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The Polyplacophora of Easter Island

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Abstract. Three species of Polyplacophora are found on Easter Island: *Plaxiphora mercatoris* Leloup, 1936, which was the only known species for 50 years, ***Rapanuia disalvoi*** gen. & sp. nov., and *Weedingia* cf. *mooreana* Kaas, 1988. The living specimens of ***Rapanuia disalvoi*** were collected in 1984–1985, and several hundred valves in more recent years, but no additional live specimens have been found. This species, at first, appears very similar to *Tonicia*, but the absence of pectination on the teeth of the insertion lamina leads us to define the new genus ***Rapanuia*** and consequently the new subfamily ***Rapanuiinae***. Three valves of a third chiton species, similar to *Weedingia mooreana*, were also discovered. The differences with *W. mooreana* are discussed.

INTRODUCTION

Easter Island is a Chilean possession and lies approximately 3500 km west of the coast of Chile (27°09′S, 109°26′W). Despite its isolation and location in the eastern Pacific, Easter Island is considered the easternmost point of the Indo-Pacific faunal realm. Previous investigations have shown that species which are not endemic to the island are similar to species known from other areas of the Indo-Pacific region, and not the eastern Pacific. This phenomenon has been repeatedly observed by Rehder (1980), DiSalvo et al. (1988), and Raines (2002).

For 50 years the only known species of Polyplacophora on Easter Island was *Plaxiphora* (*Mercatora*) *mercatoris* Leloup, 1936. However, in the mid 1980s, Dr. Luis DiSalvo discovered another small and elusive species. The first report of his discovery was listed as "*Tonicia* sp." (DiSalvo et al., 1988). Until now, no other records of this species have been reported. During two visits to the island (1998, 2000), author Raines was successful in collecting several hundred valves, although no additional live specimens were found.

To date, ***Rapanuia disalvoi***, gen. & sp. nov., the species described herein, is known from only two locations on the island: Hanga Roa and Hanga Nui (Figure 1). Both areas are of similar habitat, where inshore flats provide protection from large waves. Within the flats are large expanses of sand, which are bound within hummocks formed by chaetopterid polychaete tubes in water less than 2 m deep. ***R. disalvoi*** lives within these hummocks. Numerous single valves of ***R. disalvoi*** have been sorted from sand and rubble collected from both the tide pool areas and from the base of cliffs at depths ranging from 10 to 20 m off Hanga Roa. These valves along with the specimens collected by DiSalvo have provided enough evidence to support our findings. In addition to ***R. disalvoi***, another chiton species was also discovered in the tide pool areas near Hanga Nui. Three valves were found, which appear quite similar to those of *Weedingia mooreana* Kaas, 1988, from the Society Islands.

Abbreviations: ANSP = Academy of Natural Sciences, Philadelphia; BDA = Private collection of B. Dell' Angelo, Prato (Italy); BR = Private collection of B. Raines, Victorville (USA); LACM = Natural History Museum of Los Angeles County; MNHN = Museum National d'Histoire naturelle, Paris; MZB = Museo di Zoologia dell'Universita' di Bologna; ZISP = Zoological Institute of Russian Academy of Sciences, St. Petersburg; ZSM = Zoological State Collection Munich.

TAXONOMY

Class Polyplacophora Gray, 1821

Order Neoloricata Bergenhayn, 1955

Suborder Lepidopleurina Thiele, 1910

Family HANLEYIDAE Bergenhayn, 1955

Genus *Weedingia* Kaas, 1988

Weedingia cf. *mooreana* Kaas, 1988

(Figure 2)

cf. Weedingia mooreana Kaas, 1988:143, figs. 18–29.
cf. Weedingia mooreana Kaas & Van Belle, 1990:20, fig. 7.

Material examined: Hanga Nui: 3 valves, 1 anterior (width 1.2 mm), 1 intermediate (width 1.3 mm), and 1 posterior (width 1.4 mm) (leg. B. Raines 1998–2000).

Description: Color of valves rose-red with small white markings. Head valve semicircular, with well pronounced apex. Tegmentum covered with large polygonal granules arranged in radial striae, some of them bifurcating, 24

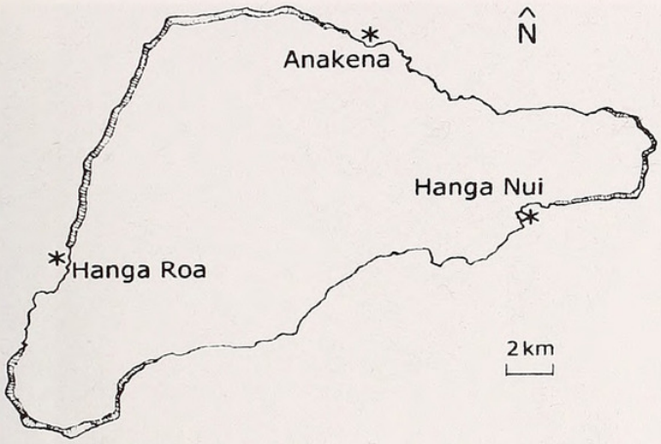


Figure 1. Map of Easter Island showing localities cited in text.

counted on front margin. Intermediate valve rectangular, front margin with wide concave jugal part, antero-lateral parts obliquely truncated; posterior margin substantially straight at both sides of the strongly protruding apex, jugal area broadly triangular, smooth, not differentiated from the latero-pleural parts, which are sculptured with same polygonal granules as head valve, arranged in nine rows (for each area) radiating from apex. Tail valve more than semi-elliptical, front margin slightly concave in wide jugal part, hind margin evenly rounded, mucro at about 3/5 of length of valve, prominent, posterior slope straight, except for small excavation directly behind mucro. Antemucronal area sculptured like intermediate valve, with large smooth triangular jugal area, postmucronal area sculptured with same large polygonal granules. Granules of the tegmentum of irregularly polygonal shape, "diameter" of about 46 to 52 μm, well separated but sometimes coalescing. Granules typically showing four to six aesthetes of equal size; when only four, normally disposed at the corners like a square. Articulamentum whitish, with rose-colored tegmentum shining through, apophyses wide apart, triangular, regularly merging into moderately long, smooth-edged, unslit insertion plates.

