

# Just undiscovered or invasive? The first record of a chiton (Mollusca: Polyplacophora) from the remote Ascension Island, southern Atlantic Ocean

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*During a recent expedition to Ascension Island in the southern Atlantic Ocean, a polyplacophoran of the genus Acanthochitona was collected, corresponding to the first recorded species of this molluscan class from this remote island. A scanning electron microscope study reveals a close affinity to Acanthochitona subrubicunda, which was so far only known from the Cape Verde Archipelago. Due to the lack of comparable type material the new finding warrants a confirmed identification and is only tentatively attributed to Acanthochitona subrubicunda. It is hypothesized that the class Polyplacophora was either overlooked during earlier surveys or colonized the island in more recent time. If the latter scenario took place, a transport by ships is thinkable.*

**Keywords:** Mollusca, Polyplacophora, Acanthochitona, Atlantic Ocean, scanning electron microscope study, benthic, zoogeography

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## INTRODUCTION

Polyplacophora, commonly called chitons, are a group of exclusively marine benthic molluscs with a worldwide distribution from the intertidal zone down to hadal depths. Inhabiting all kind of hard substrata they can be found on practically every coast. Despite their simple accessibility, at least in shallow water, so far only about 950 (+) living species have been described (Schwabe, 2010), make chitons a lesser diverse class of molluscs. It has been shown several times (e.g. Schwabe, 2006; Schwabe *et al.*, 2008; Dell'Angelo *et al.*, 2010; Sirenko, 2012) that with an enhanced sample effort regional species numbers can increase drastically, demonstrating that chitons are often under-represented during malaco-faunistic surveys. Thus, it is not too surprising that in the compiled molluscan list (89 species) of Ascension Island by Rosewater (1975) not a single chiton species was mentioned.

The isolated location of Ascension Island makes the region an attractive object for zoogeographical examinations. The island lies nearly axial on the southern equatorial part of the Mid-Atlantic Ridge and is thus flanked by two deep-sea basins: the Angola basin to the east; and the Brazilian basin to the west. The nearest land is the slightly larger St Helena island, which lies about 1130 km south-east. Nearly 1000 km closer to the West African coast than to the Brazilian coast, the island is located within the influence of the South Equatorial Current (Irving, 1989). For detailed information about the geography

and the geological age, we refer to Ashmole & Ashmole (1997) or a summary review in Irving (2013).

During a recent (2012) expedition to Ascension Island conducted by the Shallow Marine Surveys Group (SMSG) and the South Atlantic Environmental Research Institute (SAERI) several biotas were collected and photographed in the field, which are partly the subject of the present special volume.

Among them, a single species of polyplacophora was collected and is described morphologically here.

## MATERIALS AND METHODS

The specimens at hand were collected as a side effect during the investigation of shallow water phytobenthos. Samples were gained by SCUBA diving (K.T. and Peter Wirtz) down to 30 m depth, and photographed prior to fixation. Chitons, which were found attached on coralline algae, were sent to the Bavarian State Collection of Zoology, Munich (ZSM) for identification and final storage.

Terminology for species description as well as the preparation techniques for visualization follows Schwabe (2010), radula characters are combined from Saito (2004) and Schwabe (2010) while the systematic depends upon Sirenko (2006).

## Taxonomy

### SYSTEMATICS

Class POLYPLACOPHORA Gray, 1821  
Subclass NEOLORICATA Bergenhan, 1955

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Order CHITONIDA Thiele, 1909  
 Suborder ACANTHOCHITONINA Bergenhayn, 1930  
 Superfamily CRYPTOPLACOIDEA H. & A. Adams, 1858  
 Family ACANTHOCHITONIDAE Pilsbry, 1893  
 Genus *Acanthochitona* Gray, 1821

#### TYPE SPECIES

*Chiton fascicularis* Linnaeus, 1767, by monotypy.

#### GENUS DISTRIBUTION

Worldwide except for Polar Regions. Oligocene–Recent.

