



## ***Peniagone crozeti*, a new species of elasipodid holothurian from abyssal depths off the Crozet Islands in the Southern Indian Ocean\***

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### **Abstract**

Material collected from the RRS *Discovery* Cruise 300 to the Crozet Islands contained a new species of elasipodid holothurian *Peniagone crozeti* sp. nov. This new species dominated the megafauna at an abyssal site to the east of the islands under an area of high surface productivity, but was found in low abundance at a site located south of the islands under a high nutrient low chlorophyll regime, typical for many areas in the Southern Ocean. *Peniagone crozeti* differs from other members of the genus by the shape of its calcareous deposits.

**Key words:** Elpidiidae, Elasipodida, Holothuroidea, taxonomy

### **Introduction**

On the RRS *Discovery* Cruise 300 in December 2005 a number of semi-balloon otter trawls were conducted at abyssal depths in two regions under different productivity regimes around the Crozet plateau in the southern sector of the Indian Ocean (Hughes *et al.* 2007). A diverse variety of holothurians were collected including many different species belonging to the family Elpidiidae Théel, 1882. Some members of the family are known to display opportunistic responses to seasonal fluxes of nutrients and to form dense aggregations (Billett & Hansen, 1982; Gutt & Piepenburg, 1991; Billett *et al.*, 2001). Elpidiid holothurians of the genus *Peniagone* Théel, 1882 are a major component of deep-sea ecosystems in the Atlantic and Pacific oceans (Gebruk 1990; Bluhm & Gebruk 1999; Ruhl 2007), including canyon systems (Rowe 1971, 1972). In total 10 species of *Peniagone* were collected from around the Crozet Islands, representing about one quarter of the all recognised species worldwide. A new species, *Peniagone crozeti* sp. nov., is described here based on a large haul of material and underwater images which provides information on the species in its natural state.

### **Results**

Ten species of *Peniagone* were collected at both sites around the Crozet Islands in varying abundance: *Peniagone diaphana* (Théel, 1882), *P. vitrea* Théel, 1882, *P. gracilis* (Ludwig, 1894), *P. challengerii* Théel, 1882, *P. horrifera* Théel, 1882, *P. elongata* (Théel, 1879), *P. affinis* Théel, 1882, *P. willemöesi* (Théel, 1882), *P. purpurea* (Théel, 1882) and *Peniagone crozeti* sp. nov. Two species, *P. affinis* and *P. willemöesi* were abundant to the south of the Crozet Islands in an area typical of high nutrient, low chlorophyll (HNLC)

conditions. In contrast at a site under eutrophic surface production to the east of the Crozet Islands *P. crozeti* sp. nov. and *P. challengerii* were highly abundant

## Systematic Part

Order Elasipodida Théel, 1882

Suborder Psychropotina Hansen, 1975

Family Elpidiidae Théel, 1882

### *Peniagone crozeti* sp. nov. Cross et Gebruk

*Holotype*: NHM Cat. Nr. 2008.980. 1 specimen 76 mm long. RRS *Discovery* Cruise D300 St. 15773#32, 45°40.45'S, 56°33.70'E depth 4267–4270 m, 20th December 2005, semi-balloon otter trawl, mud bottom. Deposited at the Natural History Museum in London (United Kingdom).

*Paratypes*: NHM Cat. Nr 2008.981, 1 specimen 92 mm long; NHM Cat. Nr 2008.982, 1 specimen 57 mm long, and NHM Cat. Nr 2008.982, 1 specimen 52 mm long. RRS *Discovery* Cruise 300, St. 15775#13, 49°01.15'S, 51°04.52'E, depth 4187–4191 m, 20th December 2005, semi-balloon otter trawl, mud bottom. Deposited at the Natural History Museum in London (United Kingdom).

*Other examined material*: RRS *Discovery* Cruise 300, semi-balloon otter trawl. St.15773#8, 45°43.06'S, 56°32.16'E, 4258–4290 m, 12th December 2005, mud bottom, 699 specimens; St. 15773#17, 45°43.47'S, 56°36.66'E, 4301–4283 m, 15th December 2005, mud bottom, 1416 specimens; St. 15773#23, 45°40.05'S, 56°35.27'E, 4269–4275 m, 16th December 2005, mud bottom, 1779 specimens; St. 15773#32, 45°40.45'S, 56°33.70'E, 4267–4270 m, 20th December 2005, mud bottom, 2222 specimens; St. 15775#4, 48°56.21'S, 51°03.90'E, 4182–4195 m, 27th December 2005, mud bottom, 23 specimens; St. 15775#13, 49°01.15'S, 51°04.52'E, 4187–4191 m, 29th December 2005, mud bottom, 81 specimens.

