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New findings and two new species of the genus *Pallenopsis* (Pycnogonida: Pallenopsidae) from the Southern Ocean

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Summary: Pycnogonid specimens of the genus *Pallenopsis* collected during the Antarctic *Polarstern* XXIII/8 cruise (23 November 2006 to 30 January 2007) were studied. Seven species are recognized in this collection and two of them are proposed as new species: *Pallenopsis tubercula* n. sp., *P. elephantensis* n. sp., *P. gracilis* Cano-Sánchez and López-González, 2019, *P. hodgsoni* Gordon, 1938, *P. macronyx* Bouvier, 1911, *P. spicata* Hodgson, 1914 and *P.* aff. *vanhoeffeni* Hodgson, 1915. *Pallenopsis gracilis* is reported for the first time since its original description. The new species are described, illustrated and compared with their closest congeners, and their morphological variability is discussed. A cluster analysis (Euclidean distance) including our *Pallenopsis* specimens and the holotype of *P. gracilis* is carried out, based on 24 morphological characters. Finally, an updated key to the Southern Ocean species is presented.

Keywords: Antarctica; pycnogonids; sea spider; Sub-Antarctica; morphometric analysis; taxonomy.

Nuevos hallazgos y descripción de dos nuevas especies del género *Pallenopsis* (Pycnogonida: Pallenopsidae) del Océano Austral

Resumen: En este trabajo se estudian el material de picnogónidos del género *Pallenopsis* recolectados durante la campaña antártica Polarstern XXIII/8 (23 de noviembre de 2006 al 30 de enero de 2007). En esta colección se reconocen siete especies, dos de ellas se proponen como nuevas: *Pallenopsis tubercula* n. sp., *P. elephantensis* n. sp., *P. gracilis* Cano-Sánchez y López-González, 2019, *P. hodgsoni* Gordon, 1938, *P. macronyx* Bouvier, 1911, *P. spicata* Hodgson, 1914 y *P.* aff. *vanhoeffeni* Hodgson, 1915. *Pallenopsis gracilis* es citada por primera vez desde su descripción original. Las especies nuevas se describen, ilustran y comparan con sus congéneres más cercanos, discutiendo la variabilidad morfológica. Se realiza un análisis cluster (distancia euclidiana) basado en 24 caracteres morfológicos, que incluye nuestros ejemplares de *Pallenopsis* y el holotipo de *P. gracilis*. Finalmente, se presenta una clave actualizada de las especies del Océano Austral.

Palabras clave: Antártida; picnogónidos; araña marina; Subantártida; análisis morfométrico; taxonomía.

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INTRODUCCTION

Since its original description, the family affinities of the pycnogonid genus *Pallenopsis* Wilson, 1881 have been controversial and widely discussed. Some authors have attributed this genus to Phoxichilidiidae (Calman 1915, Arnaud and Bamber 1987, Pushkin 1993), while others have attributed it to Callipallenidae (Stock 1973, Child 1995, Bamber 2002). Currently, it is considered to be included within Pallenopsidae (Fry 1978, Cano-Sánchez and López-González 2019, Bamber et al. 2023) and has been found to be monophyletic in several molecular analyses (Arango and Wheeler 2007, Ballesteros et al. 2021, Zehnpfennig et al. 2022).

Pallenopsis is one of the most speciose genera among the pycnogonids (Bamber et al. 2023). Some authors considered it advisable to divide this grouping into subgenera (Stock 1975), while others even considered elevating them to genus rank (then considering two genera, *Pallenopsis* and *Bathypallenopsis*) (Pushkin 1993, Bamber 2007, Bamber et al. 2023), or simply failed to consider the creation of these subdivisions necessary (Munilla and Soler-Membrives 2009, Cano-Sánchez and López-González 2019). Furthermore, the number of valid species of *Pallenopsis* is ambiguous: some species have questionable validity (Cano-Sánchez and López-González 2019), while others can be considered as a complex of species (Weis et al. 2014, Dömel et al. 2019). Some species have been described from a very small number of specimens, mainly using morphological characters. In other cases, the specific limits are not clear, mainly because of the lack of information about character variability or the true taxonomic value of the characters used. This circumstance is particularly significant in materials collected in the Antarctic and sub-Antarctic. In the Southern Ocean, the list of *Pallenopsis* species has increased considerably since the end of the last century. Pushkin (1993) and Child (1995) considered 10 species each, resulting in at least 14 species, depending on the consideration of synonyms of some controversial species. Munilla and Soler-Membrives (2009) listed 18 species, while Cano-Sánchez and López-González (2019) considered 24 species in their proposed key to species of *Pallenopsis*. This increment is due not only to the fact that new species are described, but also to new studies that provide additional information on the variability of some features that may increase the number of species (Weis et al. 2014, Cano-Sánchez and López-González 2019, Dömel et al. 2019). Regular updating of identification keys is required because of newly received information.

In this study, data regarding seven *Pallenopsis* species collected during the Antarctic cruise Polarstern ANT XXIII/8 are presented, including a morphometric analysis. Each collected *Pallenopsis* species is diagnosed, mainly using ratios between morphometric

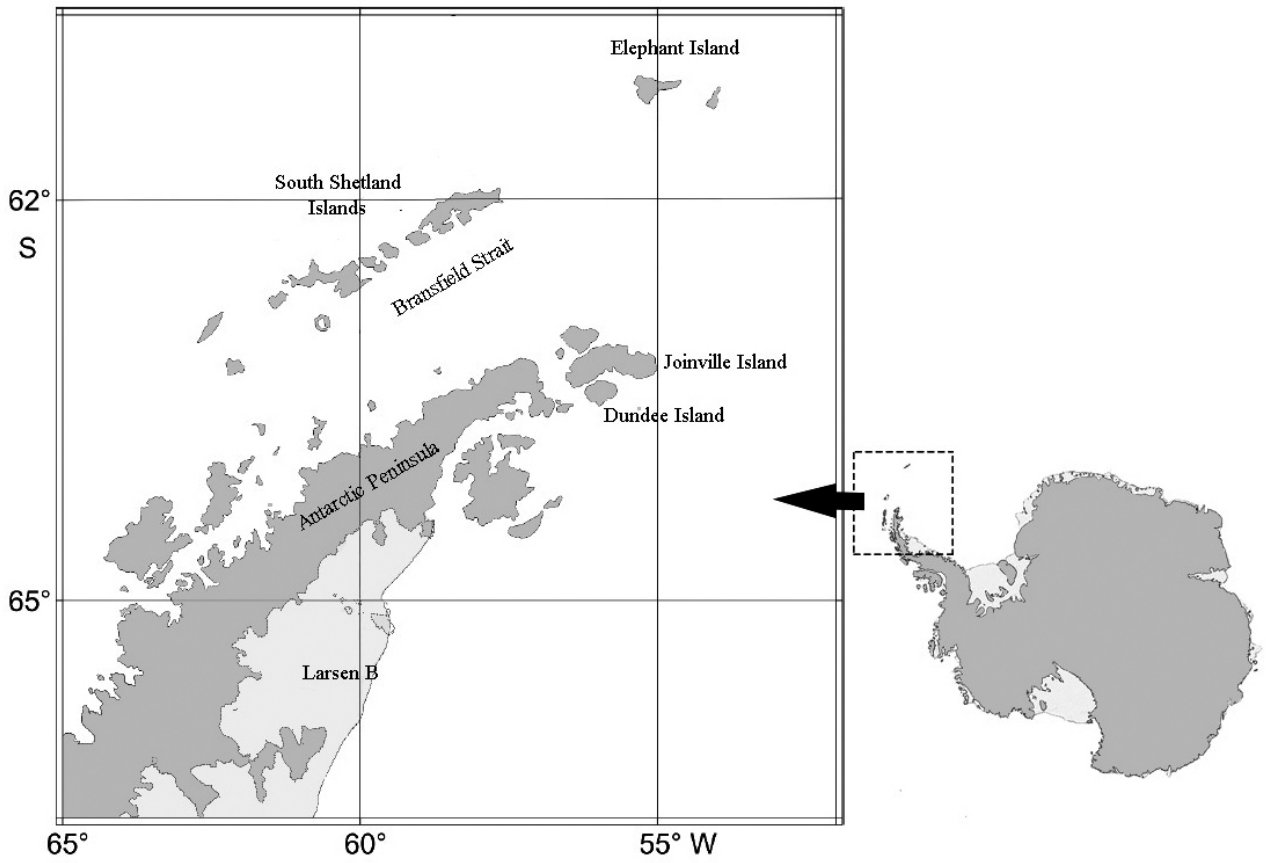

Fig. 1. – Locations of *Pallenopsis* specimens from *Polarstern* cruise XXIII/8.