*Acanthochitona* cf. *subrubicunda* Leloup, 1941  
 (Figures 1–4)

*Acanthochiton subrubicundus*: Leloup, 1941, p. 13, text figure 5, pl. 1, figure 3; Leloup, 1968, p. 74, figure 14N (in synonymy of *Acanthochitona gracilis* (Jeffreys, 1859)); Kaas & Van Belle, 1980, p. 127.

*Acanthochiton(a) subrubicunda(-us)*: Kaas, 1985, p. 601, figures 91–92 (emendation); Kaas, 1991, p. 95; Kaas & Van Belle, 1998, p. 181; Strack, 2005, p. 31.

#### TYPE MATERIAL

Originally described on three syntypes, which should be deposited in the Royal Belgian Institute of Natural Sciences (RBINS) (but see Remarks).

#### MATERIAL EXAMINED

ZSM Mol 20130027: 10 specimens from Ascension Island, Horseshoe Reef (7°54'47.8"S 14°24'16.5"W), on the tower-forming coralline red algae *Lithophyllum* sp., down to 30 m.

#### DESCRIPTION

*Animal* of small size, largest animal examined (Figure 1A–C) slightly curled, measuring 5.3 × 3.3 mm. Specimen used for scanning electron microscopy (SEM) strongly curled about 4.8 × 3 mm (Figures 2–4). Coloration variable, generally comprising reddish tones, from bright pinkish to brown, often interspersed with white freckles. Body outline elongate oval (Figure 1A, C), dorsally subcarinated, high elevated, dorsal elevation quotient of valve II: 0.53 (Figure 2D).

*Valves* quite solid, with only a thin tegmental layer. Head valve (Figure 2A, B) semicircular, anterior slope convex,

