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The occurrence of pycnogonids associated with the volcanic structures of Bransfield Strait central basin (Antarctica)

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SUMMARY: Fifty-four specimens of pycnogonids belonging to twenty-two species, eight genera and six families were collected with a rocky dredge during the cruise Gebrap-96 in the central basin of Bransfield Strait, from depths between 647 and 1592 m. The richest station in terms of abundance and biomass was DR6 (south of Livingston Island), which was also the shallowest one; at this relatively shallow depth food is more available than in deeper waters. The families Nymphonidae and Colossendeidae had the same number of specimens (21 specimens; 39% abundance each). The most abundant species were *Nymphon villosum* and *N. proximum*. *Pallenopsis buphthalmus* was collected for only the third time. The collections increased the geographical distribution of three species and the depth range of six species. The volcanic structures sampled were inactive during 1996, since none of the specimens showed signs of hydrothermal phenomena. This collection was typically representative of the west Antarctic benthic zone.

Keywords: Antarctic waters, Bransfield Strait, Gebrap-96 Cruise, Pycnogonida, volcanic structures.

RESUMEN: OCURRENCIA DE LOS PICNOGÓNIDOS ASOCIADOS A ESTRUCTURAS VOLCÁNICAS EN LA CUENCA CENTRAL DEL ESTRECHO DE BRANSFIELD (ANTÁRTIDA). – En la expedición Gebrap-96 se capturaron 54 picnogónidos pertenecientes a 22 especies, 8 géneros y 6 familias. Se prospectaron fondos del Estrecho de Bransfield, entre 647 y 1592 m con una draga de roca. La estación con más riqueza biológica fue la DR6 (sur de Livingston), la menos profunda de entre las prospectadas; a dicha profundidad hay más disponibilidad alimentícia que en aguas inferiores. Las familias más abundantes (Colossendeidae y Nymphonidae) tienen el mismo número de individuos (21; 39% abundancia cada una). Las especies más abundantes fueron *Nymphon proximum y N. villosum,* siendo *Pallenopsis buphthalmus* tercera cita mundial. Tres especies aumentan su distribución geográfica y seis su batimetría. El análisis de la picnogonifauna permite afirmar que las formaciones volcánicas permanecían inactivas en el año del muestreo, siendo esta fauna la típica de la Antártida occidental.

Palabras clave: aguas antárticas, Estrecho de Bransfield, campaña Gebrap-96, Pycnogonida, estructuras volcánicas.

INTRODUCTION

The most recent reports on pycnogonids from Antarctic and sub-Antarctic waters are those of Arntz *et al*. (2006), Bamber (1995, Falkland Islands and South Shetland Islands), Child (1994, 1995 diverse zones), Chimenz and Gravina (2001, Ross Sea), Munilla (1991, 2000, 2001a, 2002, Scotia Sea and Antarctic Peninsula), Munilla and Ramos (2005, Antarctic Peninsula), Pushkin (1993, various zones) and Turpaeva (1998, 2000, Weddell Sea). These authors collate references and the historical background of previous work from this area, particularly Child's papers. Other works (Arntz *et al*. 1990 and Galéron *et al*. 1992) provide only qualitative data about the occurrence of pycnogonids at 27 stations in the Weddell Sea, between 200 and 2000m depth. Gerdes *et al*. (1992) have provided quantitative data for this and other groups, sampled with a multibox corer, including biomass and abundance at 36 stations (170-2037) from the southeastern Weddell Sea.

Some species from Livingston Island and surrounding waters (South Shetland Islands, Drake Passage, Bransfield Strait) have been documented previously, mainly by Gordon (1932, 1944), Fry and Hedgpeth (1969), Pushkin (1993), and the Child and Bamber papers mentioned before.

The aim of the present study is to present quantitative data on the biomass and abundance of pycnogonids of the Bransfield Strait central basin in order to compare these data with other works of the same zone and with other volcanic zones. We also analysed the fauna from volcanic structures to deduce whether the volcanoes were active or inactive during 1996.

MATERIAL AND METHODS

The specimens were collected during the Gebrap-96 cruise (December 1996 to January 1997) aboard the *Hespérides* oceanographic vessel of the Spanish Navy. The benthonic sampling area was located on underwater volcanic structures located in the central basin of Bransfield Strait (CBB)(Fig. 1).

