck-156 Expedition, RV`Sonne´ 2001 (Chiloe Island).
- Polarstern cruises (11 campaigns; Antarctic Peninsula, Weddell Sea, Southern Ocean and Scotia Sea).

Data processing

- Animals were classified into 38 taxonomic groups.
- Biomass (g WM m^{-2}), Abundance (ind m^{-2}) were determined. Biomass data was transformed to g C org m^{-2} and kJ by conversion factor taken from Brey (2001) (www.thomas-brey.com).
- P/B ratio for each taxonomic groups was estimated using non-lineal model Brey (2001).
- Annual production was calculated from P/B values and group biomass.
- Specific feeding guilds and motility were noted from general zoological references (e.g. Barnes 1987, Pearse 1987) Table 1.

Preliminary results and discussion

On the basis of abundance and taxonomic composition, the dominant groups at both areas are polychaetes (Annelida), crustaceans (Arthropoda) and molluscs (Mollusca) (Fig. 2,3,6,7). However, in terms of biomass, the dominant groups are polychaetes and molluscs in the Magellan region and sponges (Porifera) in the High Antarctic (Fig 4,5).

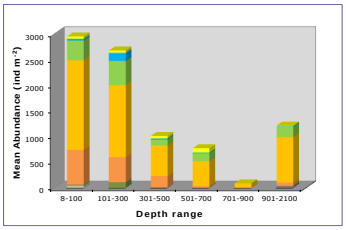


Fig. 2. Mean abundance (ind m^{-2}), Magellan region stations.

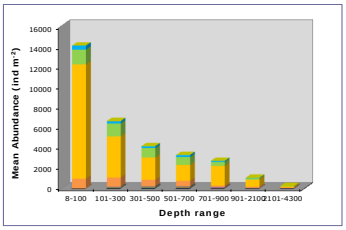


Fig. 3. Mean abundance (ind m^{-2}), Antarctic stations.

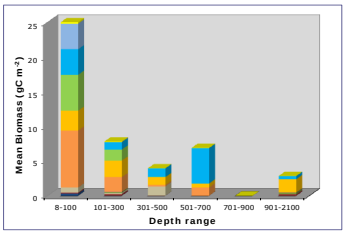


Fig. 4. Mean biomass (g C m^{-2}), Magellan region stations.

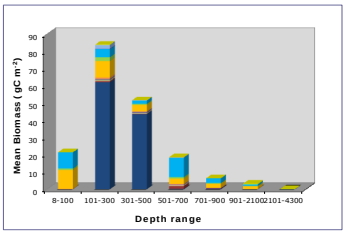


Fig. 5. Mean biomass (g C m^{-2}) Antarctic region stations.

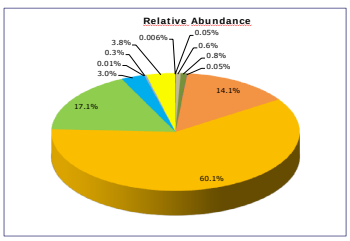


Fig. 6. Taxonomic composition, Magellan region stations.

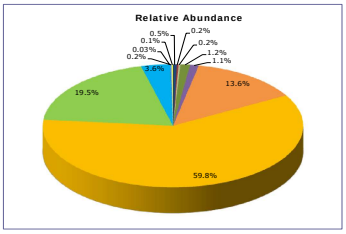


Fig. 7. Taxonomic composition, Antarctic stations.

Porifera, Scolecida, Echinodermata, Cnidaria, Mollusca, Hemichordata, Tentaculata, Annelida, Tunicata, Sipuncula, Arthropoda, Others

In the Magellan region, benthic biomass decreases from 23.9 g C m^{-2} in the 8-100 m water depth range to 2.18 g C m^{-2} in the 901-2100 m water depth range. Abundances, biomass and annual mean production ranged from 59.28 to 7731.4 m^{-2}, 0.384 to 180.2 g C m^{-2} and 1.60 to 16.64 g C m^{-2} y^{-1} respectively (Table 2).

