

Ophiuroids (Echinodermata) of southern Chile and the Antarctic: Taxonomy, biomass, diet and growth of dominant species*

CORINNA DAHM

Alfred Wegener Institute for Polar and Marine Research, P.O. Box 120161, D-27515 Bremerhaven, Germany.
E-mail: cdahm@awi-bremerhaven.de

SUMMARY: This study aims on a first comparison of the shallow water (<550 m) ophiuroid fauna of the Magellan region and the high-Antarctic Weddell Sea. Five species are common to both the Magellan region (22 species) and the Weddell Sea (42 species). The most abundant Magellan species is *Ophiuroglypha lymani*, contributing 33% to total ophiuroid abundance and 44% to total ophiuroid biomass. The diets of *O. lymani* and of three closely related (same sub-family Ophiurinae) also dominant, Antarctic species are similar, indicate however slightly different feeding strategies. The Magellan species tends more towards microphageous grazing, whereas the Weddell Sea species act more like scavengers. Within the sub-family Ophiurinae growth performance of *O. lymani* is higher than in Antarctic species and in the range of boreal species.

Key words: Ophiuroids, biomass, diet, growth, age.

RESUMEN: OFIUROIDEOS DEL SUR DE CHILE Y DE LA ANTÁRTIDA: TAXONOMÍA, BIOMASA, ALIMENTACIÓN Y CRECIMIENTO DE LAS ESPECIES DOMINANTES. – El objetivo del presente estudio es realizar una primera comparación entre la fauna de ofiuroides de aguas someras (<550 m) de la región de Magallanes y del Mar de Weddell (alta Antártida). Cinco de las especies estudiadas están presentes tanto en la región de Magallanes (22 especies), como en el Mar de Weddell (42 especies). La especie magallánica más abundante es *Ophiuroglypha lymani*, contribuyendo en un 33-100% a la abundancia numérica total de ofiuroides y en un 44-100% a la biomasa total de los mismos. La dieta de *O. lymani* y de tres especies taxonómicamente próximas (pertenecientes a la misma subfamilia: Ophiurinae), también dominantes, en la Antártida son similares, aunque presentan algunas diferencias en sus estrategias de alimentación. La especie magallánica tiende más hacia estrategias de tipo ramoneador micrófago, mientras que las especies del Mar de Weddell actúan más como carroñeros. Dentro de la subfamilia Ophiurinae, el crecimiento de *O. lymani* es mayor en comparación con el de las especies antárticas y está dentro del rango de las especies boreales.

Palabras clave: Ofiuroides, biomasa, dieta, crecimiento, edad.

INTRODUCTION

World-wide there are about 1600 existing species of ophiuroids; this class surpasses all other classes of echinoderms in number of surviving species, except asteroids. In many benthic communities of

the world oceans ophiuroids contribute significantly to species diversity, abundance and biomass of the fauna (see e.g. Hyman, 1955; Fell *et al.*, 1969; Tyler, 1980; Barnes, 1987; Voß, 1988; Gerdes *et al.*, 1992; Dahm, 1996).

Echinoderms, and especially ophiuroids, are very common on either side of the Drake Passage (Larraín, 1995) and also in the high Antarctic (Voß, 1988; Dahm, 1996). This paper is a first attempt to

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compare the Magellan and high Antarctic ophiuroid fauna. I will address the following questions:

1. How similar are the Magellan and the high Antarctic ophiuroid fauna from a taxonomic point of view?
2. How do ophiuroids contribute to total macrozoobenthos biomass in these regions?
3. Is the diet of the dominant species from the Magellan region comparable to the diet of closely related as well as dominant species from the Antarctic?
4. Are there differences in growth and age between closely related species from these regions?

MATERIAL AND METHODS

Investigation area, sampling and preservation

In the Magellan region (Fig. 1) 47 Agassiz trawl samples (max. depth 350 m) were taken during the Joint Chilean-German-Italian Magellan Campaign in 1994 by RV "Victor Hensen" and during the expedition ANT XIII/4 of RV "Polarstern" in 1996. Stations, investigation area and sample treatment are described in Arntz and Gorny (1996) and Fahrbach and Gerdes (1997). In the Weddell Sea (Fig. 1) 117 trawl samples were taken during seven expeditions of RV "Polarstern" between 1983 and 1992 (Dahm, 1996; max. depth 550 m). All samples were fixed in 4% formaldehyde buffered with hexamethyltetramine. In the laboratory all individuals were identified to species and then stored in 70% ethanol.