A total of 9 stations were sampled, but pycnogonids were only present in 6 of them. The coordinates and characteristics of stations where pycnogonids were present are shown in Table 1. Samples were obtained between 647 and 1592 meters depth; the duration of dragging was between 41 (DR6) and 85 minutes (DR2), with a mean velocity of 2 knots.

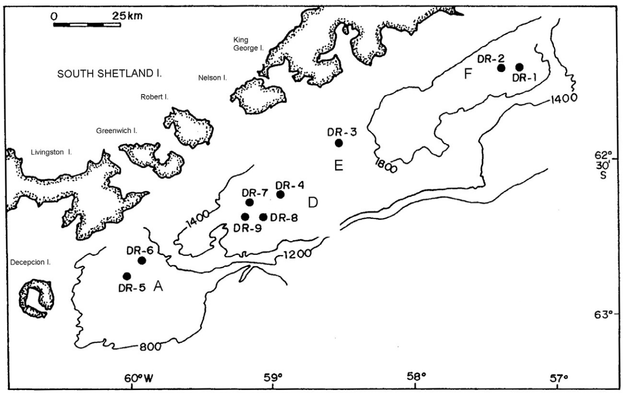

FIG. 1. – Sampling area and location of dredged stations.

A rocky dredge of 0.8 × 0.3m, with 10 mm mesh size and leather protection, was used in the hauls. Samples were sieved on board through sieves of decreasing mesh size, 10, 5 and 1 mm respectively. Specimens were fixed in 4% formalin solution and stored in 70% ethanol in the zoological collections of the Universidad Autónoma de Barcelona.

On the seafloor of the CBB, four large volcanic edifices (labelled A, D, E and F in Fig. 1, from west to east, following the labelling of Canals and Gracia, 1997) have been identified. They exhibit a range of circular (conical), semicircular, crescent and elongated or ridged forms, the latter arranged in an *en échelon* form. Edifice A showed linear volcanic ridges, and included two stations (DR5 and DR6); a series of spaced, subparallel ridges dominated edifice D, which included both DR4 and DR7; edifice E was dominated by conical seamounts, and included only one trawl, DR3; finally, edifice F, which was also associated with linear volcanic ridges, included DR2.

TABLE. 1. – Species, abundance and biomass of the pycnogonids present in the positive stations during the Gebrap-96 cruise. I.depth: Initial depth; F.depth: Final depth; T. time: Trawl time (minutes); Ab: Abundance; B(g): Biomass in grams; N.lo: *Nymphon longicoxa*; P.va: *Pallenopsis vanhoffeni*; C.te: *Colossendeis tenuipedis*; N.pr: *Nymphon proximum*; A.br: *Austropallene brachyura*; P.an: *Pentanymphon antarcticum*; N.vi: *Nymphon villosum*; N.au: *Nymphon australe*; N.ch: *Nymphon charcoti*; P.ga: *Pycnogonum gaini*; A.ca: *Ammothea carolinensis*; A.spi: *Ammothea spinosa*; A.gi: *Ammothea gibbosa*; C.ar: *Colossendeis arundorostris*; C.ro: *Colossendeis robusta*; C. au: *Colossendeis australis*; P.pa: *Pallenopsis patagonica*; C.me: *Colossendeis megalonyx*; C.ps: *Colossendeis pseudochelata*; C.to: *Colossendeis tortipalpis*; P.bu: *Pallenopsis buphthalmus*; D.au: *Decolopoda australis*.

Station	Date	Latitude S	Longitude W	I.depth (m)	F.depth (m)	T. time	Species	Ab	B(g)
DR2	30-12-96	62°13'54"	57°19'44"	1592	1269	85'	N.lo	1	0.036
DR3	30-12-96	62°28'05"	58°27'25"	1370	1286	59'	P.va	1	0.13
DR4	30-12-96	62°36'15"	58°48'11"	1527	1257	65'	C.te	2	1.54
DR5	01-01-97	62°52'40"	59°59'07"	922	699	51'	N.pr	1	0.024
DR6	02-01-97	62°48'48"	59°52'19"	672	647	41'	A.br; P.an; N.vi; N.pr; N.au; N.lo; N.ch; P.ga; A.ca; A.spi; A.gi; C.ar; C.ro; C.au; P.pa; C.me; C.ps; C.to; P.bu	48	25.98
DR7	03-01-97	62°37'53"	59°05'58"	1416	1275	66'	D.au	1	7.02

TABLE. 2. – Life stages, fresh weight (g), percentage of abundance and biomass of the pycnogonid species recorded in the Gebrap-96 cruise.