Discussion: The genus *Weedingia* was established by Kaas (1988) to describe two small species from Polynesia (Tuamotu and Society Islands) and is characterized by a finely pustulose tegmentum which is not clearly divided into central, lateral, or jugal areas, and well developed unslit insertion plates on all valves, a more or less spinulose girdle, and merobranchial, adanal (with interspace) gills. The finding of these valves is particularly important because the species of *Weedingia* are poorly known. The available material is also very scarce and the species are localized only in Polynesian Islands. According to Kaas & Van Belle (1990), the genus includes three species, which are known only from the type material: *W. exigua* (Sowerby in Broderip & Sowerby, 1832) from the Gambier Island, *W. alborosea* Kaas, 1988, from Tuamotu, and *W. mooreana* Kaas, 1988, from Moorea (Society Islands).

The three valves found at Hanga Nui at first appear quite similar to *W. mooreana,* which is known to live on dead *Acropora* from the Tiahura Barrier Reef, Moorea. The main differences are regarding the apex, which is "*small but distinct*" in *mooreana,* but very pronounced in our valves; the granules are smaller and have a more rounded polygonal shape (diameter of about 35–41 μm) in *mooreana,* whereas our valves are larger and more irregular (diameter of about 46–52 μm); the number of radial striae of granules are greater in *mooreana* (43 in head valve, 15 in pleural areas) than in our valves (24 in head valve, nine in pleural areas); in addition, our valves have a wider jugal sinus and jugal area, the antemucronal area is longer than the postmucronal area, and with a quite different outline of the tail valve.

We illustrate for comparison the holotype of *W. mooreana* at MNHN (Figure 3). The quality of SEM photos is hardly sufficient, as the photos were performed without coating the material. Strangely, there is no trace of aesthetes on the granules of the tegmentum, but we think that this could have been caused by some previous treatment of the holotype. The differences indicated seem sufficient to define a new species, but we prefer the attribution to *W. mooreana* because of the scantiness of the material at our disposal.

Suborder Ischnochitonina Bergenhayn, 1930

Family Ischnochitonidae Dall, 1899

Subfamily **Rapanuiinae** Dell'Angelo, Raines & Bonfitto, subfam. nov.

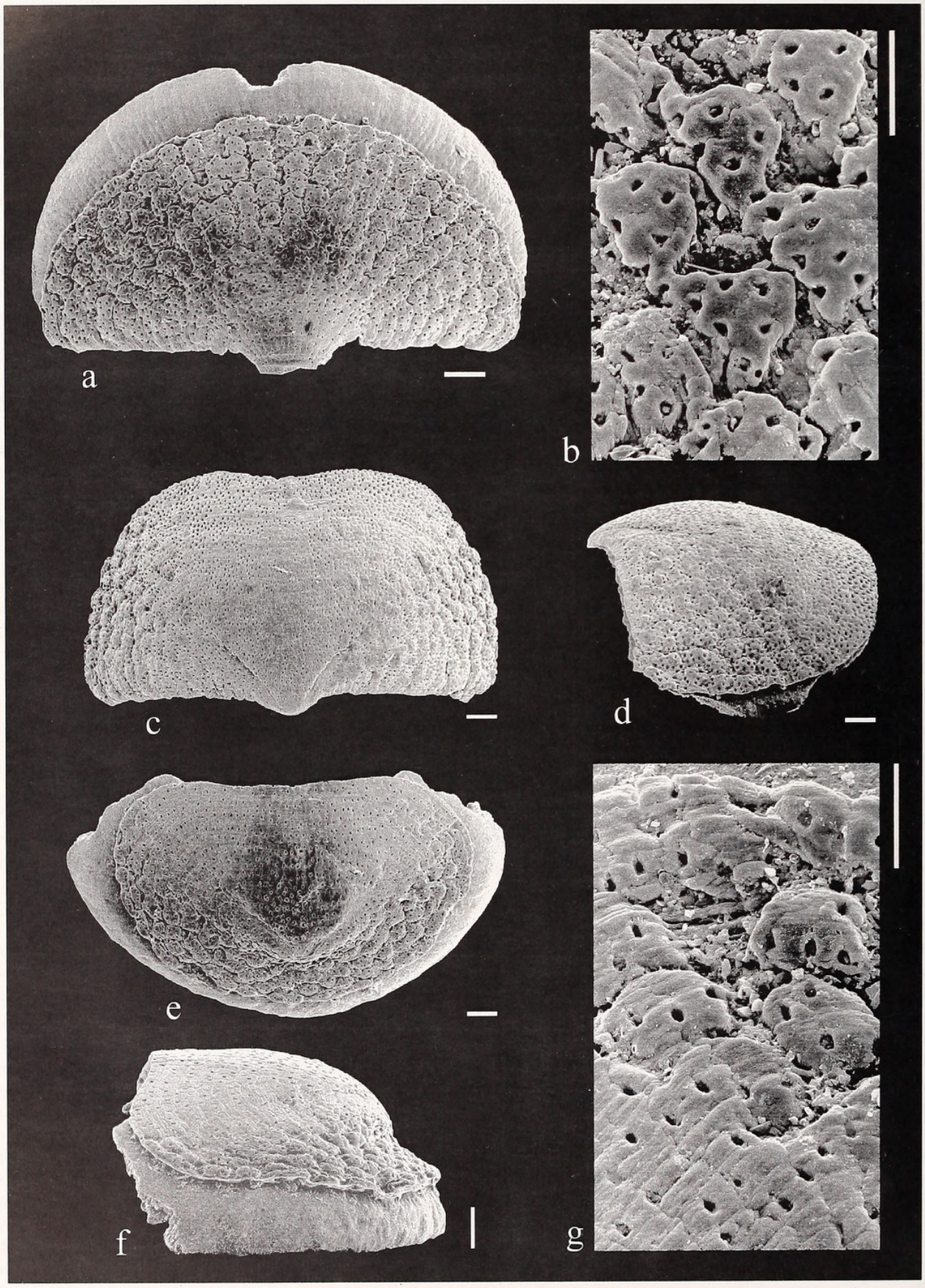
Diagnosis: Ischnochitonidae of small size, oval, tegmental sculpture almost smooth to roughish, with some scars on the pleural areas, insertion plates not pectinated, slit formula many/1/many, apophyses neatly separated, extra pigmentary eyes present, girdle with dorsal imbricate scales and ventral spicules, radula with a tricuspid major lateral teeth.

Occurrence: Known only from Easter Island.

