

## New species of Crosseolidae Hickman, 2013 (Gastropoda) from the Tropical Indo-Pacific

Federico RUBIO  
Pintor Ribera, 4-16<sup>a</sup>,  
46930 Quart de Poblet (Valencia), Spain  
federubio@ono.com

Emilio ROLÁN  
Museo de Historia Natural,  
Parque Vista Alegre, Campus Universitario Norte, 15782,  
Santiago de Compostela, Spain  
erolan@emiliorolan.com

**KEYWORDS.** Gastropoda, Crosseolidae, Indo-Pacific, new species.

**ABSTRACT.** Eight new species of crosseolid vetigastropods are described from the Indo-West Pacific: five in the genus *Crosseola* (*C. ordinata*, *C. madagascariensis*, *C. marquesensis*, *C. similiter*, *C. solomonensis*) and three in *Conradia* (*C. discreta*, *C. minor* and *C. abyssa*). All these species are compared to the previously known species in these two genera. Novel patterns of microgranulations are illustrated and are especially useful for diagnosing the new species.

**RESUMEN.** Ocho nuevas especies de crosseólidos vetigastropodos son descritas de las tres expediciones francesas en el Indo-Pacífico oeste. Las nuevas especies de *Crosseola* son: *C. ordinata*, *C. madagascariensis*, *C. marquesensis*, *C. similiter*, *C. solomonensis*, y las nuevas especies de *Conradia* son: *C. discreta*, *C. minor* and *C. abyssa*. Todas las especies son nuevas para la Ciencia y se describen haciendo comparación con las especies previamente conocidas en estos géneros. Un nuevo patrón de microgranulaciones es ilustrado, resultando especialmente útil para la diagnosis de nuevas especies.

### INTRODUCTION

Hickman (2013) defined and described the family Crosseolidae, which is placed in unassigned Vetigastropoda superfamily, and included the genera *Crossea* A. Adams, 1865; *Crosseola* Iredale, 1924; *Conradia* A. Adams, 1860 and *Conjectura* Finlay, 1926, previously placed in Skeneidae by W. Clark (1851). The classification of the family within Vetigastropoda is yet uncertain due to a lack of anatomical and molecular sequence data.

The purpose of this work is to describe new species in two of the genera currently assigned to the family: *Crosseola* and *Conradia*.

Adams' description of the Japanese type of *Crossea* was not accompanied by an illustration and a new genus name *Crosseola* was proposed by Iredale (1924) for the Australasian species. He designated as type species *Crossea concinna* Angas, 1868, from Port Jackson, New South Wales, Australia. *Crossea concinna* was the first of 17 Australian and New Zealand species (both living and fossil) described under *Crossea*.

Adams (1865: 323) originally classified *Crossea* under Epitoniidae (as Scalidae); it was classified later under Scalariidae (Watson, 1886; Tryon, 1888; Tate, 1890) and Trichotropidae (May, 1922). Later Australian and New Zealand systematists treated *Crosseola* species under Trochidae Rafinesque, 1815

(Macpherson & Gabriel, 1962); Liotiidae H. and A. Adams, 1854 (Finlay 1927; Cotton 1959), Cyclostrematidae Fischer, 1885 (Powell 1961, 1979), or Skeneidae Clark, 1851 (Beu & Maxwell, 1990; Hickman and McLean, 1990; Hickman, 1998).

The genus *Conradia* was proposed by A. Adams (1860), who designated *Conradia cingulifera* A. Adams, 1860 as the type species and placed it in the family Fossaridae A. Adams, 1860. Thiele (1929) considered placement of *Conradia* uncertain, including it at the end of Fossaridae. Higo et al. (1999) transferred the genus to Skeneidae.

### MATERIAL AND METHODS

The material used for the present work was obtained during several expeditions in the Indo-Pacific organized by MNHN and IRD in the 2000s-2010s: SALOMON 1 (PI Bertrand Richer de Forges) took place in 2001 aboard RV *Alis* and explored the central islands of the Solomons (Bouchet et al. 2008); in 2010, the expedition ATIMO VATAE (PI Philippe Bouchet) explored Madagascar "Deep South"; and in 2012, the PAPUA NIUGINI expedition (PIs Philippe Bouchet, Claude Payri, Sarah Samadi) explored the Madang lagoon and the Bismarck Sea off the north coast of Papua New Guinea. Some complementary material from French Polynesia was received from Jean Letourneux, a resident of Tahiti.

