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First record of *Holothuria* (*Theelothuria*) *princeps* and *Thyone pawsoni* (Echinodermata: Holothuroidea) in the South Atlantic Ocean

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Thyone pawsoni *and* Holothuria (Theelothuria) princeps *are reported from shallow water of the South Atlantic Ocean. A morphological description of these new records with colour figures and scanning electron microscopy images of their ossicles are provided. With these two new records for the Brazilian Coast, the genus* Thyone *is now represented by two species and* Holothuria *by six.*

Keywords: Dendrochirotida, Phyllophoridae, Aspidochirotida, Holothuriidae, taxonomy, Bahia, Brazil

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INTRODUCTION

Although Brazil has one of the highest biodiversities in the world, the knowledge about its benthic invertebrates is still unsatisfactory (Couto *et al.*, 2003; Amaral & Jablonski, 2005). In recent decades some projects have been developed to document the Brazilian biodiversity (e.g. REVIZEE, BIOTA/FAPESP, and Rede de Monitoramento Ambiental Marinho–PETROBRAS); still, the vast coastline (± 8000 km) and low number of experts in this field hinder the progress of this work.

Presently, studies on the taxonomy of echinoderms in Brazil have focused on specific classes, especially Ophiuroidea (Borges & Amaral, 2007; Gondim *et al.*, 2008; Lima *et al.*, 2011; Manso *et al.*, 2011). Holothuroidea, however, has been neglected and appears in less than 5% of the literature, most of which resulted from great expeditions (Théel, 1886; Deichmann, 1930; Tommasi, 1969). To date, this class represents less than 15% of the Brazilian echinoderm fauna (Tommasi, 1999), probably mainly due to the few number of experts in holothuroids in the country. For instance, the last new holothuroid species was described by Freire & Grohmann (1989) (*Leptosynapta brasiliensis*) and few contributions have been made since then (e.g. Tiago & Ditadi, 2001; Moura *et al.*, 2010). Furthermore, most of the genera need revision, especially with the use of new techniques (e.g. scanning electron microscopy images and/or DNA sequencing), which can help overcome the difficulties imposed by the high variability resulting from the development of the specimens and their ossicles.

In this paper, we extend the distribution range of *Thyone pawsoni* Tommasi, 1972 and *Holothuria* (*Theelothuria*) *princeps* Selenka, 1867 to shallow waters of the north-east coast of Brazil—the first occurrence of these species in the South Atlantic Ocean.

MATERIALS AND METHODS

Specimens of *H.* (*T.*) *princeps* and *T. pawsoni* were collected using a Van Veen grab, in 2004 and 2010, respectively. They were fixed in 4% formalin, preserved in 70% ethanol, and deposited in the Museu de Zoologia at the Universidade Federal da Bahia (UFBA).

The methods used to study the specimens followed those of Rowe & Doty (1977) and Samyn *et al.* (2006). The ossicles were removed from different tissues (introvert of *T. pawsoni*, tentacles, body wall, tube feet and anus) using household bleach, washed in five changes of distilled water and then in five changes of absolute ethanol. A number of samples were mounted on slides with Entellan Merck® for permanent storage, and their ossicles were then examined and measured using the software Image-Pro Express (v. 6.0) linked to an Olympus CX31-RTSF optical microscope. Other samples were dried and mounted on metal stubs with double-sided tape, coated with gold and observed with a JEOL JSM-6390LV scanning electron microscope. Photographs of specimens were taken using a Sony DSC W300 digital camera.

Abbreviations used: MCZ, Museum of Comparative Zoology at Harvard University; UFBA, Universidade Federal da Bahia; USNM, National Museum of Natural History, Washington, DC.

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RESULTS

SYSTEMATICS

Order ASPIDOCHIROTIDA Grube, 1840
Family HOLOTHURIIDAE Ludwig, 1894
Genus *Holothuria* Linnaeus, 1767
Holothuria (*Theelothuria*) *princeps* Selenka, 1867
(Figures 1 & 2)

Holothuria princeps Selenka, 1867: 332, pl. 18, figures 67–69.

Holothuria (*Holothuria*) *princeps*—Panning, 1935: 101, figure 94.

Holothuria (*Theelothuria*) *princeps*—Rowe, 1969: 157, figure 19; Hendler *et al.,* 1995: 296, figures 167, 185G–J; Cutress, 1996: 74, figures 17–23A; Pawson *et al.,* 2010: 39, figure 32.

MATERIAL EXAMINED

Holothuria (*Theelothuria*) *princeps*—Camamu, Barra Grande, BA, Brazil (13°56′S 38°59′W), 1 m, 15 July 2004, 2 specimens 25 and 28 cm long (UFBA–645).