Estimation of biomass

Ophiuroid biomass was computed from multibox corer samples taken by Gerdes *et al.* (1992) in the Weddell Sea (see Dahm, 1996) and by Gerdes (1999) in the Magellan region.

Stomach content analysis

The ophiuroid disc was cut around the perimeter and the aboral surface removed to expose the stomach. Contents were examined microscopically and food items identified as exactly as possible. Ophiuroid diet was quantified using a points method (Swynnerton and Worthington, 1940; Hynes, 1950) modified by Brun (1972) and Dearborn *et al.* (1986) which combines information on stomach fullness and volumetric contribution of food items (for fur-

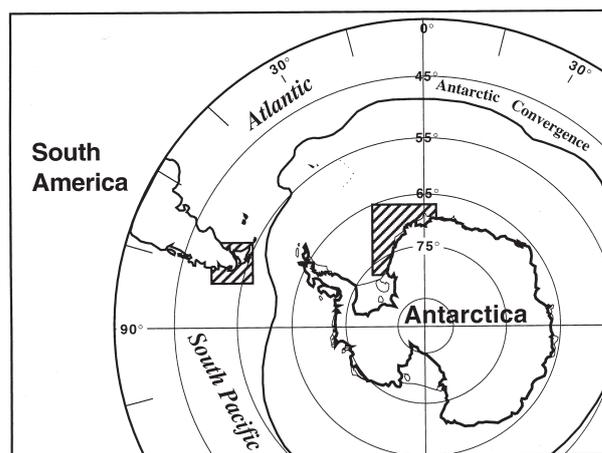


FIG. 1. – Sampling areas in the Magellan region and the Weddell Sea.

ther details see Fratt and Dearborn, 1984; Dearborn *et al.*, 1986; Dahm, 1996; Dahm and Brey, *subm.*).

Growth and age

Age of ophiuroids was determined by analyzing the microstructure of annually formed growth rings on the vertebral ossicles of the arms according to Dahm (1993, 1996), Dahm and Brey (1998) and Gage (1990a). I use the Richards function to model individual growth:

$$S_t = S_\infty (1 - D \cdot e^{-K(t - t_0)})^{1/D}$$

where S_∞ is asymptotic size, K (y^{-1}) is the growth constant, D is a shaping parameter and t_0 (y) determines the inflexion point of the curve. Growth performance was computed according to Brey (in press):

$$\varphi = \log(M_{\max}/A_{\max})$$

where M_{\max} is maximum body mass (kJ) and A_{\max} is maximum age (y).

RESULTS

Taxonomic similarity

In the Magellan region 22 species were found (15 of these identified to the species) belonging to 14 genera and 7 families in comparison to 42 species belonging to 21 genera and 6 families in the Weddell Sea. 5 species, 6 genera and 4 families are common to both regions (Table 1).

TABLE 1. – Ophiuroid species found in the Weddell Sea (Antarctica; Dahm, 1996) and in the Magellan region. Note that seven further Magellan species could not be identified to the species and are hence not included in this table.