Table 1. – Sampling data stations of the ANT XXIII/8 cruise [EI, Elephant Island; SSI, South Shetland Islands; JI, Joinville Island; BS, Bransfield Strait; B-South, Larsen B (core-station south); DI, Dundee Island (Paulet Island)].

Area	Station	Date	Latitude S	Longitude W	Depth (m)	Gear
EI	605-1	19-12-2006	61°20.35'S	55°29.16'W	151.3-145.8	Bottom trawl
EI	608-1	20-12-2006	61°11.34'S	54°43.17'W	284.2-293.0	Bottom trawl
EI	616-1	22-12-2006	60°49.81'S	55°36.76'W	483.9-486.6	Bottom trawl
EI	617-1	22-12-2006	60°54.09'S	55°39.29'W	151.2-176.2	Bottom trawl
EI	628-1	24-12-2006	61°02.28'S	55°45.61'W	119.2-159.5	Bottom trawl
EI	638-1	26-12-2006	61°09.72'S	55°59.80'W	148.6-169.9	Bottom trawl
EI	654-1	28-12-2006	61°22.01'S	56°00.95'W	352.6-356.2	Bottom trawl
EI	654-6	29-12-2006	61°22.80'S	56°03.84'W	340.5-342.3	Agassiz trawl
SSI	662-1	30-12-2006	61°35.91'S	57°17.04'W	425.4-431.8	Bottom trawl
SSI	664-1	30-12-2006	61°38.86'S	57°48.04'W	336-337.1	Bottom trawl
SSI	666-1	31-12-2006	61°40.40'S	58°51.30'W	370.5-406.7	Bottom trawl
SSI	668-1	31-12-2006	61°49.32'S	58°34.74'W	151.6-193.0	Bottom trawl
SSI	669-1	31-12-2006	61°49.97'S	58°41.30'W	191.9-208.2	Bottom trawl
SSI	670-1	01-01-2007	61°59.98'S	59°14.78'W	263.0-270.3	Bottom trawl
SSI	672-1	01-01-2007	62°06.70'S	59°28.79'W	94.9-107.5	Bottom trawl
SSI	676-1	02-01-2007	62°11.06'S	60°47.49'W	418.0-472.4	Bottom trawl
SSI	680-5	03-01-2007	62°23.37'S	61°25.58'W	348.8-324.3	Agassiz trawl
JI	688-1	04-01-2007	62°32.27'S	54°57.55'W	275.4-259.2	Bottom trawl
JI	689-3	04-01-2007	62°27.28'S	55°20.74'W	219.6-212.9	Agassiz trawl
JI	693-1	05-01-2007	62°25.84'S	55°35.07'W	243.0-290.5	Bottom trawl
BS	695-1	06-01-2007	63°00.55'S	58°38.01'W	269.4-292.6	Bottom trawl
BS	696-1	06-01-2007	63°00.50'S	58°53.82'W	360.5-361.2	Bottom trawl
BS	697-1	06-01-2007	63°13.85'S	59°06.30'W	329.1-407.9	Bottom trawl
B_South	702-9	12-01-2007	65°57.85'S	60°28.42'W	221.4-215.0	Agassiz trawl
B_South	721-2	20-01-2007	65°55.41'S	60°34.01'W	294.6-298.5	Agassiz trawl
DI	728-2	24-01-2007	63°42.63'S	56°01.63'W	292.8-297.9	Agassiz trawl

measurement of characters. Two new species are fully described and illustrated. The observed variability of some characters in comparison with previously published literature is briefly discussed. Finally, an updated key to Southern Ocean species of *Pallenopsis* (adults) is presented to help further studies.

MATERIAL AND METHODS

A total of 53 adult specimens of *Pallenopsis* collected during the *Polarstern* cruise ANT XXIII/8, Antarctica (23 November 2006 to 30 January 2007) were studied. Samples were taken using bottom trawl and a small Agassiz trawl. The sampling area is shown in Figure 1, and the sampling data are detailed in Table 1. Collected individuals were fixed in 10% buffered formalin and then transferred to 70% ethanol.

Following the considerations of Cano-Sánchez and López-González (2023) for Antarctic and sub-Antarctic *Colossendeis* species, a cluster analysis including the *Pallenopsis* specimens collected during this cruise and the holotype of *Pallenopsis gracilis* Cano-Sánchez and López-González, 2019 was carried out, based on 24 morphological features (Supplementary material Table S1).

To observe intra- and inter-specific variability, the set of 24 (traditional and new) characters used in *Pallenopsis* taxonomic studies was measured in each identified specimen (Table S1). Each structure was measured following the procedures of Fry and Hedgpeth (1969). Those characters showing sexual dimorphism were not used as diagnostic characters in the diagnoses of the different species or in the elaboration of the key to species. PRIMER v6 software (Primer-E Ltd., Plymouth, UK) was used to perform a cluster analysis using Euclidean distances with normalized data matrix.

The specimens here examined have been deposited at the Museu de Ciències Naturals in Barcelona, Spain (formerly Museu de Zoologia in Barcelona, MZB).

This published work and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the International Commission on Zoological Nomenclature. The ZooBank Life Science Identifiers (LSID) can be viewed through any

standard web browser by appending the LSID to the prefix "http://zoobank.org/". The LSID for this publication is urn:lsid:zoobank.org:pub:1AB8C5E1-A282-4FEE-8B18-D713095F63E3

RESULTS

Seven species were identified from the 53 adult specimens collected during the ANT XXIII/8 cruise. Two of them are proposed as new species and will be described below. The number of individuals per