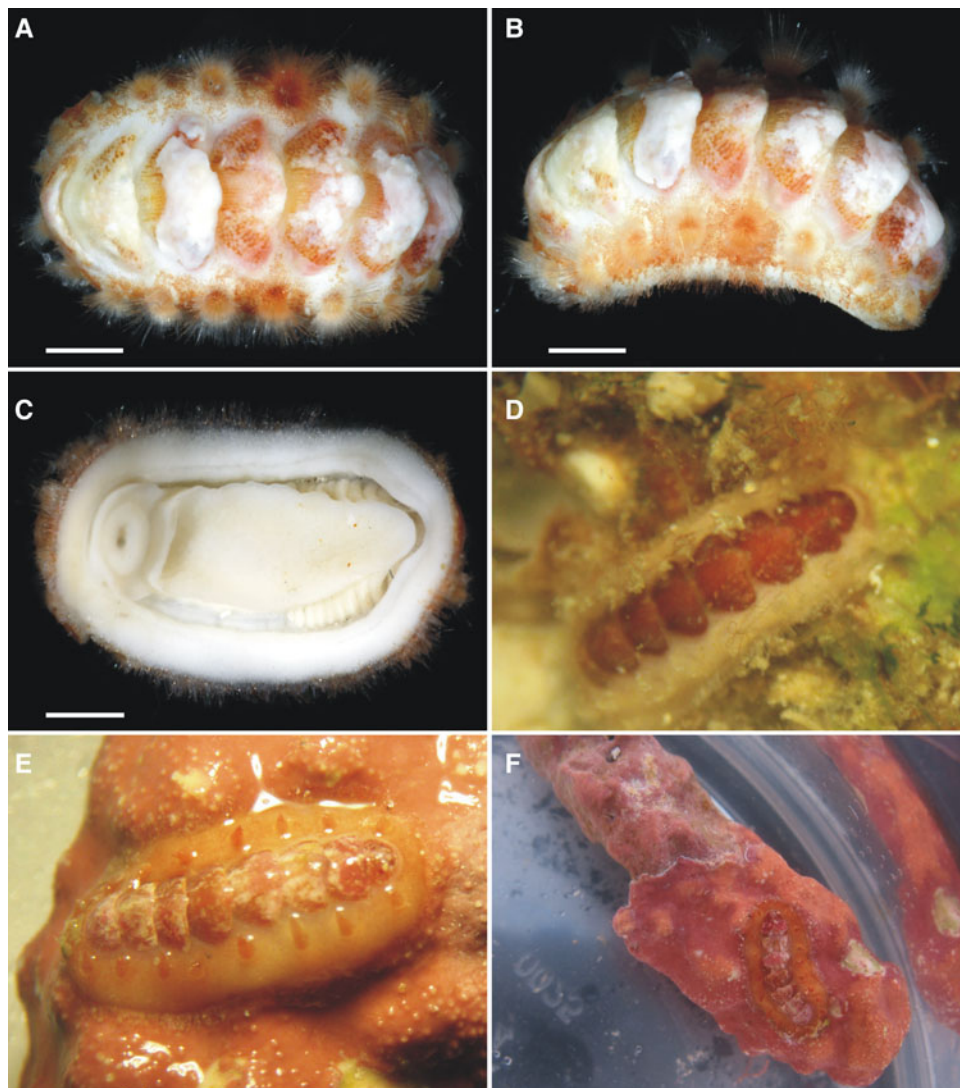


Fig. 1. *Acanthochitona* cf. *subrubicunda* Leloup, 1941: (A) dorsal view of a preserved specimen; (B) dorso-lateral view of same specimen; (C) ventral view of same specimen; (D–F) *in situ* images on the coralline red algae *Lithophyllum* sp., prior to fixation. Scale bars: A–C, 1 mm; D–F, scale unknown.