*Type locality*: South Indian Ocean, off Crozet Islands, depth 4187–4270 m.

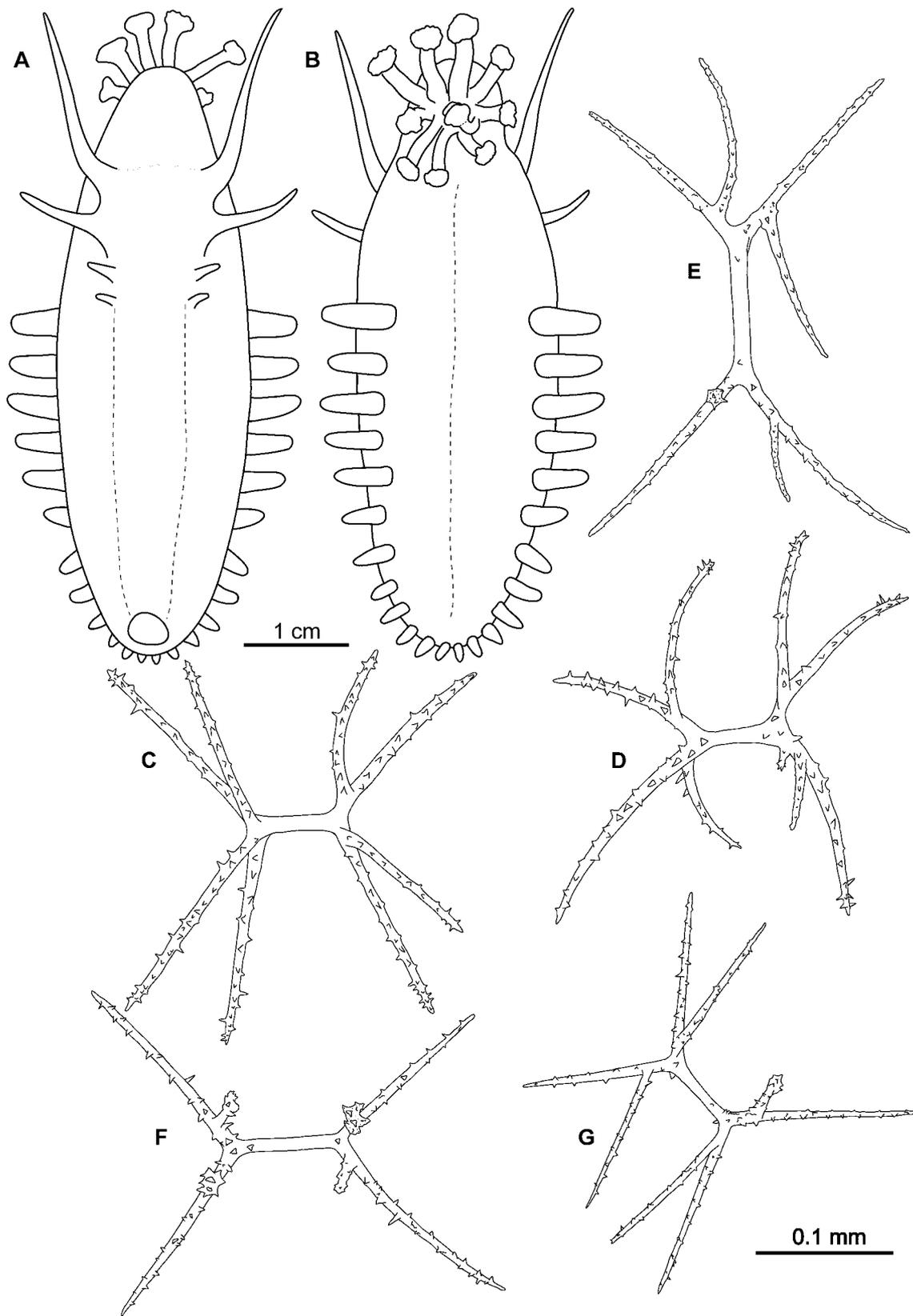
*Etymology*. The species name is derived from the Crozet Islands where this species has been discovered in great abundance.

*Diagnosis*. Body elongated with slight posterior depression. Colour in alcohol light violet to grey brown. Anus subdorsal. Tube feet 10–12 pairs, bordering posterior two thirds of the ventral sole; anteriormost 4–5 pairs of equal size, posteriormost 6–7 pairs decrease in size posteriorly. Velum composed of 2 pairs of papillae which are long and free for most of their lengths; behind these lie 2 pairs of small papillae. Tentacles 10. Calcareous deposits of main type irregular, with 4 spinous arms, strongly bent downward or flat in plane, mainly 0.15–0.3 mm long, and 2–4 (rarely 1) spinous apophyses straight or curved, of varying length, pointing in different directions and often present on the lower surface of primary crosses.