Specie	Males	Females	Juv	Total	%Abundance	Fresh weight	% Biomass
Ammothea caroliniensis Leach, 1814		1		1	1.85	0.555	1.60
Ammothea gibbosa (Bouvier, 1913)		1	1	2	3.70	1.96	5.64
Ammothea spinosa (Hodgson, 1907)	1	1		2	3.70	0.8	2.30
AMMOTHEIDAE	1	3	1	5	9.26	3.32	9.54
Austropallene brachyura (Bouvier, 1913)	1			1	1.85	0.158	0.45
PALLENIDAE	1			1	1.85	0.158	0.45
Colossendeis arundorostris Fry & Hedgpeth, 1969	1	2	2	5	9.26	3.29	9.47
Colossendeis australis Hodgson, 1907			1	1	1.85	0.05	0.14
Colossendeis megalonix Hoek, 1881	1	1		2	3.70	0.45	1.30
Colossendeis pseudochelata, Pushkin*, 1993*	1			1	1.85	0.2	0.58
Colossendeis robusta Hoek, 1881	2	3		5	9.26	4.32	12.44
Colossendeis tenuipedis Pushkin, 1993		2		2	3.70	1.54	4.43
Colossendeis tortipalpis Gordon, 1932	3	1		4	7.41	8.39	24.16
Decalopoda australis Eights, 1835		1		1	1.85	7.02	20.21
COLOSSENDEIDAE	8	10	3	21	38.89	25	72.73
Nymphon australe Hodgson, 1902	3		1	4	7.41	0.292	0.84
Nymphon charcoti Bouvier, 1911		1		1	1.85	1.13	3.25
Nymphon longicoxa Hoek, 1881		2		2	3.70	0.114	0.33
Nymphon proximum Calman, 1915	3	3	1	7	12.96	1.1926	3.43
Nymphon villosum (Hodgson, 1915)	6			6	11.11	0.314	0.90
Pentanymphon antarcticum Hodgson ,1904	1			1	1.85	0.017	0.05
NYMPHONIDAE	13	6	2	21	38.89	3.0596	8.81
Pallenopsis buphtalmus Pushkin, 1993	1			1	1.85	0.44	1.27
Pallenopsis patagonica (Hoek, 1881)	1	1	1	3	5.56	1.708	4.92
Pallenopsis vanhöffeni Hodgson, 1915			1	1	1.85	0.13	0.37
PELLENOPSIDAE	2	1	2	5	9.26	2.278	6.56
Pycnogonum gaini Bouvier, 1910		1		1	1.85	0.66	1.90
PYCNOGONIDAE		1		1	1.85	0.66	1.90
TOTAL	25	21	8	54	100.00	34.7306	100.00

RESULTS

Only six of the nine stations sampled provided pycnogonids.

A total of 54 pycnogonids were collected, belonging to 22 species, 8 genera and six families. This represents 0.8% of the total abundance (a total of 6797 specimens were collected belonging to 35 different faunal groups). The most abundant pycnogonid families were Colossendeidae and Nymphonidae. Each family included 21 specimens. The two families together constituted 78% of the total pycnogonid abundance. *Nymphon proximum* (Calman, 1915) was the richest species, with 7 specimens, followed by *Nymphon villosum* (Hodgson, 1915), with 5 specimens.

Table 1 shows the species, abundance and biomass of the pycnogonids present in each station.

Table 2 shows the species collected with their respective life stages and their percentages of abundance and biomass in relation to the total number of pycnogonid specimens collected.

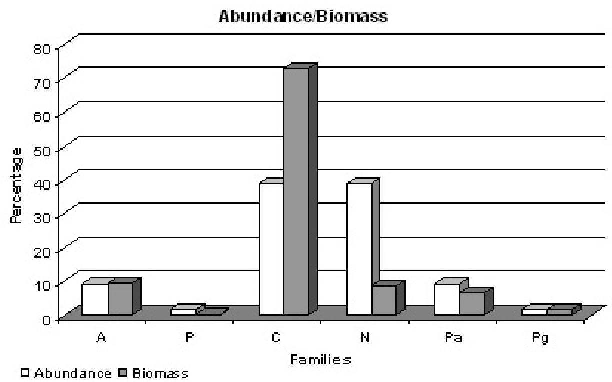

FIG. 2. – Percentages of abundance and biomass of the different families. A: Ammotheidae; P: Callipallenidae; C: Colossendeidae; N: Nymphonidae; Pa: Pallenopsidae; Pg: Pycnogonidae.