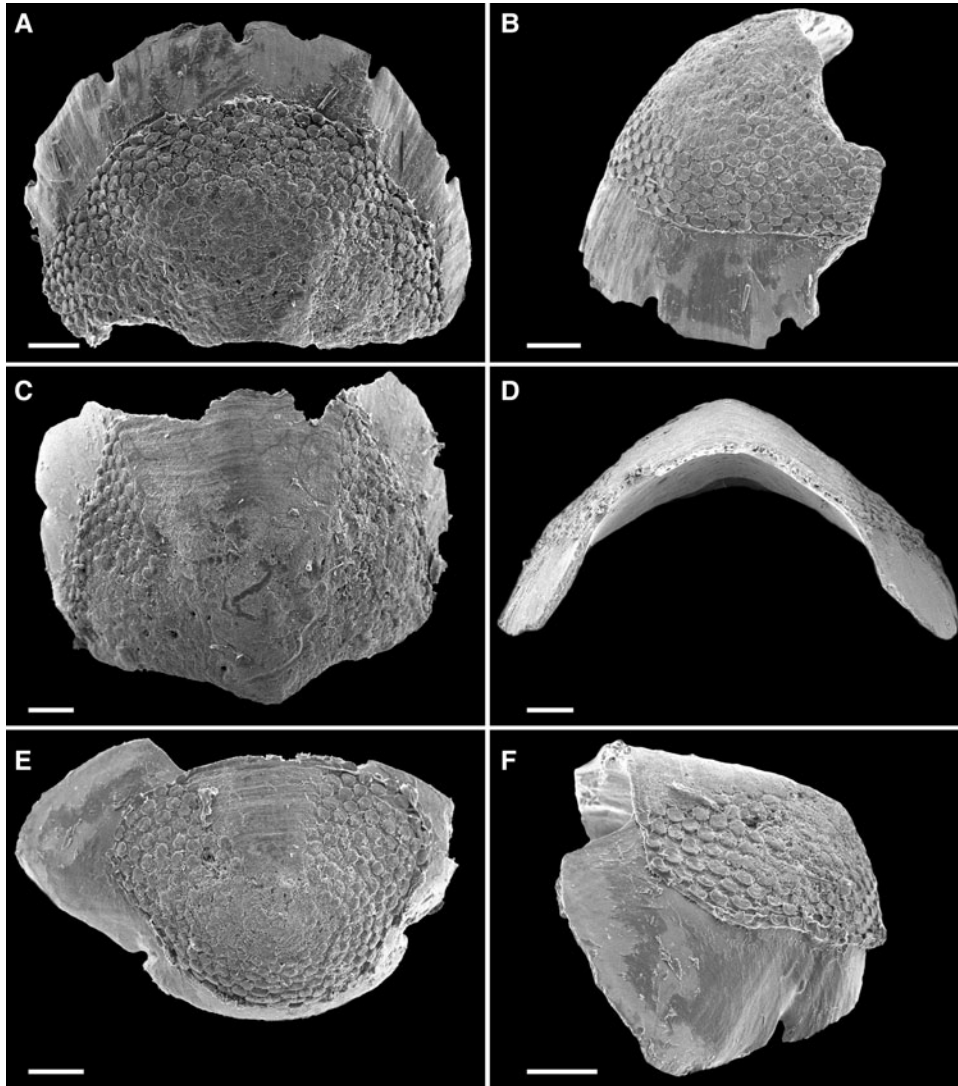


Fig. 2. Scanning electron microscopy images of *Acanthochitona* cf. *subrubicunda* Leloup, 1941: (A) dorsal view of head valve; (B) lateral view of head valve; (C) dorsal view of valve II; (D) frontal view of valve II; (E) dorsal view of tail valve; (F) lateral view of tail valve. All scale bars 200  $\mu$ m.

posterior margin straight. Intermediate valves (Figure 2C, D) rhomboid, with clearly protruding apical area, resulting in a plectrum-like shape. Tegmental layer of intermediate valves anteriorly less wide than posterior. Tail valve (Figure 2E, F) more or less circular, but tegmentum anteriorly clearly wider than posterior. Mucro situated at the posterior third, slightly forward directed, postmucronal slope steep and straight, antemucronal area straight.

*Tegmentum* (Figure 3A–D) comprises minute, round to slightly drop-shaped, slightly elevated granules, about 50  $\mu$ m in diameter. Granules surface centrally depressed with a slightly elevated megal aesthete, posteriorly the granule slopes to the valve surface, forming a shallow furrow. Microaesthetes not discernible. Granules arranged in quincunx in head valve, pleurolateral areas of valves II–VIII and postmucronal area. Intermediate valves and tail valve with broad wedge-shaped, smooth jugal area, although light microscopic examination allows a look on underlying nerve channels, given the jugal area a striated appearance. Eaves with a single channel layer only.