Discussion: The species found at Hanga Nui and Hanga Roa has the following main characters useful for the supraspecific assignment:

- insertion plates not pectinated, slit formula 8-9/1/8-11;
- extra pigmentary eyes (ocelli) present;
- girdle with dorsal imbricate scales and ventral spicules.

The first character (insertion plates not pectinated) allows us to assign the species to the family Ischnochitonidae. The Suborder Ischnochitonina is divided into four families (Kaas & Van Belle, 1985), one of which (Chitonidae) is characterized by "insertion plates pectinated," and the three others (Ischnochitonidae, Mopaliidae, and Schizo-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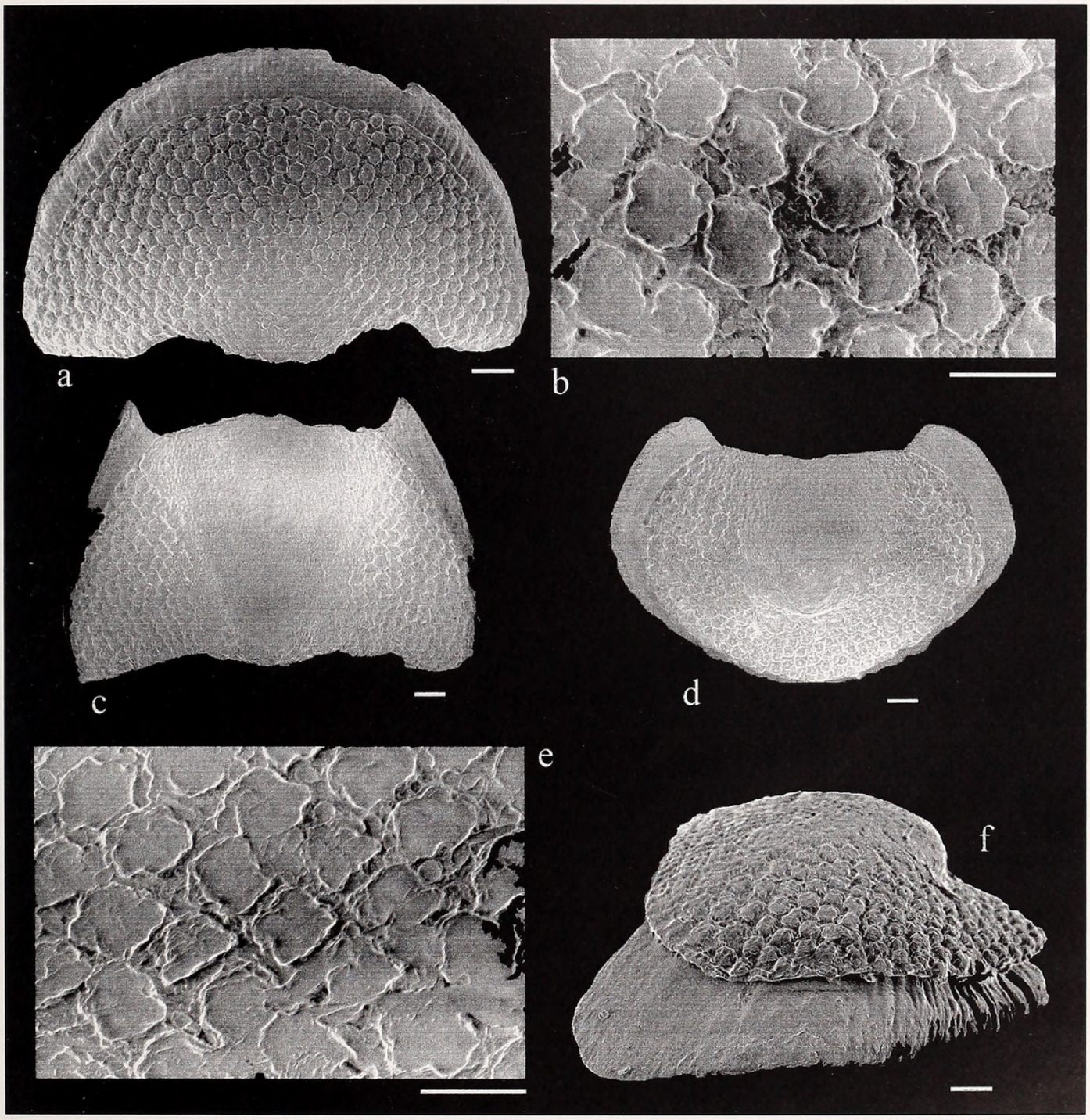

Figure 3. *Weedingia mooreana,* holotype MNHN. **a**. Head valve, scale bar = 100 μm. **b**. Microsculpture of head valve, scale bar = 50 μm. **c**. Intermediate valve, scale bar = 100 μm. **d**. Tail valve, scale bar = 100 μm. **e**. Microsculpture of tail valve, scale bar = 50 μm. **f**. Tail valve, lateral view, scale bar = 100 μm.

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Figure 2. *Weedingia* cf. *mooreana*. **a**. Head valve, scale bar = 100 μm. **b**. Microsculpture of head valve, scale bar = 50 μm. **c**. Intermediate valve, scale bar = 100 μm. **d**. Intermediate valve, lateral view, scale bar = 100 μm. **e**. Tail valve, scale bar = 100 μm. **f**. Tail valve, lateral view, scale bar = 100 μm. **g**. Microsculpture of tail valve, scale bar = 50 μm.