Although abundance was the same for both major families (Nymphonidae and Colossendeidae, 39%), biomass was about seven times greater in Colossendeidae (72.73%) than in Nymphonidae (8.81%) (Fig. 2).

Total fresh weight for all pycnogonids was 34.73 g, which represented 0.23% of all faunal groups collected (15018 g).

Note that three individuals presented teratological structures: i) right propodi with different spinulation and form to left ones in *Austropallene brachyura;* ii) functional chelae in adult of *Ammothea carolinensis;* iii) presence of a ventral bulge in the proboscis of *Pycnogonum gaini*. These features are normally the opposite to the normal ones.

DISCUSSION

Biological richness vs. abiotic factors

Although Antarctic and Subantarctic pycnogonids are well studied, it is not unusual for a cruise to find new species or new geographical or bathymetric data, and few collections have been made in the basin of Bransfield Strait (Munilla, 2000, 2001a).

The bottom bathymetry map of the central Bransfield Basin, west Antarctica, is dominated by a series of isolated volcanoes and associated ridges (formation of new oceanic crust) with distinct morphologies which illustrate three tectonovolcanic evolutionary stages: (I) conical seamounts, indicative of continuous, focused, point-source volcanism, represented by the small scattered conical volcanoes and edifice E; (II) the flat top volcanic cones are split by extensional faults in two crescent halves by a longitudinal and central volcanic ridge (this situation is well illustrated by edifices A and F); and (III) series of spaced, subparallel ridges (edifice D), resulting from the progressive disfigurement of the volcanic builds, which means that they have become volcanically inactive (Canals and Gracia, 1997).

The zone with the highest biological richness in pycnogonids and other zoological groups (Ramil and Ramos, 1997) in the Bransfield Strait, both in abundance and biomass, was DR6 station, located on edifice A, which has a bottom of mud with some gravel. The reasons for this biological richness are difficult to explain, taking into account that the dragging of DR6 station was the shortest (Table 1), but two hypotheses are presented.

The abundance of pycnogonids and other benthic groups of the preliminary study (Ramil and Ramos, 1997) decrease with depth. Depth is an approximate measure of distance from the planktonic source (Smith, 1955); that is to say, food is more abundant at the upper stations because distance to the planktonic source is shorter. Food can be acquired more easily in shallow stations (DR6), and so pycnogonids taxocoenosis may increase in abundance.

TABLE. 3. – Pycnogonida recorded on hydrothermal vents.

Specie	Author	Depth (m)
Ammothea verenae	Child, 1987	1570-2225
	Turpaeva, 1988	1800
Sericosura mitrata	Child, 1982	2100
Sericosura venticola	Child, 1987	1570-2225
Sericosura cochleifovea	Child, 1989	3660
Sericosura cyrtoma	Child, 1996	2563
Sericosura heteroscela	Child, 1996	1727

The slightly inclined orography of DR6 (Canals and Gracia, 1997) may favour the arrival of resuspended organic material in slight currents, which would be filtered by bryozoa, hydrozoa and porifera, or other suspension-feeders; these organisms increase their biomass (Ramil and Ramos, 1997) and may serve as food for pycnogonids.

San Vicente *et al*. (1997) mention that depth is the only important abiotic factor of six factors tested in waters around Livingston Island. Munilla (2001b) found that two-thirds of the Antarctic and Subantarctic pycnogonid species have only been found on the continental shelf and upper slope (also the most sampled zones) and that the number of species decreases dramatically down to 1000 m.

Are there adaptations to volcanic structures?

There are only six reports (Child, 1982, 1987, 1989, 1996; Turpaeva, 1988; Brescia and Tunnicliffe, 1998) on Pycnogonida taken from five different deep sea hydrothermal vents. All recorded species (Table 3) had a normal aspect without special morphological adaptations for the vents, except that deep-sea species did not have eyes (Turpaeva, 2002). It is interesting to note that five of the six known species of *Sericosura* have been recorded exclusively on hydrothermal vent exposures, sometimes in elevated densities (Brescia and Tunnicliffe, 1998), and no *Sericosura* species were found by the Gebrap-96 cruise despite sampling similar volcanic areas.