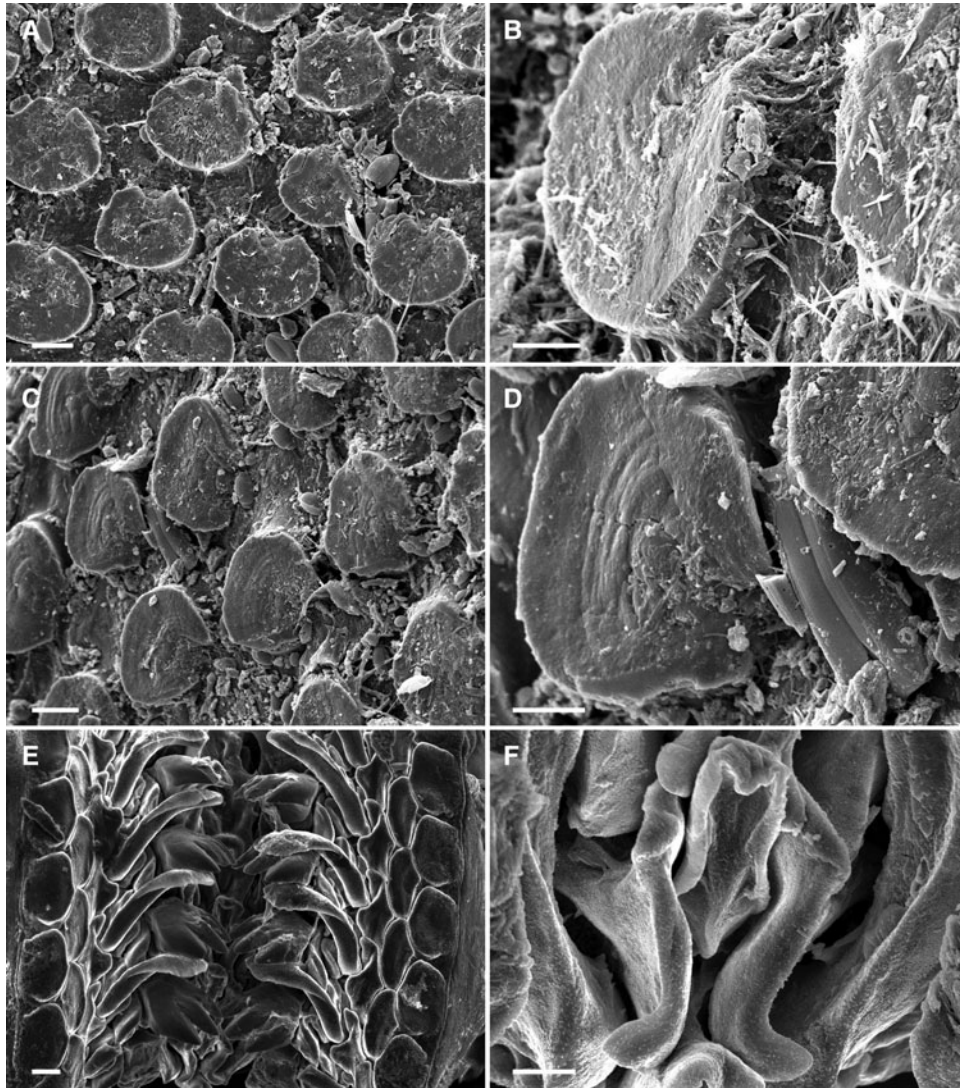
*Articulamentum* solid, shining, central parts reddish to pinkish, fading towards the outsides. Jugal tract of

intermediate valves porous, slit rays shining through, otherwise hardly visible, not perforated. Insertion plates (Figure 2A–C, E, F) large, with sharp edges, smooth, incisions deep. Slit formula: 5/1/2. Central callus deeply depressed. Ventral tegmental callus quite extended. Apophyses large, laterally extended, wing-shaped in intermediate valves and rectangular in tail valve.

*Radula* of a specimen measuring about 4.8  $\times$  3 mm, about 2.5 mm in length, anteriormost 1.6 mm underlying by cartilages. Radula (Figure 3E, F) with 43 transversal teeth rows, with 36 rows already mineralized. Central tooth (Figure 3F) slender, tulip-shaped, slightly embayed at the middle, about 36  $\mu$ m in length and 17  $\mu$ m wide at the strongly keeled base. Blade simple with a posteriorly folded projecting process. First lateral tooth (Figure 3F) S-shaped, antero-dorsal corner slightly bent inwards, no accessory process detectable. Second lateral tooth with tricuspidate head, denticles sharp-pointed, but outer one distinctively wider than inner, central denticle longest. Major uncinial tooth spoon-shaped with slender, cylindrical shaft.

*Girdle* fleshy, slightly brighter coloured than valves (Figure 1D–F), dorsally with densely arranged bilaterally





**Fig. 3.** Scanning electron microscopy images of *Acanthochitona* cf. *subrubicunda* Leloup, 1941: (A) granule arrangement at head valve; (B) lateral view of a single granule at head valve; (C) granule arrangement at pleurolateral area of valve II; (D) posterior-dorsal view on a single granule from same region as 'C'; (E) anterior rows of radula; (F) central portion of a single teeth row to show the central tooth and first lateral teeth. Scale bars: A, C, E, 20  $\mu\text{m}$ ; B, D, F, 10  $\mu\text{m}$ .

