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Coral-inhabiting barnacles (Cirripedia; Thoracica; Balanomorpha; Pyrgomatinae) from east of 150°W

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Abstract

The absence of coral-inhabiting barnacles in the eastern Pacific has been generally accepted. Examination of corals collected on seven islands of French Polynesia, presently found in the collection of the Muséum national d'Histoire naturelle, Paris, revealed the presence of four known species of coral-inhabiting barnacles, *Cantellius tredecimus*, *Trevathana dentata*, *T. paulayi*, and *Neotrevathana elongata*, and two new species, *Trevathana tureiae* and *Savignium tuamotum*. The present report extends the distribution of the pyrgomatines further east and south of their previously documented distribution.

Keywords: Coral barnacles, French Polynesia, Pyrgomatinae

Introduction

The subfamily Pyrgomatinae accommodates the Indo-Pacific coral-inhabiting barnacles. Gruvel (1912, p 350) reported *Trevathana* (*Pyrgoma*) *dentata* from Gambier, French Polynesia, in the collection of the Muséum national d'Histoire naturelle, Paris (MNHN). For nearly a century this was the only report of coral-inhabiting barnacles east of the Line Islands (Ross and Newman 2002). A comprehensive geographic distribution of the coral-inhabiting barnacles was first compiled by Ross and Newman (1973), who presented distribution maps and noted that in the Pacific, pyrgomatines are absent east of 160°W longitude, with the exception of the single record of *Pyrgoma* east of 150°W (Gruvel 1912). Since this publication, more papers compiling data on the distribution of coral barnacles, based on literature records and various collections, have been published but with no mention of these barnacles east of 160°W (Ogawa and Matsuzuki 1992). In their analysis of coral barnacles, Ross and Newman (2002), referred only to the single case mentioned by Gruvel (1912). The absence of coral-inhabiting barnacles in the eastern Pacific has been generally accepted, and supported by the absence of barnacles from the well-studied Hawaiian corals. Recent examination of corals in the MNHN revealed that the apparent absence of these barnacles from east of 160°W is due to the lack of examination of material from this region. In the present paper, we report the occurrence of four known species of

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pyrgomatines, *Cantellius tredecimus*, *Trevathana dentata*, *T. paulayi*, and *Neotrevathana elongata* and describe two new species, *Trevathana tureiae* and *Savignium tuamotum*. The specimens were collected from 11 coral samples collected on seven islands of French Polynesia by Jean-Pierre Chevalier. This extends the distribution of pyrgomatines further east and south than their previously recorded distribution.

Material

The corals used for the present study form a part of the “Chevalier collection” in the Muséum national d’Histoire naturelle, Paris, France (MNHN). All corals were collected and determined by Jean Pierre Chevalier. The coral number in the coral collection and field number given by Chevalier are presented. Details are taken from Chevalier’s notebooks kept at the MNHN and references to the notebooks are given in square brackets; the number of the note book is given in roman numbers, pages in arabic numbers. Localities are presented on the map of French Polynesia (Figure 1).

Methods

The wall plates and opercular valves were removed from the coral, immersed for about 2 h in household bleach, then rinsed in tap water followed by distilled water. The specimens were examined under the dissecting microscope, adhering chitin was removed using

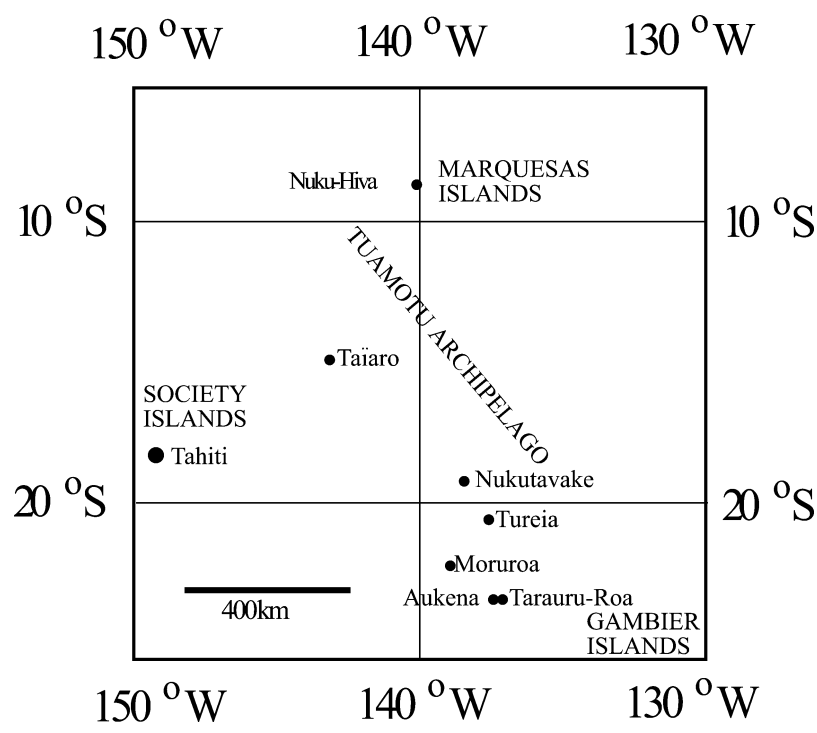


Figure 1. Collection sites of coral-inhabiting barnacles in French Polynesia. Location of Tahiti is marked for reference.