DIAGNOSIS

Large form, up to 30 cm. Body wall thick, ambulacral feet numerous and scattered throughout the body. Dorsally they form conical dark papillae. 20 small paltate tentacles. Radial and interradial pieces of calcareous ring are fused together; radials with short and forked posterior processes. Cuverian organs absent; cloaca very long and wide. Body wall ossicles are small and delicate buttons and tables. Tables formed by a small disc with dentate margin possessing 12 prolongations, and a spire ending in 6–8 teeth. Tube feet ossicles are large supporting rods with central and peripheral perforations, and large and conical tables (tack-like). Colour in ethanol is dark brown.

DISTRIBUTION

North Carolina to Brazil (up to Bahia State); depth 0–73 m (Pawson *et al.,* 2010; present paper).

BIOLOGICAL NOTES

The specimens were collected partially burrowed in sandy mud sediment from the intertidal zone. According to Wells & Wells (1961), the commensal crab *Pinnaxodes floridensis* Wells & Wells, 1961 may be found in the cloaca and respiratory tree of *H.* (*T.*) *princeps*. No commensals were found in the specimens recorded herein.

SYNTYPE

At the MCZ Catologue No. 685.

TYPE LOCALITY

Florida.

REMARKS

Coloration of preserved specimens is a mosaic of brown and yellow, with some black spots mainly ventrally. Anus surrounded by long papillae (±20). Ossicles are small tables (±50 μm) with a low spire ending in 6–8 teeth; large tack-like tables with undulated margin and four pillars, which unite to form a long, conical and thick spire with one central and large hole (±150 μm long); irregular knobbed buttons (±60 μm) and rods (±200 μm).

Holothuria (*T.*) *princeps* is also the first record of the subgenus *Theelothuria* and the sixth record of the genus *Holothuria* in the south-western Atlantic Ocean. It differs from *Holothuria* (*Cystipus*) *pseudofossor* Deichmann, 1930, *Holothuria* (*Halodeima*) *grisea* Selenka, 1867, *Holothuria*

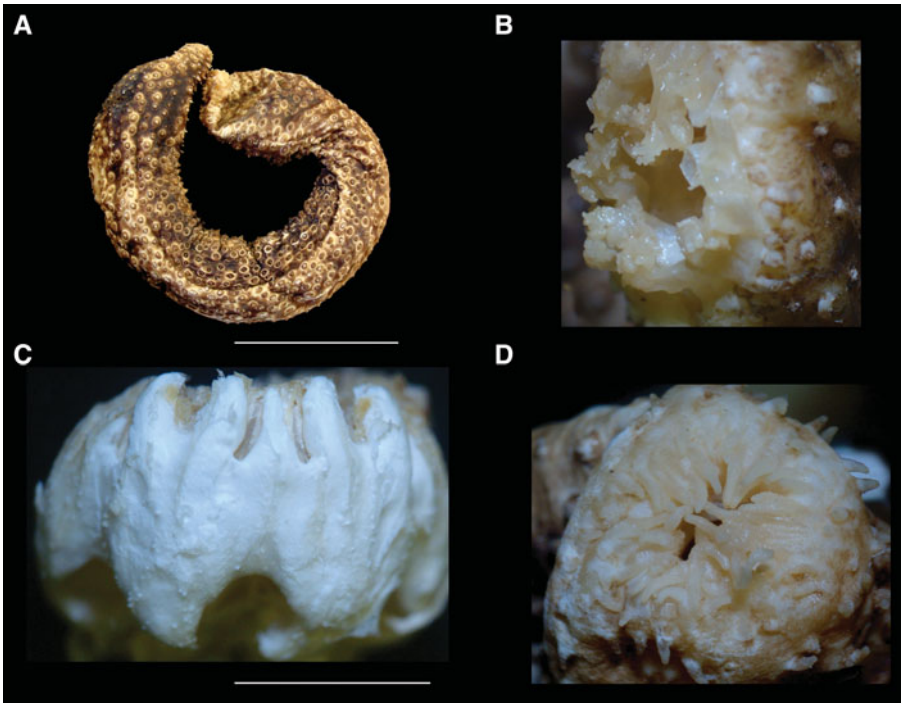

Fig. 1. *Holothuria* (*Theelothuria*) *princeps* Selenka, 1867 (UFBA–645): (A) whole animal; (B) detail of peltate tentacles; (C) calcareous ring; (D) detail of anal papillae. Scale bars: A, 10 cm; B, 1 cm; C, 10 mm; D, 1 cm.