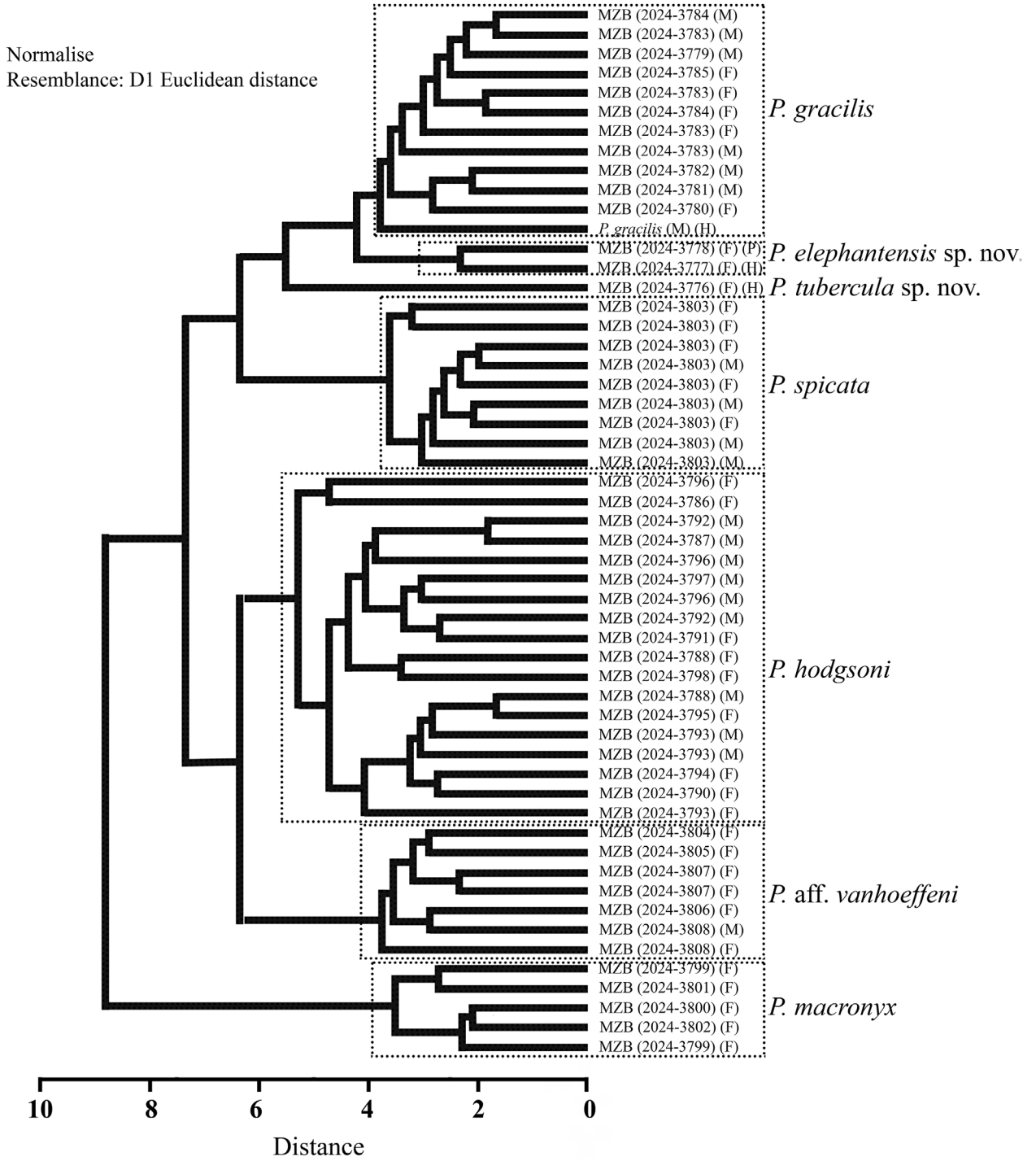

Fig. 2. – Cluster analysis of *Pallenopsis* specimens examined [Museum Code. Abbreviations: Holotype specimen (H); Paratype specimen (P); Male (M); Female (F)].

species was variable: *Pallenopsis spicata* Hodgson, 1915 (9); *P. hodgsoni* Gordon, 1938 (18); *P. gracilis* Cano-Sánchez and López-González 2019 (11); *P. vanhoffeni* Hodgson, 1915 (7); *P. macronyx* Bouvier, 1911 (5). The new species were represented by two and one specimen.

The cluster analysis of *Pallenopsis* specimens examined in this study, based on the characters listed in Table S1 (see also detailed data matrix in Table S2), showed a distinct grouping of specimens with high similarity among them (Fig. 2). Within a given species, the characters used do not show sexual dimorphism (see Fig. 2, where female and male individuals are indicated).

Taxonomy

Family Pallenopsidae Fry, 1978
Genus Pallenopsis Wilson, 1881

Pallenopsis tubercula n. sp.
urn:lsid:zoobank.org:act:7DFF1EBE-3C52-4383-96B3-1DBADC6CD1AF
(Figs 3, 4)

Material examined: MZB (2024-3776) holotype, one adult female, Polarstern cruise ANT XXIII/8, stn. 670–1. W King George Island, South Shetland Islands, Antarctica, 61°51.69'S 59°15.43'W, 263.0–270.3 m depth, bottom trawl, 1 January 2007.

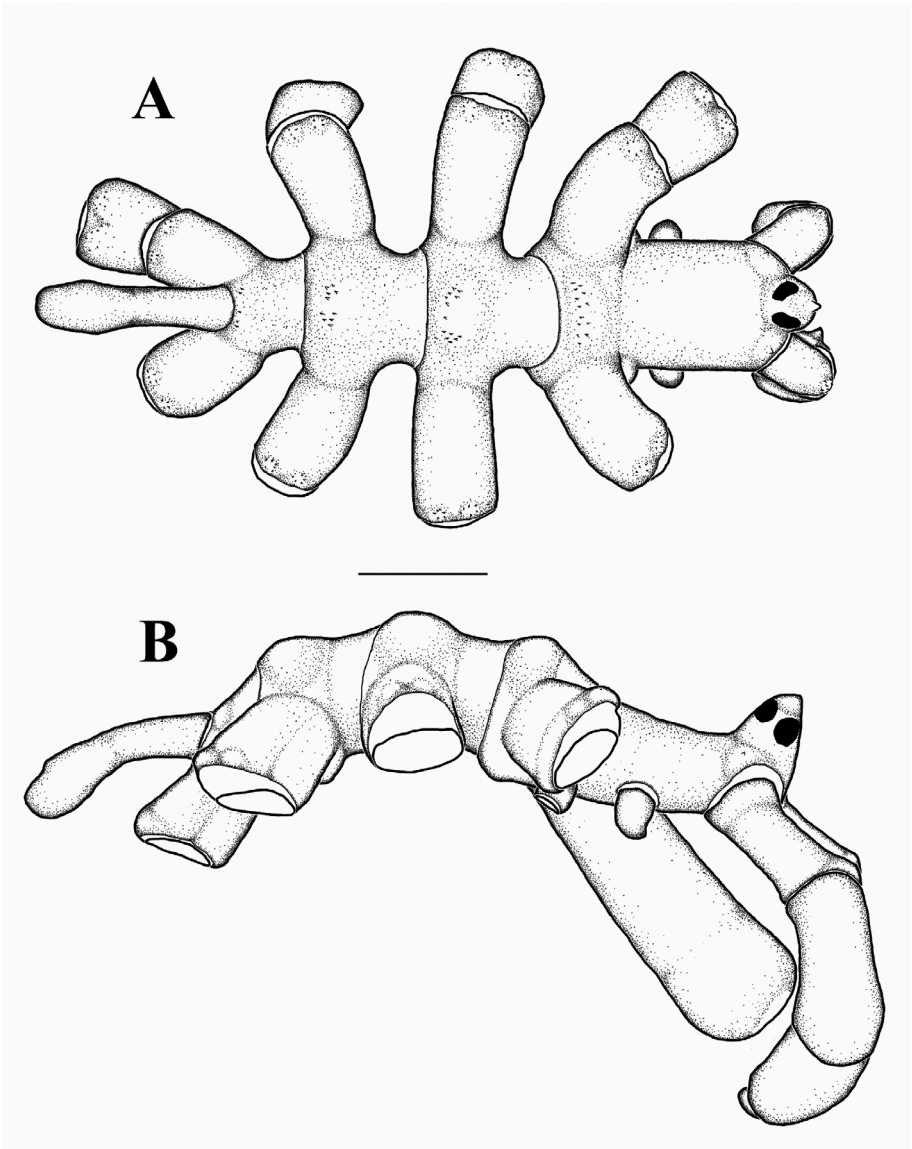

Fig. 3. – *Pallenopsis tubercula* n. sp. Holotype, female. A, dorsal view (showing the relative size and distribution of spinules); B, lateral view. Scale bars: 3 mm (A, B)