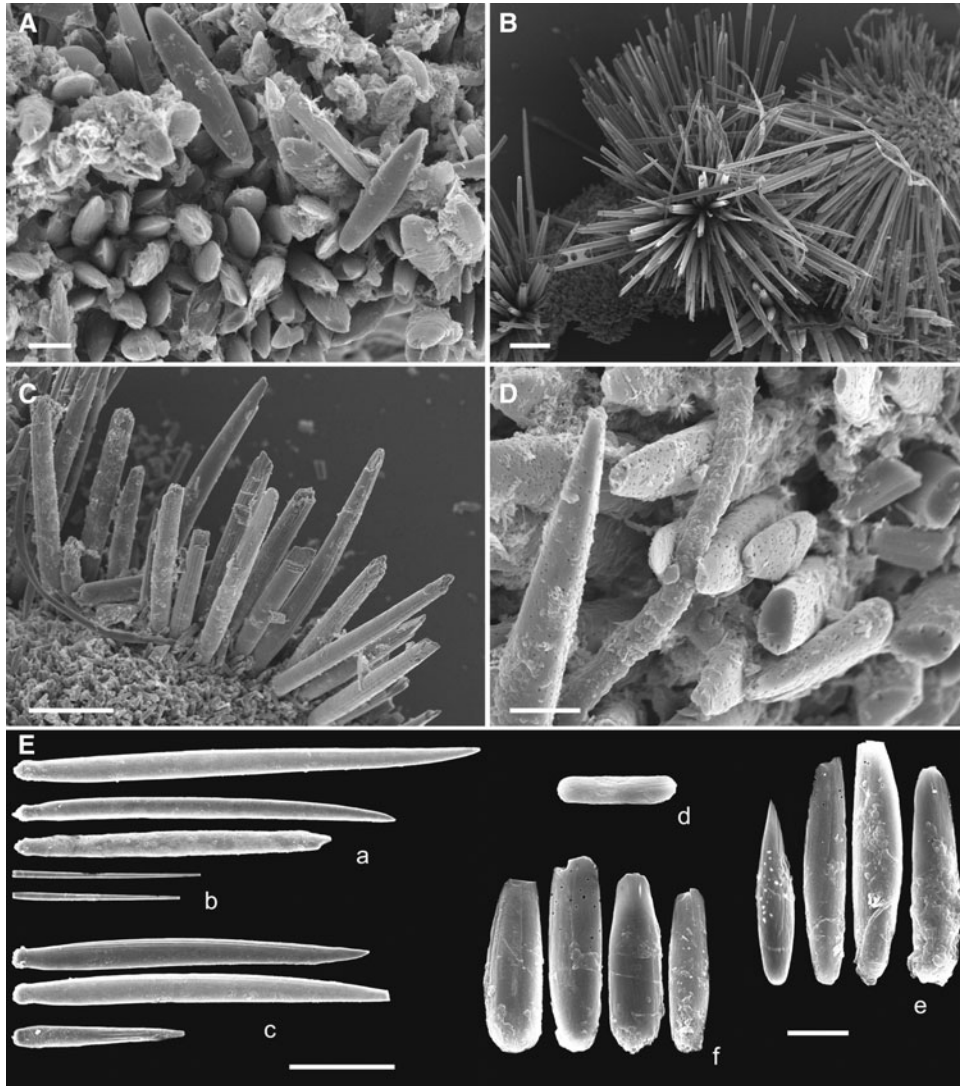
flattened, sharp to obtusely-pointed spicules (Figure 4Ee), up to 50  $\mu\text{m}$ , that show a vague longitudinal striation. Spicules straight, but terminally slightly narrower (Figure 4A). Marginal fringe (Figure 4C), dense, with sharp-pointed, straight to slightly curved spicules (Figure 4Ec), measuring up to  $350 \times 30 \mu\text{m}$ , distinctively coarser longitudinal striated than dorsal spicules. 18 tufts (Figure 4B) arranged typical acanthochitonid over the whole girdle, one at each sutural region and four encircling the anterior valve. Single tuft comprises more than 200 straight, very slender, sharp-pointed needles (Figure 4Ea), which may attain a length of nearly half a millimetre (longest measured 417  $\mu\text{m}$ ). Among the needles occur very slender straight, sharp-pointed spines, which may attain a length of up to 180  $\mu\text{m}$  (Figure 4Eb). Hyponotum (Figure 4D) with densely arranged, blunt-pointed, bilaterally flattened spicules (Figure 4Ef), up to 30  $\mu\text{m}$  in length and 10  $\mu\text{m}$  in width. They show a micro-perforation on the otherwise smooth surface; whether this is an artefact or belongs to a kind of sculpture remains unclear.