The shells were photographed at the Scanning Electron Microscopy Center (SEM) in the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo and in the Centro de Apoyo Científico y Tecnológico of the University of Santiago de Compostela (CACTUS).

## SYSTEMATICS

**VETIGASTROPODA** Salvini-Plawen, 1980

Family **CROSSEOLIDAE** Hickman, 2013

**Type genus** *Crosseola* Iredale, 1924.

**Remarks.** Hickman (2013): The diagnostic characters that distinguish this family are features that are otherwise unknown in basic gastropods: the umbilical keel, the pseudo-umbilicus, the reflected anterior portion of the columellar lip, and the characteristic short, shallow anterior canal at the base of the columella. Unusual ontogenetic features occurring in the family include variciform axial thickenings on the shell, descending suture and downturned final aperture, and adult terminal variciform thickening of the outer lip.

The family Crosseolidae currently includes the following genera: *Crosseola* Iredale, 1924; *Crossea* A. Adams, 1865; *Conradia* A. Adams, 1860 and *Conjectura* Finlay, 1926. Living and fossil species.

**Habitat.** Intertidal and shelf depths, microhabitat unknown, shells typically recovered from coarse to medium-fine clastic substrates, shell grit.

Their geographical distribution is predominantly Australasian (*Crosseola*, *Conjectura*); Indo-Pacific and Japan (*Crossea*, *Conradia*).

**Stratigraphic distribution.** Eocene to Recent (Australia and New Zealand); Cretaceous (Africa). Recovered primarily by sieving bulk samples from microfossil-rich horizons.

Genus *Crosseola* Iredale, 1924

*Crosseola* Iredale, 1924: 183, 251 [Type species (by original designation): *Crossea concinna* Angas, 1867. Recent, NSW, Australia].

**Diagnosis** (from Hickman, 2013). Shell small: Maximum adult shell size approximately 5 mm (larger than most crosseolids). Umbilical keel strongly developed and punctate, separated from the columella by a deep narrow groove (pseudo-umbilicus). Columellar lip with prominent basal pit in the type species. Shallow anterior notch prominently developed and projecting from the base of the columella. Sculpture finely cancellate to punctate, resulting from incomplete fusion of axial and spiral elements. Size and spacing of punctae decreasing on

later whorls, also present on thickened labial varix, present only on adults as terminal growth feature.

**Habitat.** It is not well known, the depth is variable from intertidal to 200 m. Only in one case is there mention of a rocky bottom with caves. It was always collected in sand grit.

**Remarks.** Hickman (2013) noted: “The robust, globose to turbinatate shells are easily recognized by the characteristic sculpture, the unique umbilical keel, the narrow pseudo-umbilicus, and the distinctive channeled notch in the basal lip. The prosocline outer lip is shallowly sinuate in some species.”

“Until now, no live animal could be observed and consequently there is no information on its external anatomy. It can be noticed that *Crosseola concinna*, type species of the genus, occurs intertidally at Long Reef, New South Wales, Australia.”

“There are 27 described species of *Crosseola*, 14 from Australia and 13 from New Zealand. Twelve of the species are known only from the Tertiary fossil records. In Australia the first appearance is an undescribed Eocene species (Buonaiuto, 1979). In New Zealand the genus ranges from Miocene (Otaian) to Recent. Bathymetrically it occurs from the intertidal zone to shelf depths. The type species is southern in its distribution, occurring from New South Wales to Tasmania, Victoria, and South Australia. The genus extends into tropical Australia with representatives off Queensland in the Coral Sea.”

Rubio & Rolán (2014) described *Crosseola gorii*, the first species of the genus for the West coast of Africa.

After having examined the photographs of the type material of *Crossea bellula* A. Adams, 1865 (MNHN-IM-2000-31037) and *Crossea cancellata* Tenison-Woods, 1878, we consider that these species belong to *Crosseola* thanks to similar morphological shell characters and their similarity with other species (*C. similiter* n. sp. and *C. favosa* Powell, 1937).