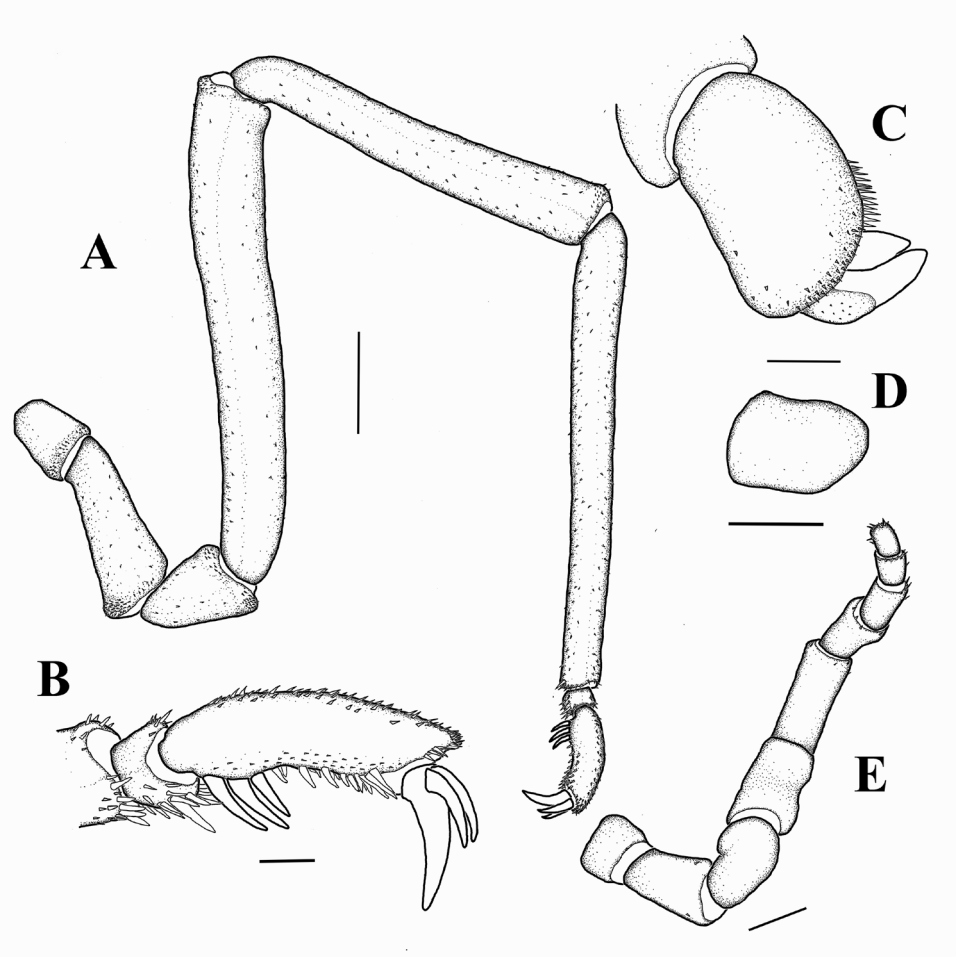

Fig. 4. – *Pallenopsis tubercula* n. sp. Holotype, female. A, third leg, right; B, distal third leg articles; C, palm + chela of chelifore; D, palp; E, oviger (due to fixed position of articles in this appendage, apparent proportions in the illustration could not reflect real relations, see text for full measurements and ratios). Scale bars: 4 mm (A); 1 mm (B, C, D, E).

Diagnosis. Proboscis straight, slightly widened distally. Cephalic segment not tapering anteriorly, with a small bump on each side of the ocular tubercle. Lateral processes separated by more than half their own diameter. Chelae fingers touching proximally when closed; movable chelae finger with little marked pad. Palps longer than wide, not in contact with basal oviger process. Walking legs without long setae (long setae = subequal or longer than the diameter of the article) on the three longest articles. Femur the longest article of the walking legs. Auxiliary claw longer than half main claw length.

Description of the holotype (female). Size moderate, leg span 148.8 mm. Proboscis mostly cylindrical, distal third slightly widened, provided with short spines.

Trunk fully segmented, with lateral processes widely separated, more than half their own diameter. Segments with fine short spines mainly on the dorsal rounded elevation. Segments first, second and third ventrally bulky. Lateral processes with fine short spines mainly on a pair of dorso-distal tiny tubercles. Fourth segment shorter than third segment. Cephalic segment flattened dorsally, not tapering anteriorly, and with a short spine on a small latero-proximal bump on the cephalic segment (on either side of ocular tubercle).

Abdomen long, down-curved, with minute spines on entire surface, and slightly widened on its distal third.

Ocular tubercle at anterior part of cephalic segment, taller than wide and topped by a rounded, slightly forward-tilted cone. Four eyes of similar size, anterior pair slightly lower than posterior pair.

Chelifores large, first escape article shorter than second, first escape article slightly raised dorso-distally and second wider distally. Chela palm longer than wide, with an inner lateral band of short setae. Fingers shorter than the width of the palm, placed more or less perpendicular to palm, smooth and touching when closed. Base of movable finger with a little marked pad with low minute setae.

Palps one-articled, longer than wide. Inserted distinctly separated from oviger basal process.

Oviger nine-articled. Third article strongly curved, fourth article is the longest and eighth article is the shortest. Last fourth articles with short setae distally.

Legs with minute spines along entire length. Second coxa shorter than sum of first and third coxae length, with increasing density of minute spines distally. Femur the longest article. Tibiae 2 with longer spines ventro-distally. Tarsus short, with ventro-distal long spines. Propodus slightly curved, slightly broader proximally with three long heel spines in a row, with heterogeneous random spines along the half distal sole. Main claw shorter than half propodus length; auxiliary claw longer than half main claw length. Sexual pores located ventrally on second coxa of all four legs.

Measurements of holotype (mm). Length of trunk (tip of the cephalic segment to the tip of fourth lateral processes): 13.8. Width of trunk across second lateral processes: 10.0. Length of cephalic segment: 7.0. Length of proboscis: 5.0. Basal diameter of proboscis: 2.5. Greatest diameter of proboscis: 2.7. Length of abdomen: 4.6. Length of left chelifore scape: 6.9. Length of articles of chelifore: first 3.2, second 3.7. Length of left palm: 2.8. Length of left chelae: 1.7. Length of left palp: 1.4. Length of third left leg: 69.4. Length of articles of leg 3: coxa 1 2.5, coxa 2 5.5, coxa 3 4.0, femur 18.5, tibia 1 14.4, tibia 2 17.7, tarsus 1.0, propodus 4.1, claw 1.7, auxiliary claws 1.2. Length of left oviger: 9.78. Length of oviger articles (1st to 9th): 0.89, 1.3, 1.35, 2.05, 1.49, 0.95, 0.81, 0.43, 0.51.

Distribution. At present, *Pallenopsis tubercula* n. sp. is known from its type locality at South Shetland Islands, at a depth of 130.7–144.3 m.

Etymology. The specific name derives from *tuberculum* (L.), referring to the small dorso-distal tubercles of the lateral processes and the small latero-proximal bumps on the cephalic segment (on either side of the ocular tubercle).

Remarks. Recently, two species have been described, *P. aulaeturcarum* Dömel and Melzer, 2019 and *P. obstaculumsuperavit* Dömel and Melzer, 2019, with dorso-distal thickenings on the lateral processes. However, both species have a combination of diagnostic characters that allows them to be easily differentiated from others. *Pallenopsis aulaeturcarum* has a triangular-shaped setose pad whose entire length is attached to the chela, abdomen orientated upwards and setae on the ventral and dorsal sides of the trunk. On the other hand, *P. obstaculumsuperavit* has a triangular-shaped setose pad but only attached to the chela by its basal half, abdomen pointing downwards and the second and third coxa with a set of setae on the ventral side as a brush. This set of characters is not shared by the new species of *Pallenopsis* proposed here.

Pallenopsis tubercula n. sp. is comparable to *P. hiemalis* Hodgson, 1907, *P. buphtalmus* Pushkin, 1993 and *P. gracilis* Cano-Sánchez and López-González, 2019, as they share the following set of characters: (1) chelae wedge-shaped, fingers touching proximally when closed; (2) without long setae on the three longest articles of walking legs; (3) movable chelae finger with setose pad; (4) palp longer than wide; (5) similar separation of lateral processes on proximal and distal part, U-shaped.

In our cluster analysis of *Pallenopsis* specimens, *P. tubercula* n. sp., *P. elephantensis* n. sp. and *P. gracilis* are closely related (Fig. 2). *P. tubercula* n. sp. differs mainly from the other two species by the relative proportion between the length of the femur and tibia 2 (longer than 1), and the length of claw and auxiliar claw (lower than 1.5) (Table S2).

The dorso-distal surface of the lateral processes is a differential character between the above listed four species. *P. hiemalis* and *P. tubercula* n. sp. have the lateral processes with dorso-distal tubercle, while *P. buphtalmus* and *P. gracilis* do not have tubercles on the lateral processes. Additionally, *P. tubercula* n. sp. has a small bump on either side of the ocular tubercle.

In *Pallenopsis hiemalis* the propodus does not have heel spines (those spines being differentiated from the rest of the spines on the sole surface) (Gordon 1932, Pushkin 1975, Cano-Sánchez and López-González 2019), while in the other three species mentioned above, the propodus has longer heel spines.

The main differences among the four species compared above have been summarized in Table 2.