needles and fine forceps and then dried on a small hot plate at 80°C. Dried samples were mounted on brass stubs, coated with gold, and examined with a JEOL scanning electron microscope at 25 kV. Images were copied and stored using Autobeam software.

Barnacle material is deposited in the crustacean collection of the MNHN, and the corals are found in the coral collection of the MNHN. Two sub-samples are kept in the zoological collection of the Hebrew University of Jerusalem, Israel (HUJI).

Cantellius tredecimus (Kolosvary, 1947)
(Figure 2)

Synonymy

Creusia spinulosa forma *tredecima* Kolosváry 1947, p 426, Figure 1.

Cantellius tredecimus Ross and Newman 1973, p 153, Figure 7s, t.

Material examined

MNHN-Ci 2956 from *Montipora verrilli* MNHN-Scle 20280 (field number MRq 26 g; [T X, p 2048]). Shell plates of four specimens, three scuta and one tergum. French Polynesia; Marquesas Islands; Nuku-Hiva Island; Baie des Tai(h)oa (Tai-o-hae) W of Anse Hakatea, between W Sentinelle and E Sentinelle; 8°49'S, 140°12'W, 3 March 1973, coll. Chevalier; MUSEUM IX Expedition.

Description

Wall white, conical, made of four compartments; rostro-carinal diameter to 4 mm; external surface covered with coral skeleton. Rostrum wider than carina; orifice diamond shape, slightly tapered at rostral and carinal ends; rostro-carinal axis of orifice about one-quarter of that of wall. Internal surface of wall smooth, sutures clearly discernible; sheath forming inner lamina, extending halfway to basal edge, growth ridges on sheath. Marginal radial septa tall, denticulate, inserting in grooves of basis. Basis white, solid, thin, shallow;

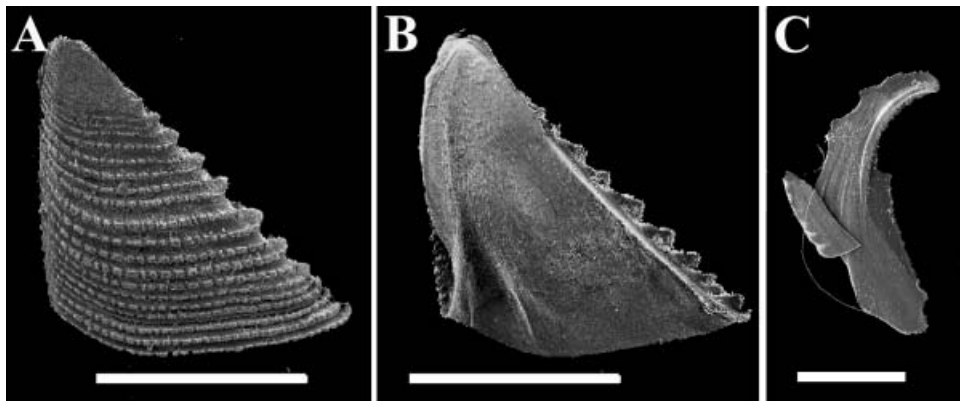


Figure 2. *Cantellius tredecimus* from Marquesas Islands; Nuku-Hiva Island. (A) Scutum, outer view; (B) scutum, inner view; (C) tergum inner view, tergum is damaged. Scale bars: 1 mm (A, B); 0.5 mm (C).

longitudinal ridges slightly sulcate separated by narrower grooves; ridges with a series of coarse parallel growth lines.

Opercular valves white; scutum triangular, growth ridges on outer surface coarse, crossed by fine striae, ridges forming teeth on occludent margin; adductor ridge, adductor pit and rostral tooth absent; articular ridge about three-quarters length of tergal margin; pit for lateral depressor at basi-tergal angle.

Distribution

Singapore, Indonesia, Great Barrier Reef, French Polynesia.