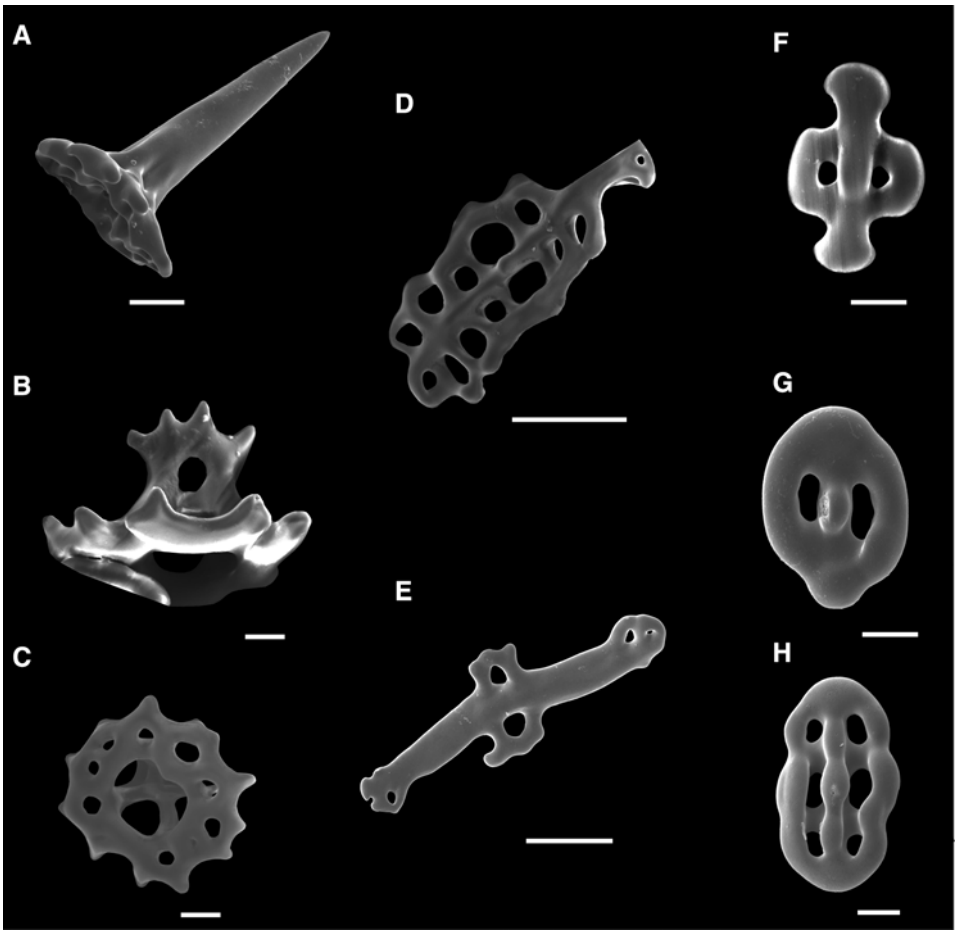

Fig. 2. *Holothuria* (*Theelothuria*) *princeps* Selenka, 1867 (UFBA–645): scanning electron microscopy images (A) tack-like table; (B) table in lateral view; (C) disc of table; (D, E) supporting rods; (F, G, H) buttons at different stages of development. Scale bars: A, 50 μm; B, C, 10 μm; D, E, 50 μm; F–H, 10 μm.

(*Semperothuria*) *surinamensis* Ludwig, 1875, *Holothuria* (*Thymiosycia*) *arenicola* Semper, 1868 and *Holothuria* (*Vaneyothuria*) *lentiginosa* Marenzeller von, 1892 by the presence of tack-like tables and knobbed buttons.

SYSTEMATICS

Order DENDROCHIROTIDA Grube, 1840
Family PHYLLOPHORIDAE Östergren, 1907
Genus *Thyone* Oken, 1815
Thyone pawsoni Tommasi, 1972
(Figures 3 & 4)

Thyone pawsoni Tommasi, 1972: 19, figures 12–15.

Thyone pawsoni—Pawson & Miller, 1981: 397, figures 2D–E; Miller & Pawson, 1984: 42, figures 34–35; Pawson *et al.*, 2010: 30, figure 22.