Pallenopsis latefrontalis Pushkin, 1993 seems to be close to *P. tubercula* n. sp. This species has not been included in the comparison because the original description does not provide information about the morphology of the palp or the setose pad on the movable finger of the chelifore. However, Pushkin (1993) uses the anteriorly widened cephalic segment (quadrangular aspect) on both sides of the ocular tubercle as a differential character and provides additional characters such as a dorsally concave neck, the four eyes located at the same height (see Pushkin 1993: 251, Fig. 221) and the longest article of the walking legs being tibia 2, which are differential characters between both species.

Pallenopsis elephantensis n. sp.

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(Figs 5, 6)

Material examined: MZB (2024-3777) holotype, one adult female, Polarstern cruise XXIII/8, stn. 605-1. S Elephant Island, 61°20.35'S 55°29.16'W, 151.3–145.8 m depth, bottom trawl, 19 December 2006. MZB (2024-3778) paratype, one adult female, Polarstern cruise XXIII/8, stn. 628-1. W Elephant Island, 61°02.28'S 55°45.61'W, 119.2–159.5 m depth, bottom trawl, 24 December 2006.

Diagnosis. Proboscis slightly widened distally, upcurved. Cephalic segment not tapering anteriorly. Lateral processes separated by almost half their own diameter. Chelae fingers touching proximally when closed, movable chelae finger without setose pad. Palps longer than wide, not in contact with basal oviger process. Walking legs without long setae (long setae = subequal or longer than the diameter of the article) on the

Table 2. – Main differences between *Pallenopsis tubercula* n. sp., *P. elephantensis* n. sp., *P. hiemalis*, *P. buphtalmus* and *P. gracilis*.

	*P. hiemalis**	*P. buphtalmus*	*P. gracilis*	*P. tubercula* n. sp.	*P. elephantensis* n. sp.
Proboscis shape	Without any widening along the entire length.	Without any widening along the entire length	Without any widening along the entire length	Mostly cylindrical, distal third slightly widened	Slightly widened at the distal third
Proboscis curvature	Straight	Straight	Slightly up-curved	Straight	Slightly up-curved
Neck	Concave dorsally, not tapering distally	Flattened dorsally, not tapering distally	Concave** dorsally, tapering distally	Flattened dorsally, not tapering distally	Flattened dorsally, not tapering distally
Ocular tubercle	Taller than wide.. Terminates in a cone above the four eyes.	As tall as wide. Without cone above the four eyes. Anterior pair of eyes more proximal than the smaller posterior pair.	Taller than wide. Pointed at the tip, curved forward. Anterior pair of eyes slightly larger and lower than posterior pair.	As tall as wide. Topped by a rounded cone. Four eyes of similar size, anterior pair slightly lower than posterior pair.	As tall as wide. Topped by a low rounded cone. Anterior pair of eyes slightly larger and lower than the posterior pair
Lateral processes	With dorso-distal tubercle	Without dorso-distal tubercle	Without dorso-distal tubercle	With 2 tiny dorso-distal tubercles	Without dorso-distal tubercle
Abdomen	Upward	Upward	Upward, slightly down-curved	Not upward, down-curved	Not upward, down-curved
Longest walking legs article	Second tibia	Second tibia	Second tibia	Femur	Second tibia
Ratio claw/ auxiliar claw	<2	>3	≈2	<2	<2
Propodal armature	Long spines along entire sole surface	4 heel spines, proximal one shorter >12 smaller sole spines	4 heel spines, proximal one shorter >12 smaller sole spines	3 heel spines, the last one slightly shorter >12 smaller sole spines	4 heel spines, proximal one shorter >12 smaller sole spines

*We take into consideration the same criteria as Cano-Sánchez and López-González (2019) about this species.

**The original description of this species (Cano-Sánchez and López-González 2019) indicates that the neck is convex, but in their illustration it is clearly concave. We assume that it is a mistake, and we here consider that it is as in the illustration.

three longest articles. Second tibia longest article of the walking legs. Auxiliary claw longer than half main claw length.

Description of the holotype (female). Size moderate, leg span 154.9 mm. Proboscis mostly cylindrical, slightly up-curved, with a little widening at the end.

Trunk fully segmented, with lateral processes separated by almost half their own diameter. Segments with fine short spines mainly on the dorsal rounded elevation. Segments first, second and third ventrally bulky. Lateral processes with fine short spines mainly on dorso-distal surface. Fourth segment shorter than third segment. Cephalic segment flattened dorsally, not tapering anteriorly.

Abdomen long, down-curved, slightly widened on its distal third.

Ocular tubercle at anterior part of cephalic segment, as tall as wide and topped by a small, rounded cone. Anterior pair of eyes slightly larger than posterior pair.

Chelifores large with minute spines along entire length, increasing in density on distal surface of second scape article. First scape article shorter than second one. First scape article with a dorso-distal elevation. Second scape article wider distally. Chela palm longer than wide, with inner lateral and distal fringe of short spines. Movable finger similar in length to palm width, smooth, touching proximally when closed. Base of movable finger without spinose pad.

Palps one-articled, longer than wide. Inserted distinctly separated from oviger basal process.

Oviger nine-articled. Third article curved, fourth article is the longest oviger article and nineth article is the shortest. Three first articles smooth, fourth and fifth with small spines distally and last fourth articles spinose mainly distally.

Legs with minute spines along entire length, with increasing in density on distal articles' surface. Second coxa shorter than sum of first and third coxae length. Second tibia longest article. Tarsus short, with ventro-distal long spines. Propodus slightly broader proximally with four long heel spines in a row, first and fourth shorter, with heterogeneous random spines along half distal sole. Main claw longer than half propodus length; auxiliary claw longer than half main claw length. Sexual pores located ventrally on second coxa of all four legs.

Measurements of holotype (mm). Length of trunk (tip of the cephalic segment to the tip of fourth lateral processes): 12.3. Width of trunk across second lateral processes: 8.5. Length of cephalic segment: 6.1. Length of proboscis: 6.0. Basal diameter of proboscis: 2.3. Greatest diameter of proboscis: 2.6. Length of abdomen: 4.5. Length of left chelifore scape: 6.4. Length of scape articles: first 3.0, second 3.4. Length of left palm: 2.4. Length of left chelae: 1.8. Length of left palp: 1.4. Length of third left leg: 73.2. Length of arti-