*Ctenidia* in the largest examined specimen arranged mero-branchial, nine per side, with the group of longest being the posterior three (Figure 1C).

#### HABITAT

The chitons were only found on the surface of the coralline red algae *Lithophyllum* sp., on which they probably also graze on the biofilm covering the algae (Figure 1D–F). The alga is currently under study (K.T.) for a final identification. Remarkable is the tower-forming growth of this species. It was several times shown that chitons as erosive grazers can (but not exclusively, see Price & John, 1980) have a massive impact on algae mutualism (e.g. Littler *et al.*, 1995; Littler & Littler, 1999). Whether *Acanthochitona* cf. *subrubicunda* has such an impact to *Lithophyllum* sp. remains unclear at present. Surprisingly, Price & John (1980) who characterized the algae composition of Ascension Island did not mention a single chiton.

The collecting locality corresponds to the intersection region of sectors 4–5 which were defined by Irving (1989) as belonging to the most sheltered sector of the open coast



**Fig. 4.** Scanning electron microscopy images of girdle of *Acanthochitona* cf. *subrubicunda* Leloup, 1941, (A–D) *in situ*, (E) isolated girdle elements: (A) dorsal spicules; (B) tufts; (C) marginal fringe; (D) ventral spicules; (E) a, tuft needles; b, tuft spines; c, marginal spicules; d, dorsal spicule near margin; e, dorsal spicules; f, ventral spicules. Scale bars: A, D, E(d–f), 10  $\mu$ m; B–C, E(a–c), 100  $\mu$ m.

(sector 4) and as biological rich (sector 5), respectively. Both sections share coarse sand and maerl patches.

#### REMARKS

The species fits rather well the original description and also the illustration that Kaas (1985) provided of one syntype of *A. subrubicundus*, except for slight differences in the present girdle elements compared to Leloup's original description. Some of his tuft needles are more curved. Also the ventral spicules are obviously more pointed compared to our material. As we present here data of a single examined specimen only and the original description shows slight variation between the elements of two illustrated specimens, the observed variation may fall in the range of variability of this species.

The syntype series consisting of three specimens should be deposited in the RBINS. However, according to Dr Yves Samyn, who checked the collection on our request, only spicule preparations are available under the name '*A. subrubicundus*'. Noteworthy, Kaas (1985; figures 91–92) illustrated a syntype of *A. subrubicunda*, but nothing is known about the

whereabouts of this specimen. As long as the type material is not traceable and a comparative study impossible, we refer only tentatively to Leloup's species.

#### DISCUSSION

The by far most isolated island in the Atlantic Ocean is surely Ascension Island. Its young age approximately  $1.5 \times 10^6$  yr BP—together with its distances to the next land masses—make it a 'natural laboratory' for the study of small-scale evolution (Ávila, 2013). Regarding the rather long distances to the West African coast (about 1500 km), as well as to the South American coast (2400 km), the nearest land mass that could serve as a colonization source is the geologically older St Helena island. The latter dates back to  $20 \times 10^6$  yr BP and lies about 1130 km south-east of Ascension Island (Irving, 2013).