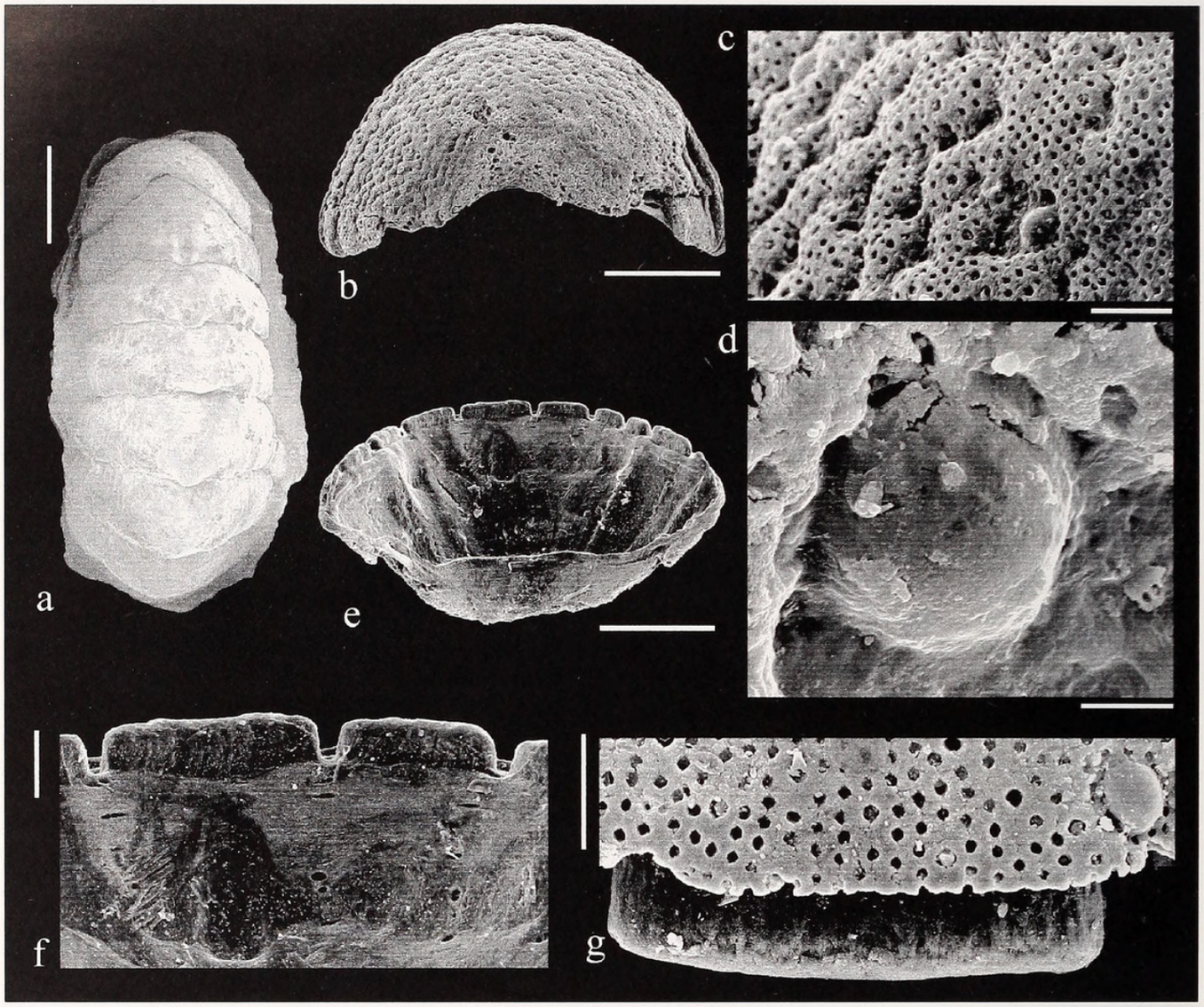


Figure 4. ***Rapanuia disalvoi*** Dell'Angelo, Raines & Bonfitto, gen. & sp. nov. **a**. Holotype MZB 40669, scale bar = 1 mm. **b–g**. Paratypes MZB 40672. **b**. Head valve, scale bar = 500 μm. **c**. Microsculpture of head valve, scale bar = 500 μm. **d**. Head valve, ocelli, scale bar = 10 μm. **e**. Head valve, ventral side, scale bar = 500 μm. **f**. Head valve, insertion lamina, scale bar = 100 μm. **g**. Head valve, tooth of insertion lamina, scale bar = 50 μm.

chitonidae) by "insertion plates not pectinated." Our species belongs to the family Ischnochitonidae (Kaas & Van Belle, 1985:7 "The insertion plates of the terminal valves are multifissurated, those of the intermediate valves have one or more fissures, the teeth are not pectinated") on the basis of articulamentum characters (lacking of a terminal sinus in tail valve, but present in Mopaliidae and Schizochitonidae).

The family Ischnochitonidae is divided into six subfamilies (Kaas & Van Belle, 1985: Ischnochitoninae, Schizoplacinae, Chaetopleurinae, Lepidochitoninae, Callochitoninae, and Callistoplacinae), of which only one (Callochitoninae) is characterized by the presence of ocelli. Callochitoninae are nevertheless also characterized by other important characters (such as the apophyses is either connected or continuous across a shallow jugal sinus, the girdle is covered with small, imbricating, inwardly directed spicules, and a different tegmentum sculpture) which are not present in our species. It is consequently necessary, in our opinion, to define a new subfamily and a new genus to correctly assign our species to a supraspecific taxon.

Genus ***Rapanuia*** Dell'Angelo, Raines & Bonfitto, gen. nov.

Type species: ***Rapanuia disalvoi***, sp. nov.