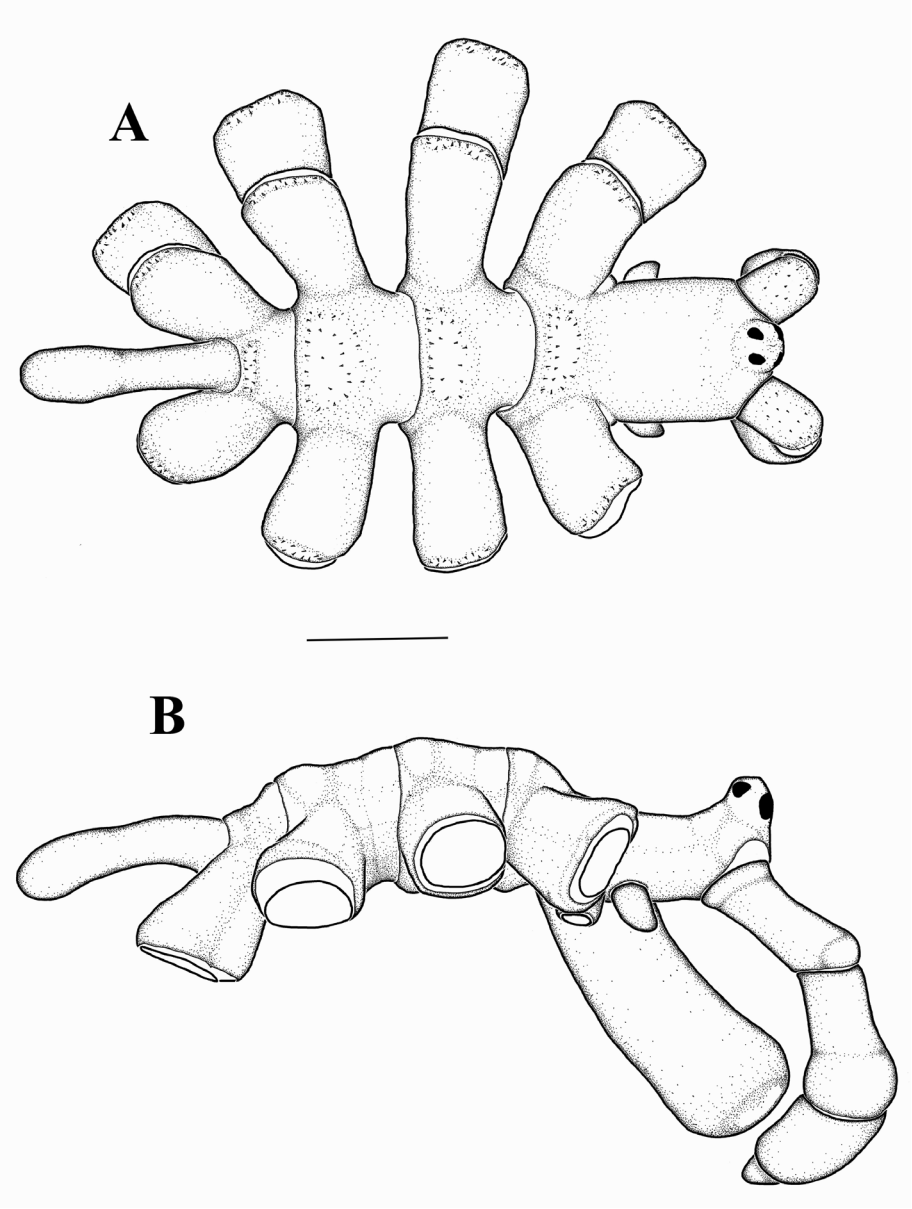

Fig. 5. – *Pallenopsis elephantensis* n. sp. Holotype, female. A, dorsal view (showing the relative size and distribution of spinules); B, lateral view. Scale bars: 3 mm (A, B).

cles of leg 3: coxa 1 3.3, coxa 2 8.0, coxa 3 6.0, femur 1 16.2, tibia 1 12.8, tibia 2 18.0, tarsus 1.1, propodus 4.8, claw 3.0, auxiliary claws 1.6. Length of right oviger: 9.19. Length of oviger articles (first to 10th): 0.58, 1.58, 1.25, 1.66, 1.5, 1.04, 0.83, 0.42, 0.33.

Variability. The paratype specimen has a slightly broader (Trunk L/Trunk W = 1.22 vs 1.45) and shorter trunk than the holotype specimen (Trunk L/CS = 1.89 vs 2.02) (see Table S2). Moreover, the paratype specimen shows the spines on trunk and appendages slightly longer than the holotype and has shorter first heel spine of propodus.

Distribution. At present, *Pallenopsis elephantensis* n. sp. is known from Elephant Island, at a depth of 119.2–159.5 m.

Etymology. This species is named after the geographical area (Elephant Island) where the type specimens were collected.

Remarks. *Pallenopsis elephantensis* n. sp. is comparable to *P. buphtalmus*, *P. gracilis* and *P. tubercula* n. sp., as they share the following set of characters: (1) chelae wedge-shaped, fingers touching proximally when closed; (2) without long setae on the three longest articles of walking legs; (3) palp longer than wide;

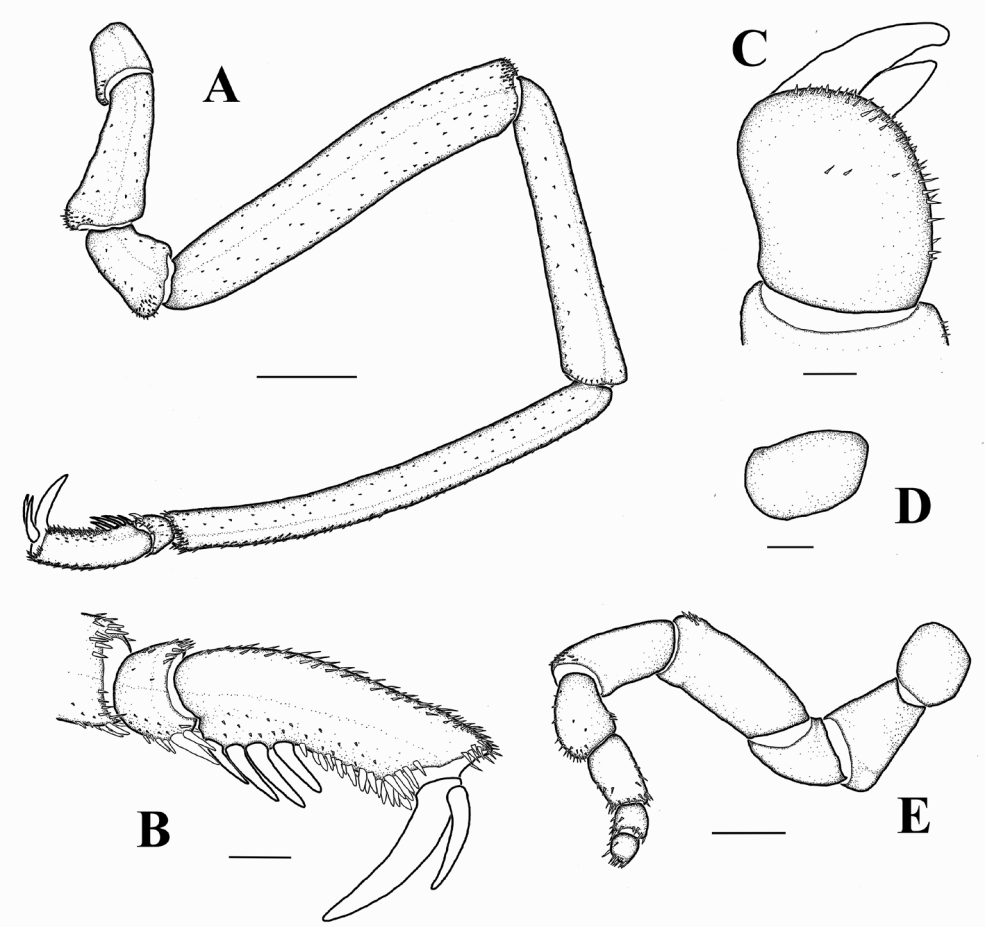

Fig. 6. – *Pallenopsis elephantensis* n. sp. Holotype, female. A, third leg, right; B, distal third leg articles; C, palm + chela of chelifore; D, palp; E, oviger (due to fixed position of articles in this appendage, apparent proportions in the illustration could not reflect real relations, see text for full measurements and ratios). Scale bars: 4 mm (A); 1 mm (B, E); 0.5 mm (C, D).

(4) neck flattened dorsally; (5) trunk with similar separation of lateral processes on proximal and distal part, U-shaped.

The absence of a clearly defined setose pad on the movable chelae finger is a differential character between *P. elephantensis* n. sp. and the other three related species.

The claw/auxiliar claw length ratio is considerably higher in *P. buphtalmus* than in *P. gracilis*, *P. tubercula* n. sp. and *P. elephantensis* n. sp. These last three species have been shown to be closely related in our cluster analysis (Fig. 2). Additional differential characters (see Table 2), not used in our cluster analysis, such as the number of spines on the heel, the distal shape of the neck, the shape of the abdomen and the shape of the proboscis may help differentiate *P. gracilis*, *P. tubercula* n. sp. and *P. elephantensis* n. sp.

The main differences among the four species compared above have been summarized in Table 2.

Pallenopsis gracilis Cano-Sánchez and López-González, 2019

Material examined: See Tables 1 and 3.

Diagnosis. See Cano-Sánchez and López-González (2019).

Remarks. *P. gracilis* has only been reported in its original description by Cano-Sánchez and López-González (2019) (holotype). Therefore, the finding of this species represents the first record after its original description. The type locality of this species is Victoria Land, at a depth of 338–350 m. Our specimens were collected from Elephant Island, Joinville Island, Bransfield Strait, B-South Larsen B and Dundee Island, between 151.2 and 407.9 m depth (Table 3). Currently only 12 individuals of this species are known, including our specimens.

As discussed above, *P. gracilis*, *P. tubercula* n. sp. and *P. elephantensis* n. sp. seem to be closely related species (see remark section of the two new species in

this paper). In fact, the characters used for the cluster analysis from the holotype and our specimens form a clearly defined group (Fig. 2). However, the set of characters: the short spine on a small latero-proximal bump on the cephalic segment, the setose pad on movable chelae finger, and the longest article of walking legs may be used to easily distinguish the three species.