MATERIAL EXAMINED

Thyone pawsoni—Guarajuba, Camaçari, BA, Brazil (12°45′–12°48′S 38°05′–38°08′W): 26 m, 20 July 2005, 2 specimens 1.5 and 2.0 cm long (UFBA–1485); 31 m, 20 August 2009, 2 specimens 2.0 and 2.5 cm long (UFBA–1482); 31 m, 20 February 2010, 2 specimens 2.5 and 3 cm long (UFBA–

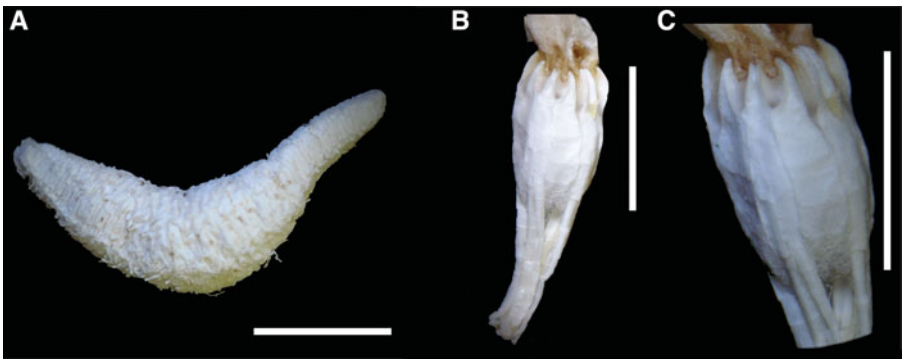

Fig. 3. *Thyone pawsoni* Tommasi, 1972 (UFBA–1485): (A) whole animal; (B) calcareous ring; (C) detail of radial and interradial plates of calcareous ring without its projections. Scale bars: A, 2 mm; B, C, 10 mm.

1481); 31 m, 10 July 2010, 1 specimen 3.5 cm long (UFBA–1484). Off Georgia, United States (31°19′N 81°13′W), 8 m, 4 February 1980, 1 specimen 2 cm long (USNM E 19512).

DIAGNOSIS

Body cylindrical, but tapering abruptly posteriorly to form a short tail. Tube feet scattered throughout the body. 10 dendritic tentacles, ventral pair smaller. Calcareous ring with long and divided forked processes. Ossicles are tables and supporting tables. Tables with an elliptical disc with four perforations, and an elongated spire ending in one tooth. Supporting tables with a narrow and curved base with four central perforations and one in each extremity; and a spire with two pillars ending in three teeth.

DISTRIBUTION

South Carolina to the Gulf of Venezuela and Brazil (up to Bahia State); depth: 6–51 m (Pawson *et al.*, 2010; present paper).

BIOLOGICAL NOTES

Burrows in silt-covered quartz sand and crushed shell sediment (Pawson *et al.*, 2010). Present specimens were found burrowed in gravel and sand.

HOLOTYPE

Lost. The shallow water echinoderm collection from Professor L.R. Tommasi was donated to the Museum of Zoology of the University of São Paulo. This collection, however, stayed