Diagnosis. As for subfamily

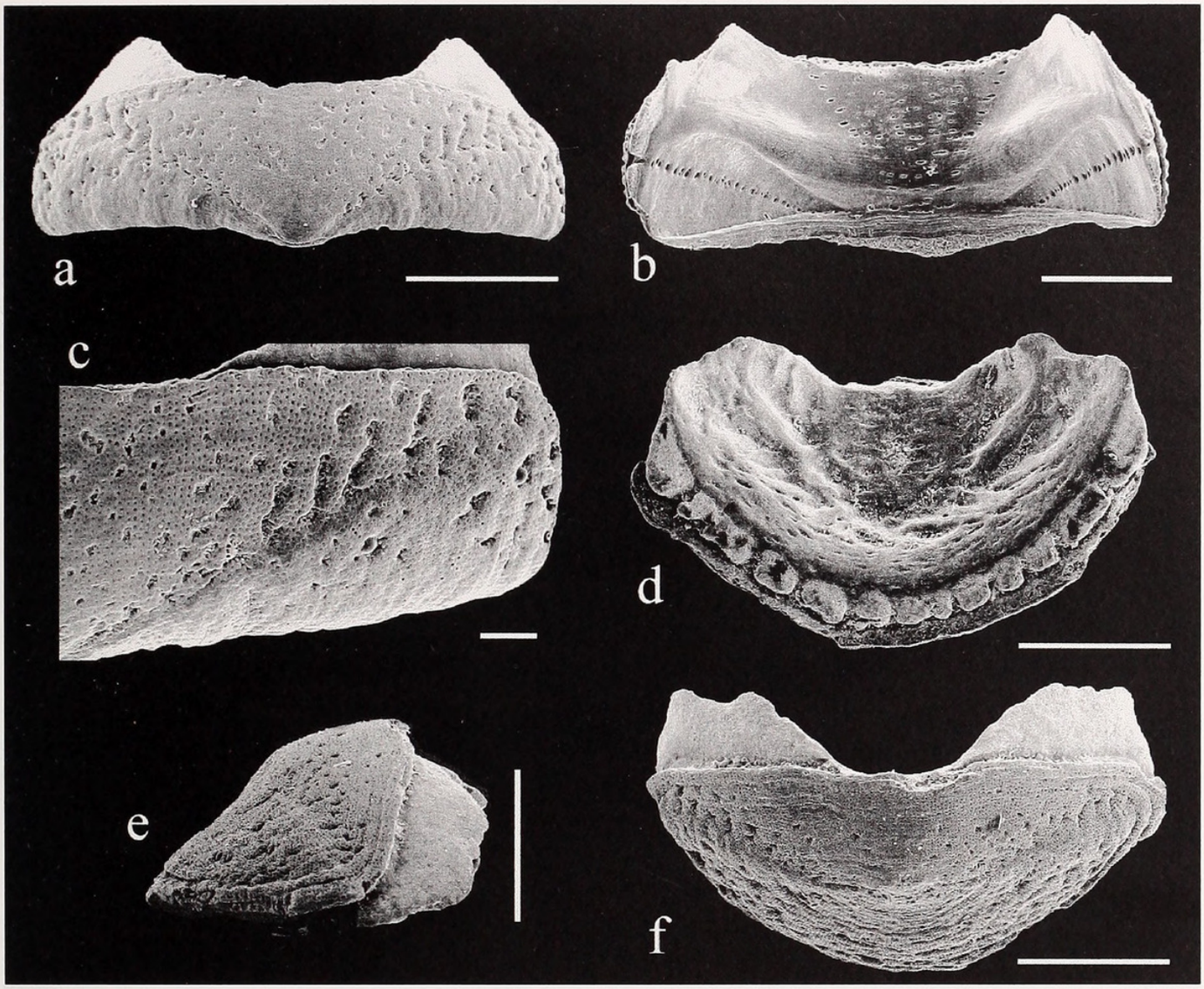


Figure 5. ***Rapanuia disalvoi*** Dell'Angelo, Raines & Bonfitto, gen. & sp. nov. paratypes MZB40672. **a**. Intermediate valve, scale bar = 500 μm. **b**. Intermediate valve, ventral side scale bar = 500 μm. **c**. Intermediate valve, right side, scale bar = 100 μm. **d**. Tail valve, ventral side, scale bar = 500 μm. **e**. Tail valve, lateral view, scale bar = 500 μm. **f**. Tail valve, scale bar = 500 μm.

Etymology: From Rapa Nui, the local Polynesian name for Easter Island.

Occurrence: Known only from Easter Island.

Rapanuia disalvoi Dell'Angelo, Raines & Bonfitto, sp. nov.

(Figures 4–6)

Tonicia sp.; DiSalvo et al., 1988:459.

Material examined: Hanga Nui: 4 specimens in alcohol, slightly curled, the larger 5.3 × 2.8 mm (1 specimen disarticulated for SEM photos, 4.5 × 2.4 mm), 3 specimens dry, 4.7 × 2.5 mm, 3.5 × 2.2 mm (disarticulated for SEM photos) and 3 × 1.9 mm (curled) (leg. L. DiSalvo 1984–85); Hanga Roa: 346 valves, 58 anterior (maximum width 2 mm), 257 intermediate (maximum width 2.7 mm) and 31 posterior (maximum width 1.8 mm) (leg. B. Raines 1998–2000).

Type material: Holotype: MZB 40669, 1 dry specimen (4.7 × 2.5 mm). Paratypes: MZB, radula (MZB 40670) and gridle from alcohol preserved specimen disarticulated (MZB 40671), 15 valves (MZB 40672); LACM 2961, 1 dry specimen (3 × 1.9 mm), 1 alcohol preserved specimen, radula and girdle from the dry specimen disarticulated, 15 valves; ANSP, 1 alcohol preserved specimen (ANSP A19983), 15 valves (ANSP 410691); MNHN, 1 alcohol preserved specimen, valves from the dry specimen disarticulated, 15 valves; ZSM 20021636, 15 valves;