*Description*. Numerous specimens were collected, most of which are lacking the outermost deposit containing layer of epidermis. The appearance of the dorsal papillae, tube feet and calcareous deposits are dependant on the physical state of the specimen. The majority of specimens had a slimy appearance with clearly visible longitudinal muscles. In these specimens the tube feet are frequently missing, as are the dorsal papillae and the velum. Other material consisted only of the outer deposit containing layer of skin which appeared to be shed in trawl samples.

Body elongate, from 14 mm up to 115 mm in length, slightly depressed posteriorly with a conspicuous downwardly bent neck region with slight lateral compression (Fig. 1: A–B).

Skin rough owing to densely crowded deposits. Skin is thick and opaque, owing to the tendency of the dermis to contract around the large deposits. The contraction of the tissue often imparts a verrucose appearance to the epidermis. Colour in alcohol varying from pink to light violet to grey brown. Underwater photographs of this species show an off white colouration sometimes with a violet tinge and clearly visible longitudinal muscle bands.



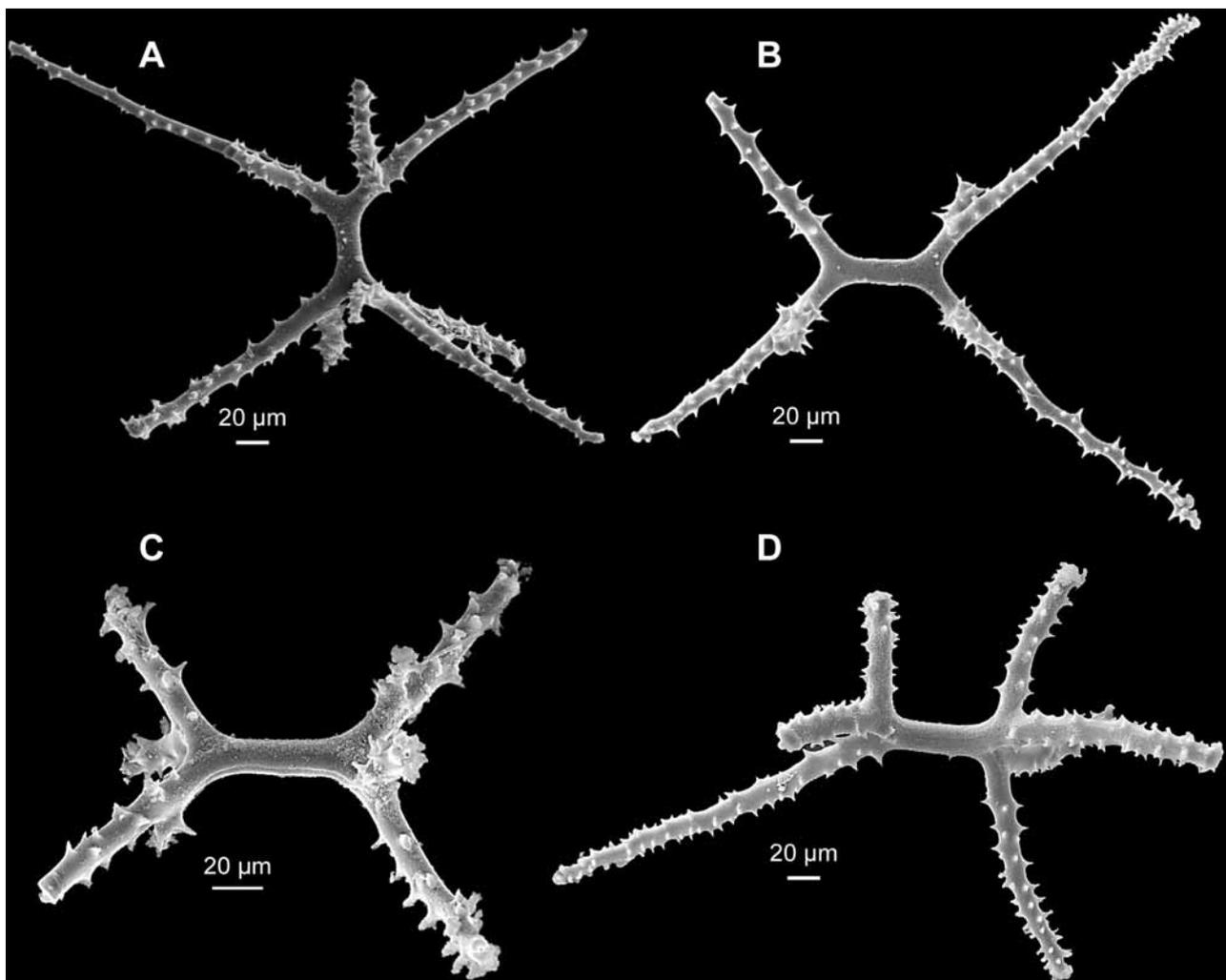
**FIGURE 1.** *Peniagone crozeti*, sp. nov., holotype. A, dorsal view; B, ventral view; C–G, dorsal deposits.