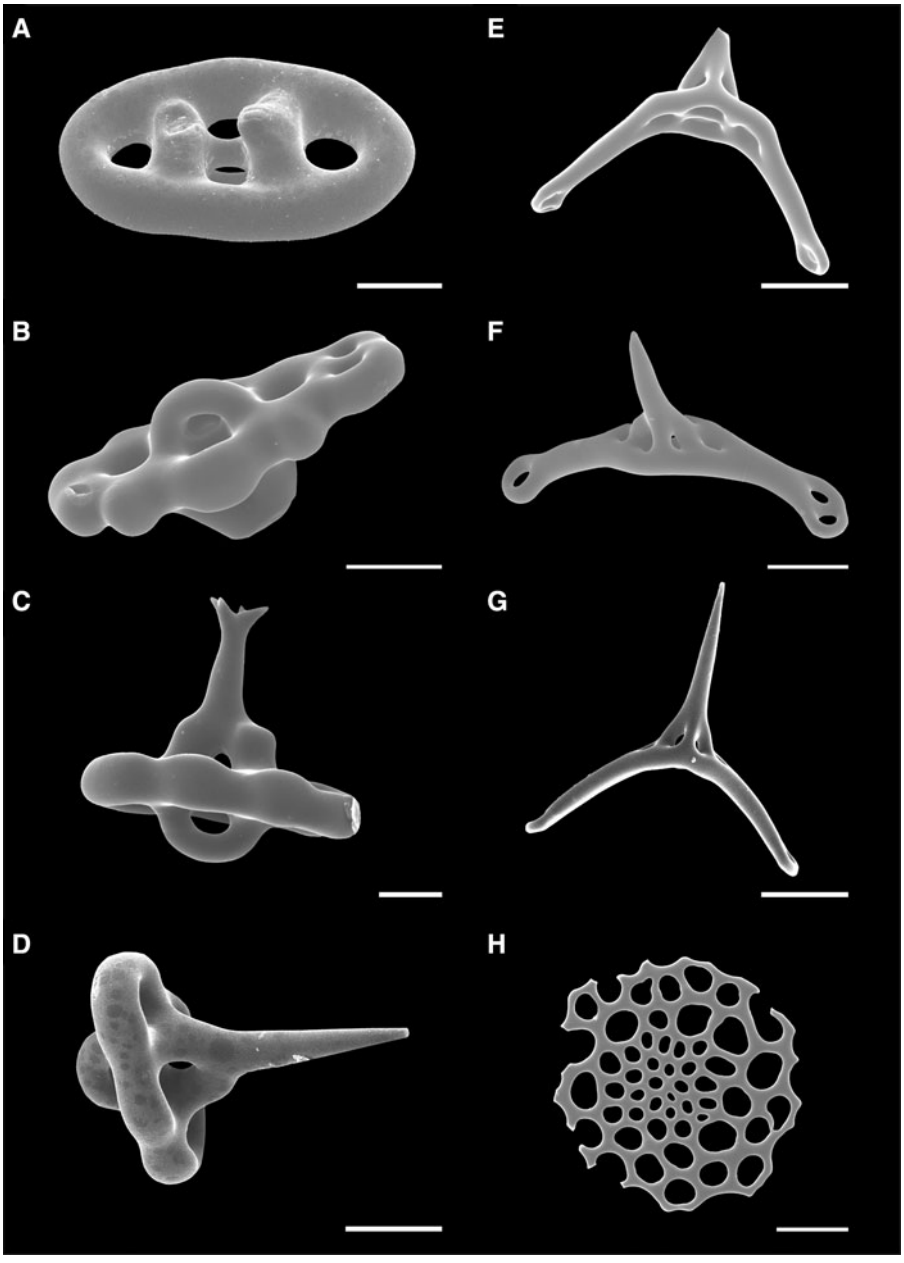

Fig. 4. *Thyone pawsoni* Tommasi, 1972 (UFBA–1485): scanning electron microscopy images (A, B, C, D) tables from body wall at different stages of development; (E, F, G) supporting tables; (H) end plate from tube feet. Scale bar: A–H, 20 μm.

many years without proper care until it could be moved, and much material (and collecting information) was lost.

TYPE LOCALITY
Gulf of Venezuela.

REMARKS
The specimens reported herein have two types of body wall tables: one bears a high tapering spire and the other ends in three teeth (and one of these may be subdivided). Although this is in accordance with Miller & Pawson (1984), Tommasi (1972) mentioned only the presence of tables with one tooth. This type may represent the high tapering spire table or it could be an error of observation, since in the figures presented by Tommasi (1972) the table has more than one tooth. Furthermore, the development of teeth at the tip of tables does not seem to be related to the size of the table since small tables with teeth and large ones without them were observed. As noted by Pawson *et al.* (2010), body wall tables with more than four perforations were found, in smaller amounts.

Although Tommasi (1972), Miller & Pawson (1984) and Pawson *et al.* (2010) mentioned the presence of three teeth on the tip of the supporting tables, the specimens reported herein (including the specimens from Georgia) have supporting tables ending mainly in a tapering spire with no tooth, regardless of their size. Supporting tables ending in three teeth were rarely found, although present. This variation, however, may not be of generic importance. Unfortunately, the holotype is missing and the figures presented by Tommasi (1972) are not in good quality for comparison.

Regarding the calcareous ring, the radials and interradials of different specimens are broken in pieces of different sizes and at different places; in some specimens the radial is almost compact, recalling a Sclerodactylinae. The formation and evolution of the calcareous ring deserves further studies, especially because it is an important structure used to distinguish phyllophorids from sclerodactylids.

Besides *T. pawsoni*, two other *Thyone* species occur on the Brazilian Coast: *Thyone pseudofusus* Deichmann, 1930 and *Thyone montoucheti* Tommasi, 1970. However, *T. montoucheti* may have been misclassified since its body wall tables have four pillars (Tommasi, 1970), while the tables of *Thyone* species have only two. Moreover, the calcareous ring of this species does not have posterior prolongations, which, accordingly, would classify *T. montoucheti* as a cucumariid, instead. Considering the cucumariids, however, *T. montoucheti* cannot simply be assigned to any of its subfamilies because of the following characteristics: ten tentacles, ventral-most two are reduced (versus 15–25 in Thyonidiinae) and presence of table and supporting tables in the body wall (versus absence in Cucumariinae and Colochirinae). In addition, the presence of tube feet scattered throughout the body and of four Polian vesicles would also exclude many genera. The holotype of *T. montoucheti* is also missing and, therefore, cannot be analysed to verify possible inconsistencies in the original description.

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