Of the 27 Recent and fossil described species, indicated by Hickman (2013), we have only been able to verify 23 that are listed hereafter and one species that was named in 2014:

### Living species:

*Crosseola bellula* (A. Adams, 1865) from Japan.

*Crosseola concinna* (Angas, 1867) from Australia.

*Crosseola cancellata* (Tenison-Woods, 1878) from Australia.

*Crosseola striata* (Watson, 1883) from Australia.

*Crosseola consobrina* (May, 1916) from Australia.

*Crosseola cuvieriana* (Mestayer, 1919) from New Zealand.

*Crosseola errata* Finlay, 1926 from New Zealand.

*Crosseola favosa* Powell, 1937 from New Zealand.

*Crosseola intertexta* Powell, 1937 from New Zealand.

*Crosseola bollonsi* Dell, 1956 from New Zealand.

*Crosseola pseudocollonia* Powell, 1957 from New Zealand.

*Crosseola foveolata* (Barnard, 1963) from South Africa.

*Crosseola gorii* Rubio & Rolán, 2014 from West Africa.

#### Fossil species:

*Crosseola princeps* (Tate, 1890).

*Crosseola lauta* (Tate, 1890).

*Crosseola semiornata* (Tate, 1893).

*Crosseola sultan* Finlay, 1930.

*Crosseola proerrata* Finlay, 1930.

*Crosseola tenuisculpta* Laws, 1936.

*Crosseola munditia* Laws, 1936.

*Crosseola sinemacula* Laws, 1939.

*Crosseola waitotara* Laws, 1940.

*Crosseola emilyae* Laws, 1950.

*Crosseola henryi* Laws, 1950.

#### *Crosseola ordinata* n. sp.

Fig. 1A-F

**Type material.** Holotype deposited in MNHN IM-2000-32818.

**Material examined.** Papua New Guinea, PAPUA NIUGINI: 1 s, Madang lagoon, Hargun Island, 05°01.4'S-145°48'E, Stn PB22, 22 m, outer slope.

**Type locality.** Papua New Guinea, Madang lagoon, Hargun Island, 05°01.4'S-145°48'E, 22 m, outer slope [PAPUA NIUGINI: Stn PB22].

**Description.** Shell of small size (<2.00 mm), globose to turbate, spire formed by slightly over 3 whorls, separated by a somewhat deep suture.

The protoconch is smooth, has slightly over one whorl and measures 320 µm in diameter. The teleoconch has 2 whorls and its periphery is rounded.

Ornamentation formed by spiral cords and marked growth lines which as they cross each other form in the interspaces an irregular reticulate pattern, whose spaces are of quadrangular shape in the first whorls and rather oval on the last one, forming a coarsely pitted shell surface; inside of the spaces there is a fine spiral thread characteristic of the species.

The cords are thick on the first whorl, with a flattened top; in apertural view 4 or 5 cords can be observed in the beginning of the teleoconch and 25-27 from there to the beginning of the last whorl. A prominent, rounded spiral ridge formed by 5 punctate cords borders and delimits the umbilicus. This is narrow and deep, formed between the periumbilical cord and the columellar lip; inside there is a thick cord that forms a shallow anterior notch, prominently developed and projecting from the base of the columella.

Aperture slightly prosocline; columella arched, reflected towards the umbilicus, with an anterior

channel at the base and a shallow anterior notch. Outer lip sinuous; edge modified by the spiral cords; external margin thickened, variciform; with a parietal angle.

Dimensions: the holotype measures 1.13 mm in diameter and 1.2 mm in height (H/D: 1.06).

**Habitat.** Infralittoral species, dredged at 22 m depth.

**Distribution.** Only known from the type locality.

**Remarks.** *Crosseola ordinata* n. sp. is characterized by its ornamentation composed of quadrangular spaces on the first whorl and oval spaces on the last one; and also by the fine spiral thread that is observed inside these spaces.

Its inclusion in *Crosseola* is due to the fact that it has the morphological characters described by Hickman (2013) for the genus: shell robust, globose to turbate; characteristic punctate or cancellate sculpture; the umbilical keel has a periumbilical cord; the narrow pseudo-umbilicus; the distinctive channeled notch in the basal lip and the prosocline outer lip shallowly sinuate.