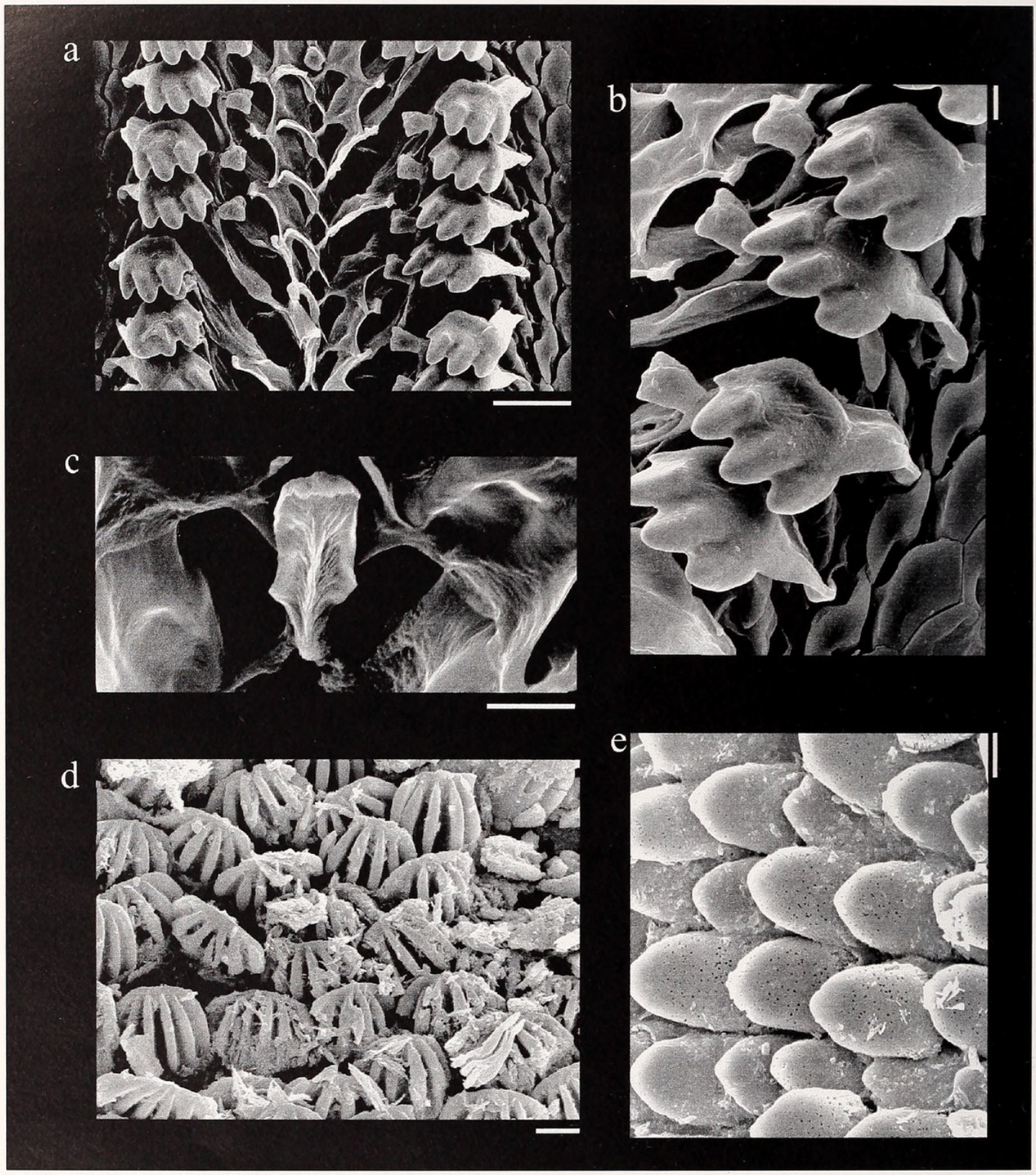


Figure 6. ***Rapanuia disalvoi*** Dell'Angelo, Raines & Bonfitto, gen. & sp. nov. paratypes MZB40670. **a**. Radula, scale bar = 50 μm. **b**. Radula, accessory plate of the second lateral, scale bar = 10 μm. **c**. Radual, central tooth, scale bar = 10 μm. Paratypes MZB 40671. **d**. Girdle, dorsal scales, scale bar = 10 μm. **e**. Girdle, ventral scales, scale bar = 10 μm.

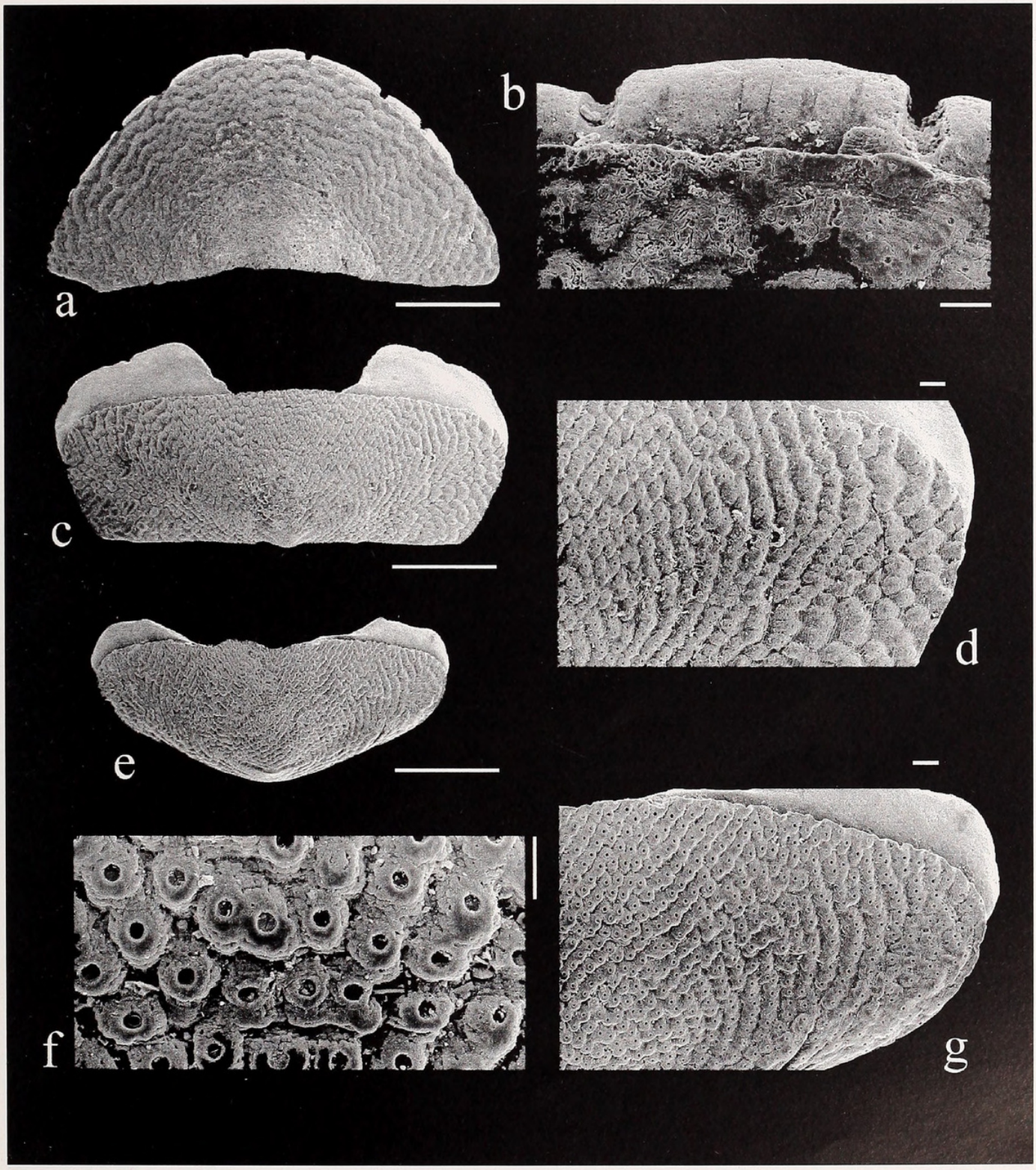
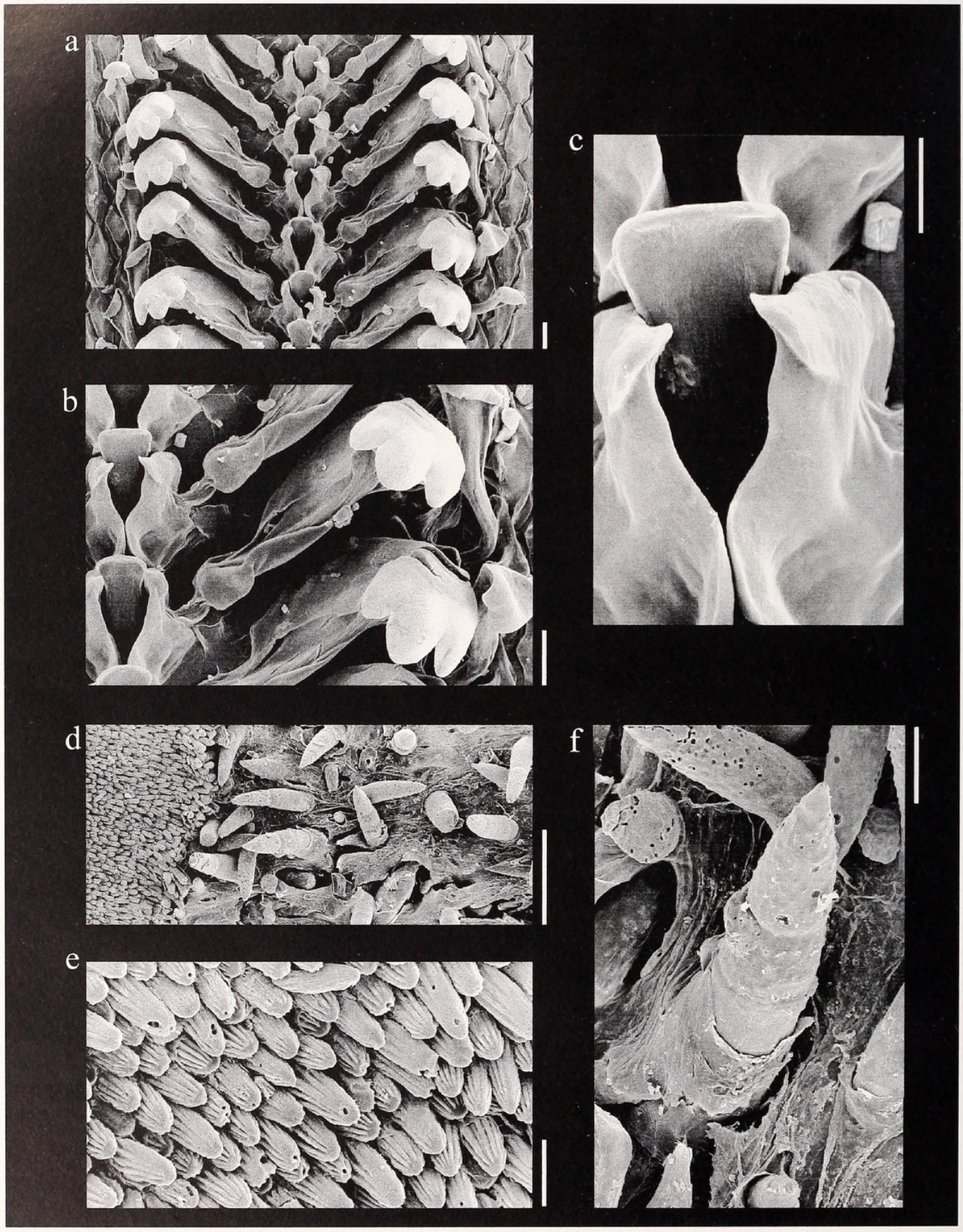