Tube feet 10–12 pairs, missing in anteriormost third of the body. Smaller specimens less than 60 mm possess 10–12 pairs of tube feet, specimens over 60 mm possess the full 12 pairs. The 4–5 anteriormost pairs of tube feet usually are of a similar size, and are equally spaced from one another. The posteriormost 6 pairs of tube feet decrease in size posteriorly, as does the interval between each successive pair.

Dorsal papillae 4 pairs, restricted to the anterior portion of the body. The anteriormost 2 pairs are partially fused and comprise a velum (Fig. 1: A). The anteriormost papillae are situated on either side of the mid dorsal interradius; they are long and forwardly directed. Behind them in the velum lies a shorter, outwardly directed second pair set in the dorsolateral region. The remaining 2 pairs of dorsal papillae are small, the posteriormost pair is the smallest. Papillae are frequently missing owing to damage. Underwater photographs of this species show the anterior 2 pairs of papillae to be 0.25–0.33 of the total body length. The papillae of velum in a 52 mm long paratype attained a maximum length of 33 mm.

Tentacles 10. The anteriormost 4 tentacles have stalks slightly longer than the posterior tentacles. Discs possess retractile processes on their margins.

Deposits: ventral and dorsal forms similar and occur in 2 layers. The outer (surface) layer deposits are extremely irregular and variable. The basic form is that of a primary cross consisting of a central stem with 4 long spinous arms up to 0.3 mm length. The arms are straight or slightly curved and usually strongly bent downward (Fig. 1: C–G; Fig. 2). From a point near to where the arms join the stem are placed 2–4 (rarely 1) slender, straight or slightly curved spinous apophyses measuring 0.1–0.2 mm. An unusual feature which sets this species apart from others of the genus is the presence of apophyses that may emerge from the lower surface of the primary cross and point downward (Fig. 1: C–D; Fig. 2: A).



**FIGURE 2.** *Peniagone crozeti*, sp. nov. A–D, dorsal deposits (SEM). Note the irregular placement of apophyses.

The innermost layer of epidermis contains deposits similar to those described above, but reduced in form. Some have the appearance of a flattened primary cross with the odd spinous knob or reduced curly process

where an apophyses would have otherwise occurred. It is not uncommon to see this type of deposit develop multi-branching processes originating from the arm tips and even from the centre of the central stem.

A third type of deposit is a spinous rod measuring 0.10–0.15 mm, either slender or robust frequently with curved tips, occurring throughout the lower layers of dermis and especially concentrated in the intestinal wall.

*Relationships.* *Peniagone crozeti* sp. nov. differs from all other species of the genus by the type of calcareous dorsal deposits which are very irregular, with four spinous arms strongly bent downward, two to four spinous apophyses straight or curved, of varying length, pointing in different directions, and often developing on the lower surface of the primary cross. The closest type of deposits in the genus is found in *P. vitrea*, but in the latter the apophyses on primary crosses never develop on the lower surface and point downward. Rod-shaped deposits in *P. crozeti* are not specific and similar to rods in other species of the genus *Peniagone*. Based on the arrangement of dorsal papillae with the two anteriormost pairs long and free for most of their lengths, the new species is most closely related to *P. incondita* Agatep, 1967 and *P. papillata* Hansen, 1975. Also in the latter the papillae are set on soft elevation similar to that found in *P. crozeti* sp. nov.

*Remarks.* The verrucose appearance of the epidermis has been observed in some elasipodid species, which possess deposits with long vertically directed processes. (e.g. *Peniagone incondita* Agatep, 1967).

*Peniagone crozeti* sp. nov. is the most abundant species at the locality sampled under eutrophic surface water conditions to the east of the Crozet Islands (Hughes *et al.*, 2007). It was present to the south of the islands, only 200 km distant, but only in moderate numbers. That such an abundant species should not have been collected before in the Southern Ocean may indicate that surface water productivity may have an important role in regulating the geographic ranges of certain species.

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