Remarks

Cantelius tredecimus was described by Kolosváry (1947) from *Tridactphyllia lactuca* from Singapore. Ogawa and Matsuzaki (1992) mentioned this species only from unidentified *Montipora*, which agrees with the present findings. Achituv (unpublished) surveyed the coral collection of the Museum of Natural History, Leiden, The Netherlands, which is based mainly on corals from Indonesia and found *C. tredecimus* on 20 species of corals from 13 genera, including *Montipora*.

***Trevathana paulayi* Asami and Yamaguchi, 2001** (Figure 3)

Synonymy

Trevathana paulayi Asami and Yamaguchi 2001, p 20, Figures 1–3.

Material examined

Sample lost after examination and description, from *Acanthastrea* sp. MNHN-Scle 20283 (field number GAM 94 c; [T IX, p 1691]). Two specimens; shells and opercular valves. French Polynesia; Gambier Islands; Aukena Island; 23°07'S, 134°54'W; Tauna reef, depth 0.2–0.3 m, 3 May 1969, coll. Chevalier; MUSEUM VI Expedition.

Description

Wall oval, with radial ribs, rostro-carinal diameter to 5 mm. Reddish purple, the area between the two rostral radial ribs white, orifice oval. Scutum transversally elongated, growth lines distinct, short broad articular ridge, no occludent ledge. Tergum nearly quadrangular, no external furrow, indistinct spur, internal tooth blunt.

Distribution

Guam, French Polynesia.

Remarks

Trevathana paulayi was recently described by Asami and Yamaguchi (2001). This species is distinguished from *Trevathana dentata* by the reddish purple colour of its shell, the lack of occludent ledge on the scutum and the lack of internal tooth in the tergum. The type

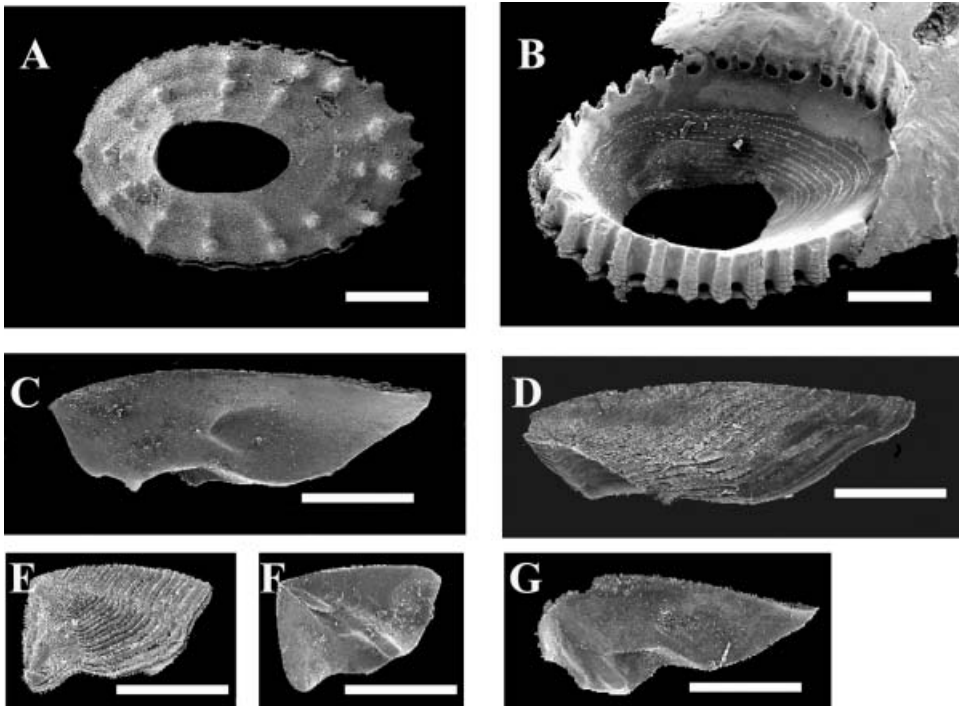


Figure 3. *Trevathana paulayi* sample lost, from Gambier Islands; Aukena Island. (A) Shell outer view; (B) shell inner view showing part of basis and interlocking; (C) scutum inner view; (D) scutum outer view; (E) tergum external view; (F) tergum inner view; (G) scutum and tergum attached showing position of internal tooth. Scale bars: 1 mm.

location of *T. paulayi* is Guam. It was not reported from other localities and the present report indicates that this species is found only in the eastern Pacific. Ross and Newman (2002) noted that the restricted distribution of some pyrgomatines might be an artefact due to lack of information. However, examination of the rich coral collection from Indonesia in the Museum of Natural History in Leiden, The Netherlands (Y. Achituv, unpublished), did not reveal any specimen of *Trevathana paulayi* supporting the hypothesis that this barnacle is restricted to the eastern Pacific.