None of the pycnogonids or other taxa (Ramil and Ramos, 1997) sampled by this cruise found specimens with specific volcanic adaptations (e.g. external mucus-filamentous bacteria, dark sulphide crust-vent Pycnogonida), leading us to believe that these sampled volcanic zones were inactive during 1996. The same occurred on the hydroids sampled in this cruise (Peña Cantero and Ramil, 2006).

TABLE. 4. – Geographical distribution and depth range in meters. E, east Antarctic zone; C, circumpolar; P, Antarctic Peninsula; R, Ross Sea; S, Scotia Sea; W, Weddell Sea; * indicates a new zone or depth of distribution.

Species	Distribution	Depth range (m)
Ammothea carolinensis	C	3-670
Ammothea gibbosa	C	0-672*
Ammothea spinosa	P,R,S	76-1679
Austropallene brachyura	C	85-920
Colossendeis arundorostris	R,S*,W	610-672*
Colossendeis australis	C	15-3935
Colossendeis megalonyx	C	7-4900
Colossendeis pseudochelata	E,S	125-672*
Colossendeis robusta	C	0-3610
Colossendeis tenuipedis	C	250-1527*
Colossendeis tortipalpis	C	160-4026
Decolopoda australis	P,R,S	0-1890
Nymphon australe	C	8-3000
Nymphon charcoti	C	3-1200
Nymphon longicoxa	R,S	318-2998
Nymphon proximum	E,P,R,S*	40-1138
Nymphon villosum	E,R,S*	13-672*
Pallenopsis buphthalmus	E,S	106-830
Pallenopsis patagonica	C	3-4540
Pallenopsis vanhoffeni	C	3-1370*
Pentanymphon antarcticum	C	3-3227
Pycnogonum gaini	C	24-2495

Faunistic and taxonomic traits

In this study, the genus *Colossendeis* was found to be as abundant as *Nymphon*. This differs somewhat from other Antarctic collections (Munilla, 2000, 2001a), in which the most abundant genus was *Nymphon* (the most speciose genus), and the second most abundant was *Ammothea*.

Colossendeis and *Nymphon* are two genera with very large legs, adapted to moving on muddy bottoms (DR6 station), and in deep currents (Turpaeva, 2002).

Although the Colossendeidae and Nymphonidae are equal in abundance, biomass is much greater for the Colossendeidae (Fig. 2) due to their generally larger size compared to the smaller Nymphonidae. Munilla (1991) found a similar situation, and ranked the Colossendeids (heavier to lighter) like this: *Decolopoda australis*, *Colossendeis australis* and *C. robusta*. Since the Colossendeids are much larger than an average pycnogonid, this may help to account for their greater longevity (Munilla, 1991), and indicates that they are probably employing the K-strategy (environmental stability, slow growth, big size and low metabolism) instead of the r-strategy, which is typical of smaller pycnogonids such as nymphonids.

In this expedition *Pallenopsis buphthalmus* was collected for only the third time. Three species (*C. arundorostris, N. proximum, N. villosum*) have increased their geographical distribution, and six (*C. arundorostris, C. pseudochelata, C. tenuipedis, N. villosum, A. gibbosa, P. vanhoffeni*) their depth range (Table 4). However, 14 of the 21 species have a circumpolar geographical distribution, characteristic of Antarctic pycnogonids (Fry and Hedgpeth, 1969; Hedgpeth, 1971; Munilla, 2000, 2001a, b).

We consider *Ammothea gibbosa* of Bouvier (1913, Fig. 81), (not *Colossendeis gibbosa* of Möbius, 1902, pl. XXX, Fig. 1-5, which is a juvenile of Ammothea confused with a juvenile of *Colossendeis*), to be a valid species and not a synonym of *A. carolinensis* (Leach, 1814), as suggested by Fry and Hedgpeth (1969, p. 75). *Ammothea gibbosa* has a rounded ocular tubercle, a basal tubercle on the inclined abdomen, a curved fourth article of the palp and present dorsal tubercles on the trunk segments. In comparison, *A. carolinensis* has a conical ocular tubercle, does not have a basal tubercle on the inclined abdomen, the fourth palpal article is not curved and the dorsal tubercles of the trunk are pointed and oriented backwards.

Finally, it is necessary to carry out more volcanic deep water expeditions in order to expand the knowledge of the specific biodiversity, bathymetrical and zoogeographical distribution of pycnogonids, and other benthic groups.

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