Species	Weddell Sea	Magellan Region
Gorgonocephalidae:		
<i>Astrotoma agassizii</i> Lyman, 1875	•	•
<i>Astrochlamys bruneus</i> Koehler, 1912	•	
<i>Astrochlamys sol</i> Mortensen, 1936	•	
<i>Astrohamma tuberculatum</i> (Koehler, 1923)	•	
<i>Gorgonocephalus chilensis</i> (Philippi, 1858)		•
Ophiacanthidae:		
<i>Ophiacantha pentactis</i> Mortensen, 1936	•	
<i>Ophiacantha antarctica</i> Koehler, 1901	•	•
<i>Ophiacantha vivipara</i> Ljungman, 1870	•	•
<i>Ophiacantha frigida</i> Koehler, 1908	•	
<i>Ophiacantha cosmica</i> Lyman, 1878		•
<i>Ophiosparte gigas</i> Koehler, 1922	•	
<i>Ophiomitrella falklandica</i> Mortensen, 1936	•	
<i>Ophiacamax gigas</i> Koehler, 1901	•	
Amphiuridae:		
<i>Amphiura proposita</i> Koehler, 1922	•	
<i>Amphiura protecta</i> Hertz, 1927	•	
<i>Amphiura lymani</i> Studer, 1885	•	
<i>Amphiura algida</i> Koehler, 1911	•	
<i>Amphiura belgicae</i> Koehler, 1901	•	
<i>Amphiura eugeniae</i> Ljungman, 1867	•	
<i>Amphiura deficiens</i> Koehler, 1922	•	
<i>Amphiura microplax disjuncta</i> Mortensen, 1936	•	
<i>Amphiura dilatata gaussi</i> Hertz, 1927	•	
Ophioleucidae:		
<i>Ophiroleuce regulare</i> (Koehler, 1901)	•	
Ophiuridae:		
<i>Ophioceres incipiens</i> Koehler, 1922	•	
<i>Glaciacantha dubium</i> (Koehler, 1901)	•	
<i>Glaciacantha döderleini</i> (Hertz, 1927)	•	
<i>Ophiocten dubium</i> Koehler, 1901	•	
<i>Ophiocten megaloplax</i> (Koehler, 1901)	•	
<i>Ophiocten amitinum</i> Lyman, 1878		•
<i>Ophiuroglypha lymani</i> (Ljungman, 1870)		•
<i>Ophionotus victoriae</i> Bell, 1902	•	
<i>Ophioperla koehleri</i> (Bell, 1908)	•	
<i>Ophiosteira echinulata</i> Koehler, 1922	•	
<i>Ophiosteira debitor</i> Koehler, 1922	•	
<i>Ophiosteira rotundata</i> Koehler, 1922	•	
<i>Ophiosteira senouqui</i> Koehler, 1901	•	
<i>Ophiurolepis brevirima</i> Mortensen, 1936	•	
<i>Ophiurolepis gelida</i> (Koehler, 1901)	•	
<i>Ophiurolepis martensi</i> (Studer, 1885)	•	
<i>Ophiurolepis tumescens</i> Koehler, 1922	•	
<i>Ophiogona döderleini</i> (Koehler, 1901)	•	•
<i>Ophiura rouchi</i> (Koehler, 1912)	•	
<i>Ophiura serrata</i> Mortensen, 1936	•	
<i>Ophiura ambigua</i> (Lyman, 1878)		•
<i>Homalophiura inornata</i> (Lyman, 1882)	•	
<i>Theodoria relegata</i> (Koehler, 1922)	•	
<i>Ophiozonella falklandica</i> Mortensen, 1936		•
Hemieuryalidae:		
<i>Ophiochondrus stelliger</i> Lyman, 1879	•	•
Ophiactidae:		
<i>Ophiactis asperula</i> (Philippi, 1858)		•
Ophiomyxidae:		
<i>Ophioscolex nutrix</i> Mortensen, 1936		•
<i>Ophiomyxa vivipara</i> Studer, 1876		•
Ophiodermatidae:		
<i>Toporkovia antarctica</i> (Lyman, 1882)		•
Total:	42	15

Biomass

According to the data of Gerdes (1999) and Gerdes *et al.* (1992) ophiuroids contribute 1% (=0.07 gC_{org} m⁻²) to total macrozoobenthos biomass in the Magellan region and about 4% (= 0.44 gC_{org} m⁻²) in the Weddell Sea. Taking into account a correction necessary for underestimation of ophiuroid biomass by corers (Dahm, 1996), true biomass is about 3% of macrobenthic biomass in the Magellan region and 12% in the Weddell Sea, respectively.

Diet

Diet was compared within the sub-family Ophiurinae which includes the dominant ophiuroids of both regions, *Ophiuroglypha lymani* in the Magellan region and *Ophionotus victoriae*, *Ophiurolepis gelida* and *Ophiurolepis brevirima* in the Weddell Sea (see Dahm, 1996). Figure 2 shows the diet composition of *O. lymani* after the first phytoplankton bloom and subsequent sedimentation event of the year. The species is omnivorous and feeds mainly on crustaceans (25%), sediment (25%) and phytodetritus (23%). The three Antarctic species feed on the same range of items shown in Figure 2, but their diet contains distinctly more crustaceans (about 47%), less phytodetritus (about 12%) and occasionally polychaetes and sponge needles (Dahm, 1996).