Trevathana dentata (Darwin, 1854)

Synonymy

Pyrgoma dentatum Darwin 1854, p 369–370, Plate 13, Figure 3a–g.

Savignium dentatum: Ross and Newman 1973, p 159, Figure 17h–k.

Trevathana dentatum: Anderson 1992, p 329, 336, Figures 38L, 39.

Trevathana dentata: Asami and Yamaguchi 1997, p 13, 14, Figures 1, 2.

Material examined

MNHN-Ci 2957 from *Montastraea* or *Favia* sp. MNHN-Scle 20272 (field number TUR 6 c; [T VI, p 1067]). Eight specimens, shells, opercular valves and broken shells; bases left on

original coral. French Polynesia; Tuamotu Archipelago; Tureia Island; NE coast of the atoll; 20°50'S, 138°33'W, 4 November 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

MNHN-Ci 2958 and HUJI Cirr-222 from *Favia fava* MNHN-Scle 20275 (field number GAM 43 b; [T VI, p 1132]). Five specimens; shells, opercular valves and broken shells; bases left on original coral. French Polynesia; Gambier Islands; Tarauru-Roa Island; 23°07'S, 134°52'W; NW point of outer reef, 17 November 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

MNHN-Ci 2959 from *Favia* sp. MNHN-Scle 20269 (field number MUR 177c; [T VIII, p 1619]). French Polynesia; Tuamotu Archipelago; Moruroa Island, Viviane Bay; 21°53'S, 138°54'W; depth 2–3 m, 14 April 1969, coll. Chevalier; MUSEUM VI (CEA) Expedition.

MNHN-Ci 2960 from *Montastraea curta* MNHN-Scle 20270 (field number MUR 74 f; [T V, p 979]). French Polynesia; Tuamotu Archipelago; Moruroa Island; Giroflée Bay; 21°50'S, 138°57'W, 22 October 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

MNHN-Ci 2961 from *Montastraea* sp. MNHN-Scle 20273 (field number TUR 4 a; [T VI, p 1059]). One specimen, shell and operculum valves, one tergum missing. French Polynesia; Tuamotu Archipelago; Tureia Island, Fakamaru; 20°50'S, 138°33'W, 3 November 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

MNHN-Ci 2962 from *Favites* sp. MNHN-Scle 20274 (field number TUR 11 b; [T VI, p 1071]). French Polynesia; Tuamotu Archipelago; Tureia Island; SW side of the lagoon; 20°50'S 138°33'W, 5 November 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

MNHN-Ci 2963 from *Favia* sp. MNHN-Scle 20289 (field number NUK 20 b; [T VIII, p 1462–1464]). French Polynesia; Tuamotu Archipelago; Nukutavake Island, between the village and NE of beginning point of internal reef plate; 19°17'S, 138°48'W, subtidal to 3 m depth, 23 March 1968; MUSEUM V Expedition.

MNHN-Ci 2964 and HUJI Cirr-221 from *Favia* sp. ? (alternative determination *Montipora curta*). MNHN-Scle 20281 (field number TAI 35 a; [T X, p 1981]). French Polynesia; Tuamotu Archipelago; Taiaro Island; 15°46'S, 144°37'W, exterior reef, sheltered coast, 17 July 1972, coll. Chevalier; MUSEUM VIII Expedition.

MNHN-Ci 2965 from *Montastraea curta*. MNHN-Scle 20282 (field number TAI 1; [T X, p 1935]). French Polynesia; Tuamotu Archipelago; Taiaro Island; 15°46'S, 144°37'W, exterior reef, depth 12.5 m, 10 July 1972, coll. Chevalier; MUSEUM VIII Expedition.

Description

Shell colour variable, white, pale pink to red-purple; form concrescent, oval, maximum carino rostral diameter 6 mm, lateral diameter 4 mm; radiating ribs carrying rows of finger-like projections, maximum four per row. Shell tubiferous, number of radiating tubes equal to number of ribs. Ridges white, primary radial ridges reaching the orifice, secondary ridges reaching halfway from margins to orifice, five to six projections on primary ridges; ridges ending at margins as studs that interlock to basis. Shell internally pink to white, with concentric growth lines. Orifice oval, one-third of carino rostral diameter. Basis embedded in host coral, white, tapering.

Scutum elongated, total length from (and including) tergal tooth 2.5–3 times maximal width. Basal margins sinusoidal; adductor pit distinct; adductor ridge extending beyond basal margin; tergal tooth width about half width of tergal margin. Small protuberances on inner side of tergal tooth. Growth lines on outer surface; oblique, shallow furrow running from middle of tergal margin to middle of basal margin; additional furrow running from middle of tergal margin to basi-occludent angle.