Figure 7. *Plaxiphora mercatoris*. (MZB 40667) **a**. Head valve, scale bar = 1 mm. **b**. Head valve, tooth of insertion lamina, scale bar = 100 μm. **c**. Intermediate valve, scale bar = 1 mm. **d**. Microsculpture of intermediate valve, scale bar = 100 μm. **e**. Tail valve, scale bar = 1 mm. **f**. Aesthetes of tail valve, scale bar = 50 μm. **g**. Microsculpture of tail valve, scale bar = 100 μm.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BDA 4607, 1 alcohol preserved specimen, 15 valves; BR 1021, 1 alcohol preserved specimen, 15 valves.

Diagnosis: Animal oval, small, maximum length 5.3 mm, normal length 3–4.5 mm, moderately elevated (dorsal elevation 0.4–0.48), profile from regularly round to subcarinate. Color of tegmentum and girdle cream to light brown, always with lighter marblings, with darker stains on the lateral areas of the valves near the girdle.

Description: Anterior valve almost semicircular, with posterior edge shaped like inverted V. Intermediate valves broadly rectangular, subcarinated, front margin slightly concave in wide central part, convex at the pleurae, hind margin almost straight with apex little pronounced, lateral areas hardly raised. Tail valve small, semi-elliptical, hind margin slightly convex, mucro at anterior third of valve. Tegmentum with succession of small undulations or small warty rugosities, giving to whole area a rough appearance. Only some very short scars present in pleural areas along margin of lateral areas. Ocelli rounded, black, 25 μm diameter, from 10 to 20 randomly disposed in anterior plates of medium width (1.2–1.6 mm), more numerous (30–40) in larger anterior plates (width 1.8–2 mm), mostly disposed in about 10 radial rows. Four ocelli present in lateral areas of intermediate valves, in a single row toward apex, and also in posterior valve some ocelli present, less visible than in other valves. Aesthetes very dense, not separable in macro- and microaesthetes, of similar width, radially disposed in head valve, lateral areas of intermediate valves and postmucronal area of tail valve, longitudinally in central areas of intermediate valves and antemucronal area of tail valve. Articulamentum white, porcelaneous, apophyses rounded, trapezoidal in tail valve, jugal sinus wide. Insertion lamina divided into rather large, irregular teeth, not pectinated. Slit formula 8–9/1/8–11. Girdle densely covered with small round-topped rectangular imbricate scales, 22–27 × 17–20 μm, ornamented with six marked ribs that do not reach base of scales. Ventrally, girdle covered with small imbricate scales, smooth, round-topped, about 39 × 18 μm. Central tooth of radula elongate, with small blade, first lateral tooth slender, major lateral with tricuspid cap, denticles uniform in length.