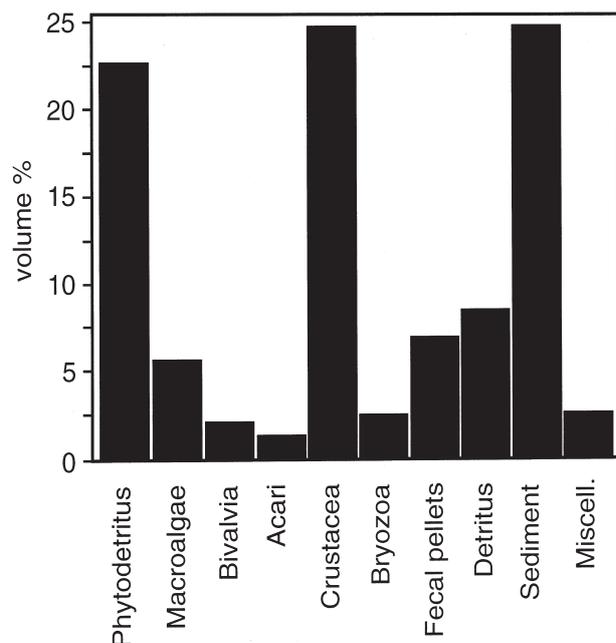


FIG. 2. – Diet composition of *O. lymani* in the Magellan region (Beagle Channel, 200 - 350 m water depth, N = 63) in summer.

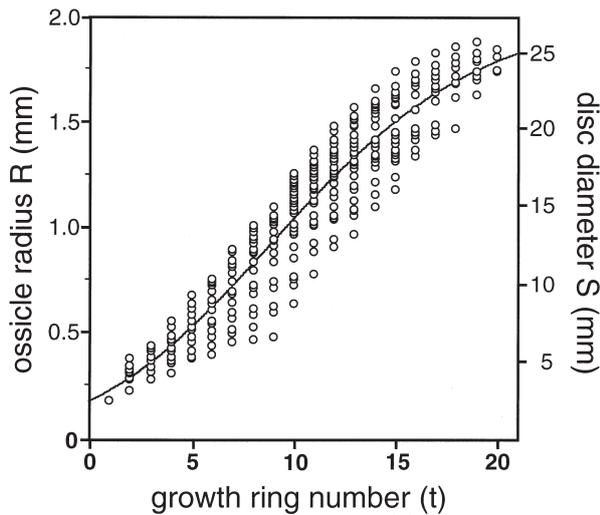


FIG. 3. – Growth of ossicle radius R and disk diameter S of *O. lymani* in the Magellan region. Richards growth function fitted to size-at-age data obtained from ossicle growth band readings (320 band readings from 42 individuals). Growth parameters: $R_{\infty} = 2.1$ mm; $K = 0.17$; $t_0 = 8.58$; $D = 0.41$

Age and growth

Figure 3 shows the growth curve of *O. lymani* in the Beagle Channel fitted to size-at-age data obtained from ossicle readings. The oldest specimens of *O. lymani* were 20 years old with a disc diameter of about 25 mm. For the three Antarctic species, Dahm (1996) determined maximum age and disc diameter to be 22 years and 32 mm for *O. victoriae*, 33 years and 21 mm for *Ophiurolepis gelida* and 25 years and 21 mm for *Ophiurolepis brevirima*. Growth performance of the Magellan species *O. lymani* is higher than that of the three Antarctic species but in the range of boreal species (Fig. 4).

DISCUSSION

Ophiuroids can tolerate a wide depth as well as temperature range (e.g. Brey *et al.*, 1996). Therefore we should expect many Antarctic species to occur outside the South Polar Sea (South America or New Zealand). As shown here (Table 1), five high Antarctic (Weddell Sea) species are present in South America, whereas New Zealand and Antarctica have only one species in common (Fell *et al.*, 1969). The range of many shelf and slope ophiuroid species is controlled by depth, hence only the existence of shallow water routes allows wider dispersal (Fell *et*