Tergum triangular; growth lines on outer surface; spur short with shallow furrow. Groove running from middle of scutal margin to basi-carinal apex. Inner tooth pointed, located on internal side of spur, perpendicular to basal margin reaching middle of scutal margin. Growth lines inside depression for articulation of tergal tooth.

Distribution

Red Sea, Mauritius, Persian Gulf, Indian Ocean, Andaman Sea, Bay of Bengal, Singapore, Indonesia, Papua New Guinea, Great Barrier Reef, Philippines, Palau Is., Taiwan, Hong Kong, Japan, Niue Islands, Fiji, French Polynesia.

Remarks

Darwin (1854) described three varieties of *Pyrgoma dentatum*. The diagnostic differences between the varieties are mainly based on shape and position of the internal tergal tooth. Examination of the present material as well as material from other localities reveals that there are more “varieties” of *Trevathana dentata*. We also noticed that there are additional differences between the “varieties”: the nature of the external radial ridges of the shell differ in specimens collected from different corals. The ratio between the width and length of the shell may also differ, as well as the shape of the tergal tooth of the scutum. We found that in some cases it was difficult to refer the opercular valves from various barnacles to any of Darwin’s varieties. Examination of the cirri and mouth appendages of *T. dentata* from different corals revealed differences that might justify their separation to different species (Mokady et al. 1999), suggesting that Darwin’s varieties of *T. dentata* and other undescribed “varieties” present a group of related species. Recently, Southward and Newman (2003) emphasized the importance of the “arthropodal characters”, cirral appendages and trophi, in the separation of closely related species. Mokady et al. (1999) also showed that *Trevathana dentata* from different corals are genetically different.

***Trevathana tureiae* Achituv sp. nov.** (Figure 4)

Material examined

Holotype: MNHN-Ci 2966 from *Goniastrea* sp. MNHN-Scle 20271 (field number TUR 6e [T VI, p 1067, 1060]). Opercular valves. French Polynesia Tuamotu Archipelago; Tureia Island; 20°50’S, 138°33’W, 4 November 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

This barnacle was found together with *Neotrevathana elongatum* and *Savignium tuamotum* on the same piece of *Goniastrea*.

Diagnosis

Shell fused, oval, scutum transversally elongated more than four times as long as wide, adductor ridge missing deep adductor ridge, tergum triangular, spur distinct, no inner tooth.

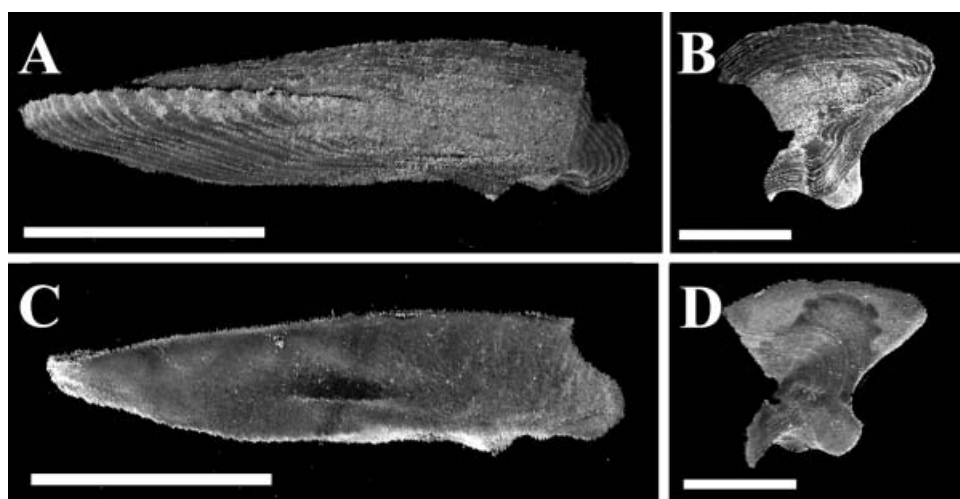


Figure 4. *Trevathana tuariae* from Tuamotu Archipelago; Tureia Island. SEM micrographs of opercular valves. Scale bars: 2 mm (A, B); 1 mm (C, D).

Description

Shell white; fused, flat, oval, rostro-carinal diameter 3 mm; coral skeleton covering most of concentric growth ridges. Scutum and tergum white, separate. Scutum transversally elongate, four times longer than wide, rounded tooth projecting at tergal margin. Outer surface with growth ridges, closed furrow nearly parallel to occludent margin. Inner surface adductor ridge absent, adductor pit deep, elongated; lateral depressor muscle pit elongated, shallow. Tergum triangular, externally with growth ridges, internally with shallow depression accommodating scutal tooth; growth lines inside depression. Spur low, inwardly projecting, teeth absent.