Evolutionary pathways might be best shown by direct comparisons between faunistic components of an island and its



surrounding land masses. Rosewater (1975) made such an attempt for the malaco-fauna and several other authors for additional invertebrates and fish (see references in the present special volume). The author clearly demonstrated that the fauna of marine molluscs at Ascension Island is only 50% of what is known from St Helena. Ascension, with 89 mollusc species, shares 42% of its species with St Helena. That leaves the question of the origin of the remaining Ascension species unanswered.

A clear evolutionary pattern is not traceable, as only 9% of 89 species could be considered endemic, while all other species have a wider distributional range, ranging to both sides of the Atlantic or even the East Pacific and Indian Ocean.

From its geographical position in the upper slope of the north-westward flowing South Equatorial Current (Irving, 1989), one would expect a colonization from the Indo-Pacific, but Ascension shares only seven species with this region. Also the West African fauna, with 22% overlapping species, falls behind the western Atlantic, where a slightly higher percentage (27%) of Ascension marine molluscs is shared. According to Rosewater (1975) 21% of the marine molluscs at Ascension occur on both sides of the Atlantic. They should be of special interest as gene flow might show the evolutionary relationship of the involved species. Unfortunately such studies are missing for molluscs and we have to refer to Padula *et al.* (2017) to substantiate this. Here we present the first chiton ever mentioned from Ascension Island. Making the picture sketched above more intricate, the chiton species mentioned herein is potentially identical to *A. subrubicunda*, a species previously known from the Cape Verde Archipelago only (Leloup, 1941; Kaas, 1985). Ávila (2013) shows in an exemplary manner the restricted overlapping of some molluscs from Cape Verde Island and Ascension Island, interestingly with representatives of all dispersal types: brooders and species with non-planktotrophic and planktotrophic larvae. The long distance between island groups and the in-between South Equatorial Current make a direct north-south connection unlikely. The Cape Verde chitons, however, show a considerable high overlapping of 21.4% with the chiton fauna of the São Tomé and Príncipe Islands (Dell'Angelo *et al.*, 2014). Hence, one colonization direction of *A. subrubicunda* could be via the São Tomé and Príncipe Islands, but so far the species has not been confirmed from this region (Dell'Angelo *et al.*, 2014).

In how far rafting is a hypothetical explanation for the occurrence of *A. subrubicunda* remains unclear until data about the species' reproductive mode are studied or a direct proof for this scenario appears. The possibility, however, was suggested for intertidal invertebrates by Hoeksema *et al.* (2012).

With the recent single record of a chiton from Ascension Island over a long period of investigation (summary in Irving, 2013, p. 213 ff.) the question arises whether chitons were overlooked in the past or if they have newly invaded Ascension Island. To our best knowledge there is no fossil malaco-faunistic record from Ascension Island. If colonization occurred earlier it might be tested by the examination of lava fields to find tempestites—which may show shallow water habitat conditions during the geological past of the coastline (e.g. Meireles *et al.*, 2013). Noteworthy also is that the geologically older St Helena island also lacks published chiton records. According to Bruno Anseeuw (personal

communication) he recently received isolated valves (no live material) of two chiton species, an ischnochitonid species and an acanthochitonid species. Whether the latter belongs to the same species presented in the present study requires further investigations and preferably live collected material.

From the above-mentioned considerations we assume that the chitons could be a result of a recent introduction to Ascension Island, especially as Price & John (1980) during their phytobenthic examination also did not mention the occurrence of associated chiton species. Such an invasion event could be well explained by ship transport, a scenario which has also been suggested for other chiton species (e.g. Arias & Anadón, 2013). Adding the new chiton record and seven further new gastropods (Padula *et al.*, 2017) to the previously known species number (Rosewater, 1975) the molluscan fauna of Ascension Island now comprises 97 marine species.

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