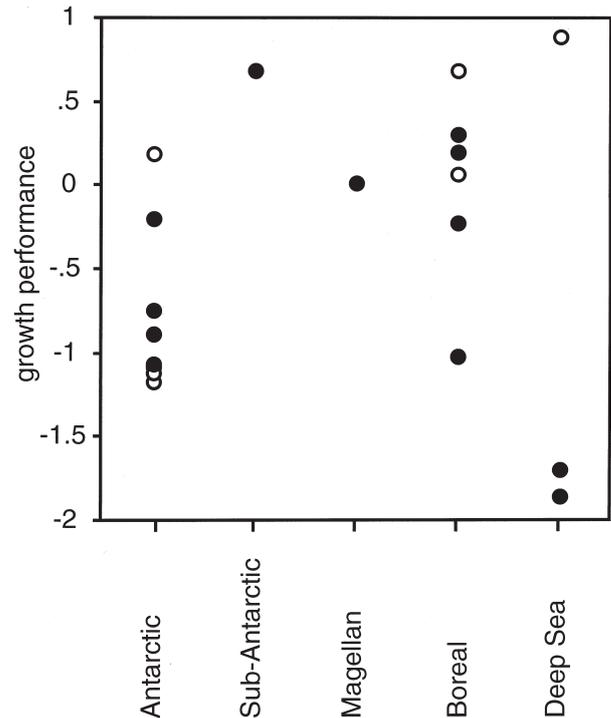


FIG. 4. – Growth performance ($\varphi = \log(M_{\max}/A_{\max})$) of ophiuroids from various regions. Dots: Species belonging to the sub-family Ophiurinae. Circles: Species belonging to other taxa. Data sources: Antarctic: Dahm (1996); sub-Antarctic: Morison (1979); Magellan: this study; Boreal: Dahm (1993), Munday and Keegan (1992); Warwick *et al.* (1978), Warwick and George (1980); George and Warwick (1985); Deep Sea: Gage (1990b), Gage and Tyler (1981, 1982a, b).

al., 1969). No such shallow water route existed in the more recent history between New Zealand and Antarctica, whereas there is a submerged ridge, the Scotia Arc, between the Antarctic Peninsula and South America (Fell *et al.*, 1969). This is the most likely migration route for eurybathic species and may explain the higher number of common species. However, there are no fossil records which might indicate the direction or time scale of this migration (Arntz *et al.*, 1994).

Species numbers and biomass

In terms of species numbers and biomass, ophiuroids play a less significant role in the Magellan region (22 species, 3% of biomass) than in the Weddell Sea (42 species, 12% of biomass). The strong presence of ophiuroids in environments with low and highly seasonal food input such as polar seas or many deep sea regions indicates special adaptations and higher competitiveness of ophiuroids under those conditions. Consequently, the lower biomass of ophiuroids in the Magellan region may be related

to more favourable conditions for the benthic fauna. Longer periods of food availability may enable other taxa to compete better against ophiuroids. It should be noted, however, that certain boreal benthic communities may be dominated by ophiuroids, too, as observed by George and Warwick (1985) or O'Connor *et al.* (1986).

Diet, age and growth

It might have been more meaningful to compare diet and growth of the same species in the Magellan region and in the Weddell Sea, however, none of the species encountered occurred in sufficient numbers in both regions.

The diet of all four species of Ophiurinae analysed here is basically similar (crustaceans, phytodetritus, sediment), but nonetheless indicates differences in feeding strategy between the Magellan and Antarctic species. The Magellan species *O. lymani* contains comparatively more phytodetritus and sediment, indicating some kind of microphagous "grazing" strategy (Warner, 1982). The higher amount of crustaceans ingested by the Antarctic species, 47% compared to 25% in *O. lymani*, indicates that these species act more like scavengers, which ingest phytodetritus and sediment either accidentally or as a second choice food (Warner, 1982). This difference may indicate that competition for the principal food source of benthic animals, i.e. sedimented matter, is higher in the Antarctic, forcing the dominant ophiuroid species to vertically expand their trophic niche (see Dahm, 1996).

With only one Magellan ophiuroid species analyzed so far (Fig. 3), I am not able to make solid general statements about growth and growth performance. My data, however, indicate that Antarctic species show lower growth performance than closely related species from the Magellan area or other more northerly regions (Fig. 4). This is in accordance with previous comparisons based on data referring to various benthic taxa from Antarctic and non-Antarctic regions (Arntz *et al.*, 1994).

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