Etymology

The specific name has been derived from the locality where this species was found, Tureia Island.

Remarks

The description and separation of this species is based on the form of the opercular valves. The shell is similar to those of other species of *Trevathana* and it is impossible to separate the species on this basis. The scutum and tergum are similar to those of *Trevathana dentata*, the characters that separate this species from *T. dentata* are the scutum without an adductor ridge. The tergum has spurs that project inward perpendicular to the inner surface of the tergum and does not carry the internal tooth of the tergum. The revised diagnosis of *Trevathana* (Asami and Yamaguchi 2001) indicates the presence of an internal spur tooth. The dominant features of the opercular valves of *Trevathana* are the elongated scutum with prominent rounded tooth projecting at tergal margin that join the tergum, and the triangular tergum. We suggest that the diagnosis of the genus should be amended and would not include the presence of internal tooth of the tergal tooth, this character is specific

to *Trevathana dentata*, a sister species to *Trevathana tureiae*. On the basis of these differences we suggest that they will be assigned to a new species.

Neotrevathana elongatum (Hiro, 1931)
(Figure 5)

Synonymy

Pyrgoma elongatum Hiro 1931, p 154–155, Plate XIV Figure 2, 2b.
Savignium elongatum: Ross and Newman 1973, p 159, Figure 171–n.
Newmania elongatum: Anderson 1992, p 329, Figure 38N.
Wanella elongatum: Anderson 1993, p 377.
Neotrevathana elongatum Ross 1999, p 835, Figure 1.

Material examined

MNHN-Ci 2967 from *Goniastrea* sp. MNHN-Scle 20271 (field number TUR 6e; [T VI, p 1067, 1060]). Four specimens; shells and opercular valves. French Polynesia; Tuamotu Archipelago; Tureia Island; 20°50'S, 138°33'W, 4 November 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

Description

Wall oval, with radial ribs, rostro-carinal diameter to 5 mm. White or pink orifice large oval. Inner surface with growth lines, growth line pear shape with pointed end directed to rostrum, blunt end carinal. Scutum and tergum fused, transversally elongated, no suture between scutal and tergal parts of opercular valves. Opercular valves curved inward, apex pointed. Basal margins sinusoidal, short broad articular ridge, no occludent ledge. Indistinct spur, internal tooth blunt, directed inward, located on basal margins on tergal part of valve. Growth lines on outer surface, no external furrow.

Distribution

Red Sea, Japan, French Polynesia.

Remarks

Neotrevathana elongatum was first described by Hiro (1931) from Japan and Brickner (1994) reported its presence in the Red Sea. The specimens of *Neotrevathana elongatum* were found extracted together with sample MNHN-Ci 2966 and MNHN-Ci 2969 on the same piece of *Goniastrea*.

Savignium tuamotum Achituv sp. nov.
(Figure 6)

Material examined

Holotype: MNHN-Ci 2969 from *Goniastrea* sp. MNHN-Scle 20271 (field number TUR 6e; [T VI, p 1067, 1060]). One specimen; opercular valves. French Polynesia; Tuamotu