Etymology: The species has been named in honor of Luis DiSalvo, who first discovered it.

Occurrence: Known only from the type locality.

Discussion: The living specimens of ***Rapanuia disalvoi*** were collected in 1984–1985 by Louis DiSalvo at Hanga Nui in a particular habitat, "sand hummocks" (DiSalvo et al., 1988: "In water 1 to 2 m deep, great expanses of sand were bound by chaetopterid polychaete tubes often forming hummocks provided spatially complex microhabitats where a variety of juvenile invertebrates took refuge. The invertebrates included juveniles of the chiton *Plaxiphora mercatoris* . . . and juveniles of the chiton *Tonicia sp.*"). In November 1985, DiSalvo Sent several specimens to Dr. Antonio Ferreira, who examined them and concluded that they were juveniles of an unidentifiable *Tonicia* species. However, despite all additional efforts by DiSalvo or Raines, they have not been able to find any specimens larger than 5.3 mm. Even single plates of dead specimens have been no larger. Up to now, the only living specimens found are those collected by DiSalvo. The maximum width of the 346 valves found are 2 mm (head), 2.7 mm (intermediate), and 1.8 mm (tail). The width of the valves of the dry specimen disarticulated (4.5 mm length) are, respectively, 1.8, 2 and 1.6 mm. After examining all of the available material, there are no reasons to think that the present material is juvenile. Unfortunately, many of the living specimens collected by DiSalvo did not preserve well, and the valves are unusable.

R. disalvoi, at first, appears similar to *Tonicia*, a genus belonging to family Chitonidae (and so characterized by "insertion plates pectinated"), especially in the tegmental sculpture, the presence of ocelli, and general appearance. However, the absence of pectination on the teeth of the insertion lamina leads us to define the new genus ***Rapanuia*** and the new subfamily **Rapanuiinae**. We have found no evidence in literature on the possible age variation in teeth pectination in *Tonicia,* and the absence of any trace of pectination in all the 346 valves examined seems quite significant to us. Moreover, other characters in *Rapanuia* are different from *Tonicia,* i.e., the girdle formations and the radula, with a quadricuspid major lateral typical in *Tonicia.*

The only paper found in literature showing changes in morphology during the early growth stages of a chiton species is that by O'Neill (1984) for the New Zealand species *Onithochiton neglectus* de Rochebrune, 1881. The genus *Onithochiton,* along with *Tonicia,* belongs to the subfamily Toniciinae in the family Chitonidae (Van Belle, 1999), which is also characterized by "insertion plates pectinated." By examining a series of *O. neglectus* specimens, in the transition phase between "juvenile" (1–4 mm) and "adult," O'Neill noted that changes had occurred in the radula, gills, tegmental color, mucro, ocelli, and the girdle elements. However, no variation of the pec-

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Figure 8. *Plaxiphora mercatoris.* (MZB 40673) **a**. Radula, scale bar = 100 μm. **b**. Radula, scale bar = 100 μm. **c**. Radula, central tooth, scale bar = 50 μm. **d**. Girdle, dorsal scales, scale bar = 500 μm. **e**. Girdle, ventral scales, scale bar = 50 μm. **f**. Girdle, dorsal scales, scale bar = 100 μm.

tinate insertion plates was recorded in the juvenile chitons described in O'Neill's paper.

Family Mopaliidae Dall, 1889

Subfamily Mopaliinae Dall, 1889

Genus *Plaxiphora* Gray, 1847

Subgenus *Mercatora* Leloup, 1942

Plaxiphora (Mercatora) mercatoris Leloup, 1936

(Figures 7,8)

Plaxiphora (Poneroplax) mercatoris Leloup, 1936:1, figs. 1–9.

Plaxiphora mercatoris; Martin & Poppe, 1989:5, fig. p. 6; Osorio Ruiz et al., 2000:41; Slieker, 2000:92, fig. 12.

Plaxiphora (Mercatora) mercatoris; Leloup, 1942:40, fig. 18J; Burghardt, 1971:66; Rehder, 1980:16, pl. 4, fig. 1; Osorio & Cantuarias, 1989:304; Kaas & Van Belle, 1994:315, fig. 128.

Acanthopleura brevispinosa; Lamy, 1936:267 [non *Acanthopleura brevispinosa* (Sowerby, 1840)].

Material examined: Anakena: 4 specimens, 35 × 21.5 mm (MZB 40673), 23.3 × 18.6 mm (collected by B. Raines and M. Taylor from rocks at low tide, March 1998), the two others are smaller and strongly curled up (coll. B. Dell'Angelo); 8 valves (1 specimen disarticulated); 46 smaller valves, 10 anterior (maximum width 5 mm), 37 intermediate (maximum width 6.5 mm) and 9 posterior (maximum width 3.5 mm) (coll. B. Dell' Angelo): 10 smaller valves (MZB 40667).

Description: The overall description reported by Kaas & Van Belle (1990) fits the characters of this species quite well. Since the tegmentum is normally severely eroded in large specimens, we have illustrated a few smaller valves where the sculpture is clearly visible. The granules are small, rounded, sometimes coalescing, with a single aesthete in the center (see figure 7f). Referring back to Kaas & Van Belle (1990), we find some discrepancies regarding the description of the radula, and figure 8 of their document is incorrect. See Figure 8 of this paper, and note particularly the shape of the blade of the first lateral tooth.

Discussion: *Plaxiphora mercatoris* is endemic to Easter Island and Sala y Gomez, and is commonly found in the rocky system from mid to low intertidal with densities between 1 and 8 individuals/m^2 (Osorio Ruiz et al., 2000).

Acknowledgments. We express our sincere appreciation to Luis DiSalvo for providing photocopies of his notes, and examples of the specimens he collected. We also thank Bruno Anseeuw (Merelbeke, Belgium) and Yves Terryn (Gent, Belgium) for the information and the help given for the present work; Boris Sirenko (ZISP), Bruno Sabelli (MZB), and Karen Gowlett-Holmes (CSIRO Division of Marine Research, Tasmania) for comments and suggestions in preparation of this paper and for critically reviewing it. Finally, we thank Philippe Bouchet and Virginie Héros (MNHN) for the loan of the type material of *Weedingia mooreana*.

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