The present examined specimens agree in general aspects with the description given by Cano-Sánchez and López-González (2019) for the holotype specimen. However, we observed variability in some characters, which are shown in Table 2.

Pallenopsis hodgsoni Gordon, 1938

See complete list of synonyms and references in Cano-Sánchez and López-González (2019, p. 525)
Material examined: See Tables 1 and 3.

Diagnosis. See Cano-Sánchez and López-González (2019).

Remarks. *Pallenopsis hodgsoni* is considered circumpolar and has a wide depth range, 120–2450 m (Child 1995). Our specimens do not modify the known information about the geographical and bathymetric distribution of this species.

Pallenopsis hodgsoni has been considered a synonym of *P. pilosa* by some authors (Turpaeva 1974, Pushkin 1993, Munilla and Soler-Membrives 2009). However, other authors recognize both species as valid (Child 1995, Munilla and Soler-Membrives 2015, Cano-Sánchez and López-González 2019).

Cano-Sánchez and López-González (2019) summarized the information provided by earlier authors on the differential characters between the two species, and then these authors proposed a set of diagnostic characters for *P. hodgsoni.* The specimens examined here agree in general aspects with this description, only one specimen has auxiliary claws longer than half main claw length.

In our cluster analysis, the examined *P. hodgsoni* specimens form a well-defined group (Fig. 2). However, this group is heterogeneous and within it we can observe defined subgroups, all of them attributed here to *P. hodgsoni* (Fig. 2), since we have not observed additional differential characters. Further integrative taxonomic studies on this species are needed, exploring whether the molecular results are consistent with the subgroups obtained from the analysis of large data sets of morphological characters, allowing or not the consideration of different species now under the name of *P. hodgsoni*.

Pallenopsis macronyx Bouvier, 1911

Pallenopsis macronyx Bouvier, 1911, p. 1139; 1913, pp. 112-117 (Figs. 66–73); Child, 1995, p. 145; Munilla and Soler-Membrives, 2009 (list.); 2015 (list.); Bamber et al., 2023 (list.)
Pallenopsis knipovichi Turpaeva, 1974, pp. 291–293 (Fig. 7); Munilla, 1991, pp. 32–34 (Fig. 15)
Bathypallenopsis macronyx Pushkin, 1993, p. 271

Material examined: See Tables 1 and 3.

Diagnosis. Lateral processes separated by less than half their own diameter. Chelae fingers curved, slender and leaving a gap proximally when closed, without setose pad. Palps longer than wide. Walking legs without long setae (subequal or longer than the diameter of the article) on the three longest articles. Femur subequal or longer than tibia 1. Propodus narrowing distally. Claw longer than propodus. No auxiliary claw.

Remarks. *Pallenopsis macronyx* has a wide geographical distribution in Antarctic and sub-Antarctic waters. It has been cited in the Scotia Sea, Antarctic Peninsula, Ross Sea and Weddell Sea, over a wide depth range, 100–1138 m (Munilla and Soler-Membrives 2009). Our specimens are within the known geographic and bathymetric range for this species.

The *P. macronyx* specimens examined here agree with diagnoses provided by Bouvier (1913), Turpaeva (1974), Pushkin (1993) and Child (1995). This species shows conspicuous features such as chelae fingers curved, slender and leaving a gap proximally when closed; propodus narrowing distally; claw longer than propodus; without auxiliary claw. In fact, our *P. macronyx* material forms a clearly defined group in the cluster analysis (see Fig. 2).

Pallenopsis spicata Hodgson, 1914

Pallenopsis spicata Hodgson, 1914–15, p. 146; 1927, pp. 338–339 (Fig. 10); Calman, 1915, pp. 44–46 (Fig. 9); Gordon, 1932, pp. 90–91; 1938, p. 19; 1944, p. 48; Arnaud, 1972, p. 148; Krapp, 1980, p. 6; Munilla and Soler-Membrives, 2009 (list.); Bamber et al., 2023 (list.)
Clavigeropallene spicata. Pushkin, 1974, pp. 938–940 (Fig. 1); 1993, pp. 210–212 (Fig. 190)

Material examined: See Tables 1 and 3.

Diagnosis. Three anterior trunk segments with a pair of dorsal conical tubercles. Lateral processed with dorso-distal conical tubercle. Cephalic segment wider than long and swollen over the base of each chelifore. Chelifore with scape undivided, chelae fingers touching proximally when closed, movable chelae finger considerably larger than immovable finger and swollen on the outer surface. Walking legs without long setae (subequal or longer than the diameter of the article) on three longest articles. First coxae of walking legs with dorso-distal conical tubercle. Second tibia longest article of walking legs. No auxiliary claw.

Remarks. *Pallenopsis spicata* is considered circumpolar with a wide depth range, 25–549 m (Child 1995, Munilla and Soler-Membrives 2009). Our specimens do not modify the known information about the geographical and bathymetric distribution of this species.

Table 3. – Sampling data for the examined specimens of *Pallenopsis* species of the ANT XXIII/8 cruise and museum codes [EI, Elephant Island; SSI, South Shetland Islands; JI, Joinville Island; BS, Bransfield Strait; B-South, Larsen B (core-station south); DI, Dundee Island (Paulet Island)].

Species	Stations	Area	Bathymetric range (m)	Museum Code (specimens)
P. gracilis	617-1	EI	151.2-176.2	MZB (2024-3779) one adult male
	693-1	JI	243.0-290.5	MZB (2024-3780) one adult female
	696-1	BS	360.5-361.2	MZB (2024-3781) one adult female
	697-1	BS	329.1-407.9	MZB (2024-3782) one adult male
	702-9	B-South	215.0-221.4	MZB (2024-3783) three adults male and two adults female
	721-2	B-South	294.6-298.5	MZB (2024-3784) one adult female
	728-2	DI	292.8-297.9	MZB (2024-3785) one adult female
P. tubercula n. sp.	670-1	SSI	263.0-270.3	MZB (2024-3776) holotype, one adult female
P. elephantensis n. sp.	605-1	EI	151.3-145.8	MZB (2024-3777) holotype, one adult female
	628-1	EI	119.2-129.5	MZB (2024-3778) paratype, one adult female
P. macronyx	608-1	EI	293.0-284.2	MZB (2024-3799) two adults female
	616-1	EI	486.6-483.9	MZB (2024-3800) one adult female
	638-1	EI	148.6-169.9	MZB (2024-3801) one adult female
P. spicata	676-1	SSI	418.0-472.4	MZB (2024-3802) one adult female
	728-2	DI	297.9-292.8	MZB (2024-3803) four adults male and five adults female
P. hodgsoni	608-1	EI	293.0-284.2	MZB (2024-3786) one adult female
	616-1	EI	486.6-483.9	MZB (2024-3787) one adult male
	654-1	EI	352.6-356.2	MZB (2024-3788) one adult male
	654-6	EI	342.3-340.5	MZB (2024-3789) one adult female
	662-1	SSI	425.4-431.8	MZB (2024-3790) one adult female
	664-1	SSI	337.1-336.0	MZB (2024-3791) one adult female
	666-1	SSI	370.5-406.7	MZB (2024-3792) two adults male
	668-1	SSI	193.0-151.6	MZB (2024-3793) two adults male and one adult female
	669-1	SSI	208.1-191.9	MZB (2024-3794) one adult female
	672-1	SSI	94.9-107.5	MZB (2024-3795) one adult female
	680-5	SSI	348.8-324.3	MZB (2024-3796) two adults male and one adult female
	689-3	JI	219.6-212.9	MZB (2024-3797) one adult male
	728-2	DI	297.9-292.8	MZB (2024-3798) one adult female
P. aff. *vanhoeffeni*	670-1	SSI	263.0-270.3	MZB (2024-3804) one adult female
	688-1	JI	259.2-275.4	MZB (2024-3805) one adult female
	695-1	BS	269.4-292.6	MZB (2024-3806) one adult female
	696-1	BS	360.5-361.2	MZB (2024-3807) two adults female
	728-2	DI	297.9-292.8	MZB (2024-3808) one adult male and one adult female

The specimens of *P. spicata* examined in this study agree with the description provided by previous authors (Hodgson 1927, Krapp 1980, Child 1995). This species exhibits a particular set of characters that ensure that it cannot be confused with any other Antarctic or sub-Antarctic *Pallenopsis* species, these features being trunk, lateral processed and first coxae with dorsal conical tubercles; cephalic segment swollen over the base of chelifores; scape undivided; and no auxiliary claw.