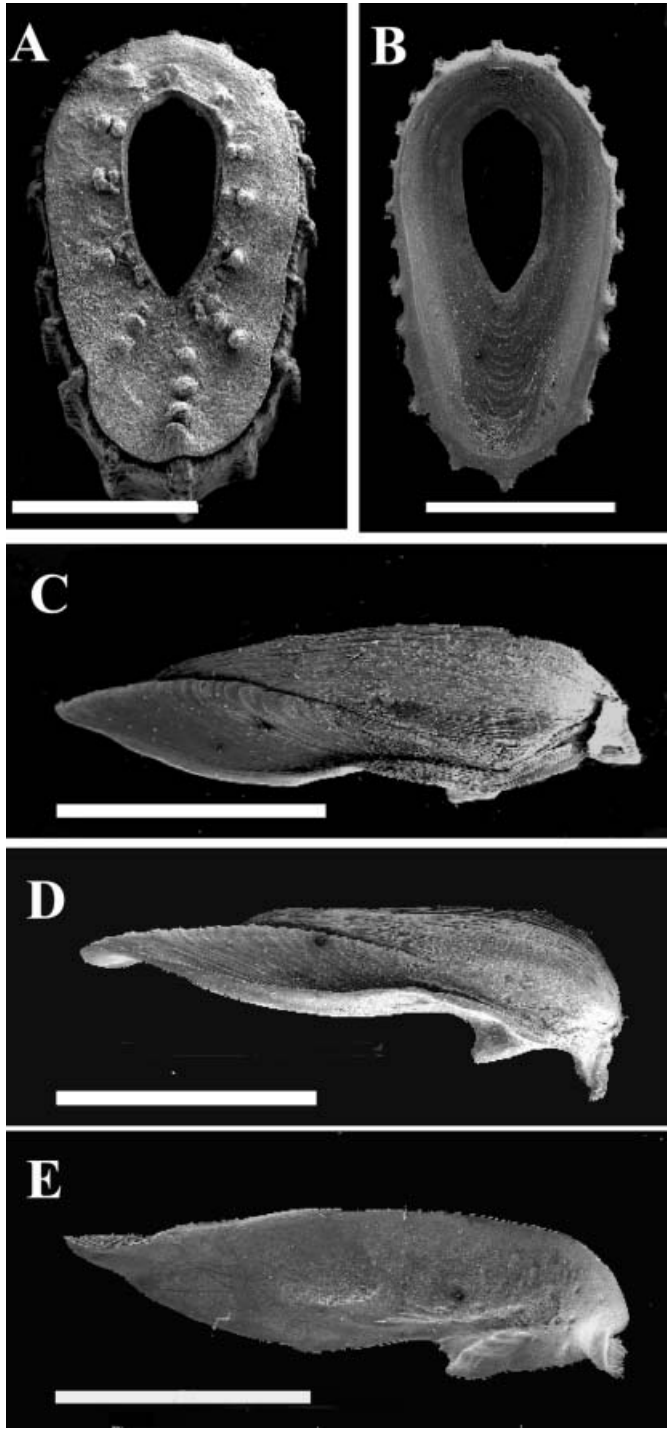


Figure 5. *Neotrevathana elongatum* from Tuamotu Archipelago; Tureia Island. (A) Shell external view; (B) shell inner view; (C) fused scutum and tergum external view; (D) basi lateral view; (E) internal view. Scale bars: 2 mm (A, B); 1 mm (C–E).