In comparison with the High Antarctic, the benthic biomass decreased from 21.40 g C m^{-2} in the 8-100 m water depth range to 0.09 g C m^{-2} in the 2101-4300 m water depth range. However, from 101-300 m water depth, the biomass increased to 83.81 g C m^{-2}. (Table 3). This value is distinctly different than Brey & Gerdes (1999) estimated at the same depth range. This might be probably because the number of stations, 112 compared with 20 stations by Brey & Gerdes (1999) is rather high and could indicate the high variability of biomass data. Abundances, biomass and annual mean production ranged from 226.3 to 14040.5 m^{-2}, 0.09 to 83.81 g C m^{-2} and 0.11 to 44.47 g C m^{-2} y^{-1} respectively.

Table 2. Depth distribution of Macrobenthos in Magellan region waters.

Depth range	N° of stations	Mean N (ind m-2)	Range N (ind m-2)	Mean Biomass (gC m-2)	Range B (gC m-2)	Mean Production (gC/m-2/y-1)
8-100	21	2946.7	59.28-7731.4	23.90	0.384-180.2	16.64
101-300	21	2506.8	29.64-8783.0	7.03	0.0004-31.5	8.98
301-500	8	900.1	12.6-2813.9	4.23	0.12-13.7	3.00
501-700	6	595.4	41.2-1333.8	5.90	0.16-30.6	3.89
701-900	1	201.7	24.6-491.7	3.03	0.003-7.6	1.60
901-2100	4	725.3	37.8-1632.9	2.18	0.43-5.3	2.68

Table 3. Depth distribution of Macrobenthos in Antarctic waters.

Depth range	N° of stations	Mean N (ind m-2)	Range N (ind m-2)	Mean Biomass (gC m-2)	Range B (gC m-2)	Mean Production (gC/m-2/y-1)
8-100	5	14040.5	1430-36735	21.40	0.64-52.3	44.47
101-300	112	6618.9	30.5-46520	83.81	0.06-5038.7	28.97
301-500	65	4153.1	131.02-13476	51.63	0.018-1742.3	14.88
501-700	20	3287.7	335.01-13520	18.50	0.47-143,1	17.04
701-900	9	2709.8	454.01-8920.4	6.3	0.01-28.9	9.13
901-2100	16	1040.2	17.2-2826.62	3.2	0.03-13.05	3.95
2101-4300	5	226.3	21-431	0.09	0.01-0.2	0.11

Annual production related to water depth

Linear regression analysis indicated that the benthic biomass and production decreased with depth waters at both areas (Fig. 8 a,b Magellan region and Fig. 9 a,b Antarctic). This seems to be a common pattern and has been reported from numerous other regions, *e.g.* for the high Antarctic Weddell and Lazarev Seas (Brey & Gerdes 1998), Magellan Province (Thatje & Mutschke 1999).

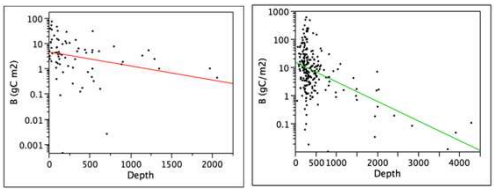


Fig. 8 a , b. a) Mean biomass related to water depth, Magellan region. Log(B)=1,526-0.0013*Log(D+1); r2=0.171; P<0.0001; n=53. b) Mean biomass related to water depth, Antarctic. Log(B)=2,726-0.0016*Log(D+1); r2=0.226; P<0.0001; n=232.

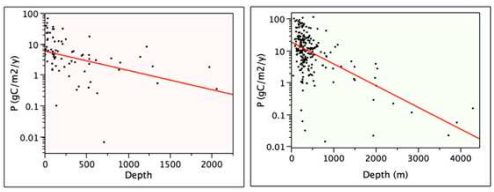
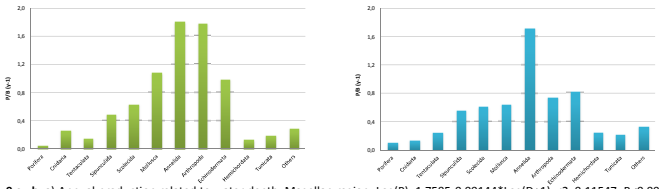


Fig. 9 a , b. a) Annual production related to water depth, Magellan region. Log(P)=1,7595-0.00144*Log(D+1); r2=0.11547; P<0.0001; n=53. b) Annual production related to water depth, Antarctic. Log(P)=2.923-0.00157*Log(D+1); r2=0.524; P<0.0001; n=232.

The annual production and P/B ratios varied substantially among marine taxa.



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DAAD Deutscher Akademischer Austausch Dienst German Academic Exchange Service

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