Pallenopsis* aff. *vanhoeffeni Hodgson, 1915

Material examined: See Tables 1 and 3.

Remarks. *Pallenopsis* aff. *vanhoeffeni* is morphologically very close to *P. vanhoeffeni*. Our specimens were collected from South Shetland Islands, Joinville Island, Bransfield Strait, B-South Larsen B and Dundee Island, between 259.2 and 361.2 m depth (Table 3).

P. vanhoeffeni is another setose species close to *P. hodgsoni* and *P. pilosa,* with broad, wedge-shaped chelae fingers, touching when closed and without a setose pad on the movable finger. Our *P.* aff. *vanhoeffeni* material forms a clearly defined group in the cluster analysis (see Fig. 2). However, characters such as the presence of long setae on the three long articles of legs arranged in rows, on dorsal and lateral surfaces, and the small antero-lateral bump on the cephalic segment may be used to easily distinguish *P. vanhoeffeni* and *P.* aff. *vanhoeffeni* from the other setose species above listed.

The specimens examined for this study agree in general aspects with the description of *P. vanhoeffeni* provided by previous authors (Hodgson 1927, Child 1995, Cano-Sánchez and López-González 2019). However, most of the specimens examined here did not show some features, such as the two dorsal groups of long, slender setae on the three anterior segments (specimens MZB 2024-3805 to MZB 2024-3808)
, or auxiliary claws shorter than half the claw length (specimens MZB 2024-3804 to MZB 2024-3806, and MZB 2024-3808) (see also Table S2), as previously reported. For these reasons, we preferred to not include at this time a diagnosis for this material, and maintain our specimens as a form close to Hodgson's species. We consider it too risky, from a nomenclatural point of view, to include this variability in the current conception of *P. vanhoeffeni*, or to propose the description of a new species, or to consider it as a species complex. Therefore, we leave the final identification of this material pending examination of additional specimens and, where possible, other sources of information.

Key to Antarctic and sub-Antarctic species of *Pallenopsis* (adults)

The key proposed here is an update of the key to Antarctic and sub-Antarctic species of *Pallenopsis* (adults) published by Cano-Sánchez and López-González (2019). It includes the newly described species and considers the new knowledge concerning the variability of some characters.

1. Chelae fingers curved, slender and leaving a gap proximally when closed 2
1'. Chelae fingers broad, wedge-shaped and touching proximally when closed (fingers touching along their entire length or having a gap between them at mid-length)..... 6
2. Without or with small auxiliary claw (less than one-third of the main claw)..... 3
2'. With auxiliary claw (more than one-third of the main claw)..... 4
3. Claw longer than propodus. Without auxiliary claw..... *P. macronyx* Bouvier, 1911
3'. Claw subequal or shorter than propodus. With small auxiliary claws..... *P. longiseta* Turpaeva, 1957
4. Dorsal series of long forward curved setae on the three longer articles of the walking legs ..... *P. meridionalis* Hodgson, 1914[(1)]
4'. Without these dorsal series of curved setae..... 5
5. Lateral processes about 1.5 times longer than their diameter. Chelae immovable finger placed perpendicularly at half length of lateral edge palm..... *P. lateralia* Child, 1995
5'. Lateral processes as long as wide. Chelae fingers (movable and immovable) placed distally on palm ..... *P. villosa* Hodgson, 1907
6. Without auxiliary claw *P. spicata* Hodgson, 1915
6'. With auxiliary claw 7
7. Propodus with 5 small, short heel spines..... *P. lattina* Pushkin, 1993[(1)]
7'. Propodus with other configuration 8
8. Proboscis with distinct swelling in the middle ..... *P. yepayekae* Weis, 2014
8'. Proboscis without swelling in the middle 9
9. Setae on the three longest articles of walking legs mostly long (subequal or longer than the diameter of the article) 10
9'. Setae on the three longest articles of walking legs mostly short 13
10. Movable finger of chelae with setose pad ..... *P. rotunda* Cano-Sánchez and López-González, 2019
10'. Movable finger of chelae without setose pad 11
11. Long setae without setules ..... *P. pilosa* (Hoek, 1881)
11'. Long setae with setules..... 12
12. Walking legs with setae less than two times longer than the diameter of the article ..... *P. vanhoeffeni* Hodgson, 1915
12'. Walking legs with setae more than two times longer than the diameter of the article ..... *P. hodgsoni* Gordon, 1938
13. All lateral processes touching proximally ..... *P. obliqua* (Thomson, 1884)
13'. Not all lateral processes touching proximally.. 14
14. Proboscis tip truncated (flat mouth) ..... *P. boehmi* Schmkewitsch, 1930 [(1)]
14'. Proboscis tip rounded..... 15
15. Movable and immovable chelae fingers well curved, on entire inner and external edges..... *P. candidoi* Mello-Leitao, 1949

15’. Movable and immovable chelae fingers only slightly curved on external edges, but inner edges straight at least half their length 16
16. Ratio claw/auxiliar claw length >3 .... *P. buphtalmus* Pushkin, 1993
16’. Ratio claw/auxiliar claw length <3 17
17. Crossed fingertips of the chela when closed..... ..... *P. kupei* Clark, 1971
17’. Parallel fingertips of chelae when closed 18
18. Femur is the longest article of the walking legs ..... *P. tubercula* n. sp.
18’. Tibia 2 is the longest article of the walking legs 19
19. Cephalic segment widened anteriorly (quadrangular) on either side of the ocular tubercle .... *P. latefrontalis* Pushkin, 1993
19’. Cephalic segment not widened anteriorly (not quadrangular) on either side of the ocular tubercle .. 20
20. Ratio length/width of palp >1.5 21
20’. Ratio length/width of palp <1.5 25
21. Lateral processes with a dorso-distal tubercle... 22
21’. Lateral processes without a dorso-distal tubercle 24
22. Propodus without distinct heel spines .... *P. hiemalis* Hodgson, 1907(1)
22’. Propodus with distinct heel spines 23
23. Chelae with setose pad attached along its entire length to the base of the movable finger .... *P. aulaeturcarum* Dömel and Melzer, 2019
23’. Chelae with setose pad attached only by its basal half to the base of the movable finger .... *P. obstaculumsuperavit* Dömel and Melzer, 2019
24. Movable finger of chelae with setose pad ....*P. gracilis* Cano-Sánchez and López-González, 2019
24’. Movable finger of chelae without setose pad... ..... *P.elephantensis* n. sp.
25. Ratio length/width of propodus >4..... ..... *P. tumidula* Loman, 1923(2)
25’. Ratio length/width of propodus <4 26
26. Proboscis without any widening along the entire length ..... *P. patagonica* (Hoek, 1881)(1)
26’. Proboscis with some widening at its length . 27
27. Propodus with long spines on more than half of sole ..... *P. gurjanovi* Pushkin, 1993
27’. Propodus with heel spines (on not more than half of sole) ..... *P. leiopus* Pushkin, 1993

(1) We consider these species following the same criteria as Cano-Sánchez and López-González (2019).

(2) The original description of *P. tumidula* notes in text that “Palp a thick, round knob between bases of chelifore and oviger” but the illustration does not show the palp clearly. Moreover, this description did not provide information about the chelae fingers or propodus morphology, but Stock (1957) illustrated the syntypes of this species showing the chelae and propopdus morphology.

SUPPLEMENTARY MATERIAL

The following supplementary material is available through the online version of this article:

Table S1. Selected characters considered in the *Pallenopsis* specimens identified from the cruise ANT XXIII/8.

Table S2. Character values analyzed in each specimen used in the cluster analysis.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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AUTHORSHIP CONTRIBUTION STATEMENT

E. Cano-Sánchez: Conceptualization, formal analysis, investigation, visualization, writing original draft, review & editing.

P.J. López-González: Conceptualization, resources, investigation, validation, review & editing.

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