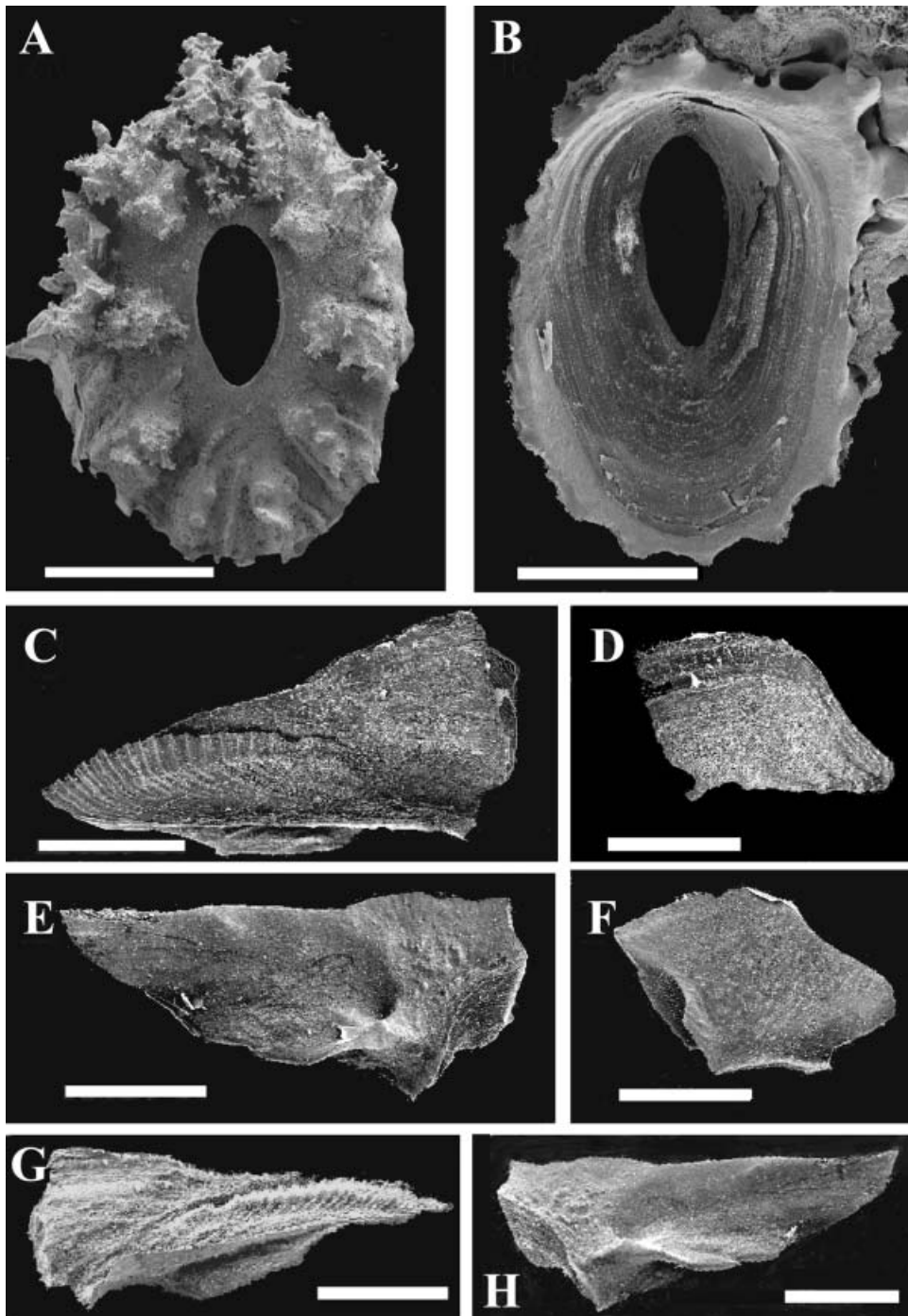


Figure 6. *Savignium tuamotum* from Tuamotu Archipelago; Tureia Island. SEM micrographs. (A) Shell outer view; (B) shell inner view; (C) scutum external view; (D) tergum external view; (E) scutum inner view; (F) tergum inner view; (G) scutum oblique out-lateral view seemed from basal margins, showing basal margins and adductor ridge; (H) scutum oblique in-lateral view seemed from basal margins, showing developed adductor ridge. Scale bars: 2 mm (A, B); 1 mm (C–H).

Archipelago; Tureia Island; 20°50'S, 138°33'W, 4 November 1965, coll. Chevalier; MUSEUM II (CEA) Expedition.

The specimen of *Savignium tuamotum* was found together with *Neotrevathana elongatum* (MNHN Ci 2967) and *Trevathana tureiae* (MNHN Ci 2966) on the same piece of *Goniastrea*.

Diagnosis

Shell fused, oval; scutum transversally elongated, externally concave; adductor ridge distinct; tergum quadrangular, spur absent, inner tooth lacking.

Description

Shell white; fused, flat, oval, rostro-carinal diameter 4 mm. Scutum and tergum white, separate. Scutum transversally elongate, about three times longer than wide; externally concave due to basal margins curved upward forming shallow trough along basal margin; growth ridges prominent, mainly at basal margin, growth ridges along basal margins arching towards occludent margin; oblique, long, narrow furrow from middle of tergal margins to middle of occludent margin. Tergal margins with low wide articulation tooth, growth lines on tooth; adductor ridge prominent, projecting beyond basal margins; adductor pit prominent; adductor ridge and basal margins flaring.

Tergum quadrangular; growth line highly eroded, more distinct at scutal margins; spur absent, articular ridge distinct, furrow with growth lines; internally concave resulting from elevation of articular ridge and carinal margins; crests for depressor muscle absent.

Etymology

The specific name has been derived from the locality where this species was found, Tuamotu Archipelago Island.

Remarks

The genus *Savignium* was resurrected by Ross and Newman (1973) to accommodate the pyrgomatine barnacles with a fused, oval shell and a transversally elongated scutum. Originally, this genus included four species. Anderson (1992, 1993) erected two new genera: *Trevathana* that contains the Darwin varieties of *T. dentata*; and *Wanella*, which contains *W. milleporae* Darwin. Anderson (1992) suggested that *Savignium* contained two species, *S. crenatum* with separate opercular plates and *S. elongatum* with calcified opercular valves. Subsequently, Ross (1999) allocated *S. elongatum* to a new genus, *Neotrevathana*. Therefore *Savignium* contain only one species, *S. crenatum*. In *Savignium*, the articular ledge of the scutum is wide and occupies the whole tergal margin, the adductor ridge is developed and projects beyond the basal margins. The material from French Polynesia clearly show these characters but the tergum is different from that of *S. crenatum*, therefore, we deduce that our material is a new species of *Savignium*.

Discussion

Ross and Newman (2002) noted that the greatest number of genera of pyrgomatines occur in Australia, followed by Japan. They believe that this pattern of distribution represents a

collecting bias and does not reflect the real distribution of this group. Our report on the occurrence of four known species of pyrgomatines and two new species in French Polynesia, based on the examination of a limited number of corals, supports the notion of Ross and Newman that the rarity of pyrgomatines in the south-east Pacific is due to inadequate collecting rather than absence of this group from this region. Examination of more corals from areas as yet unstudied may reveal the presence of more pyrgomatines species and change our knowledge of the biogeography of this group. Combined with a study of the distribution of the host corals this information will also shed light on species specificity and the coevolution of these groups.

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