**Etymology.** From the Latin *ordinatus* which means "regular, ordered" alluding the ordered sculpture of the shell.

#### *Crosseola madagascariensis* n. sp.

Fig. 2A-E

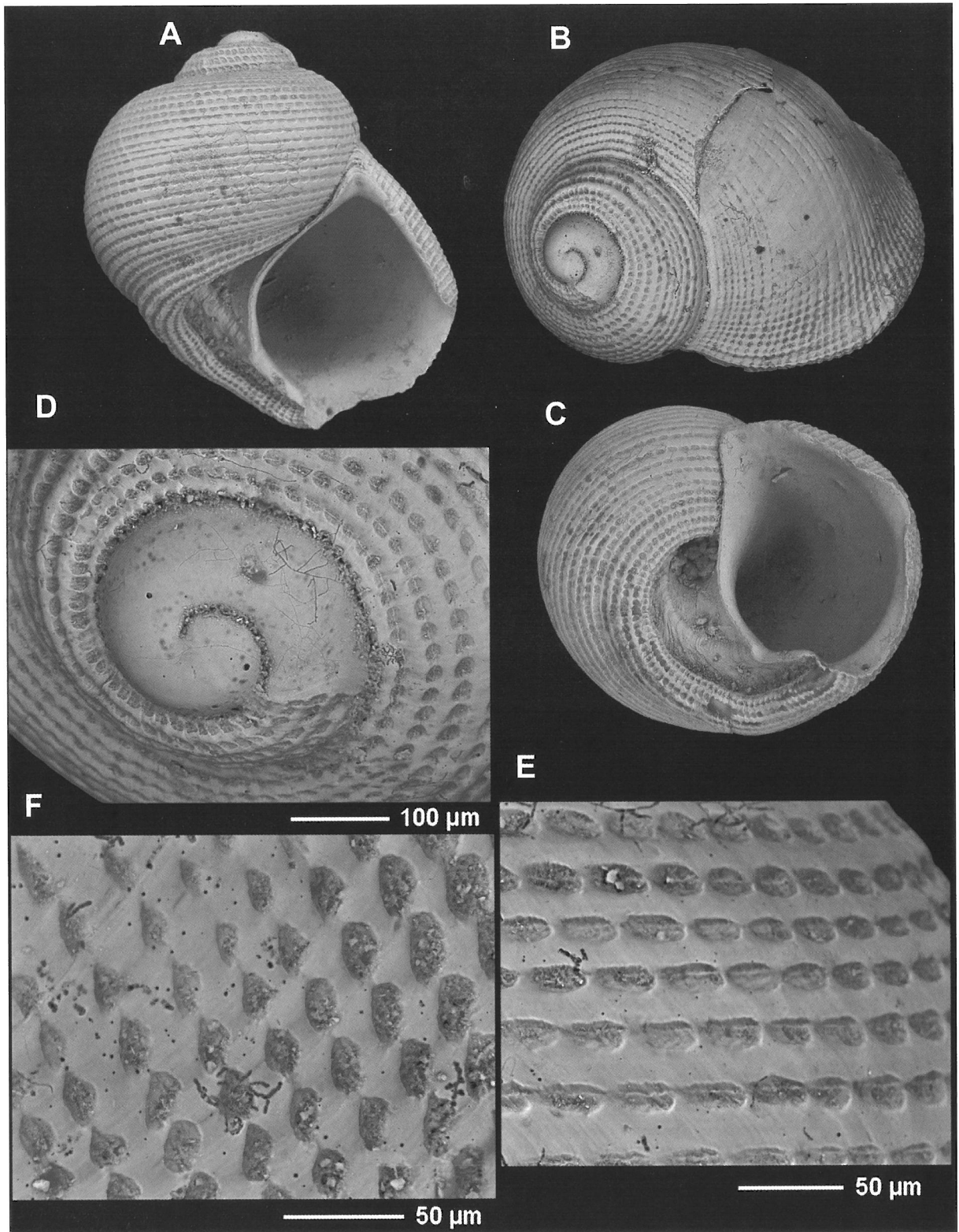
**Type material.** Holotype deposited in MNHN IM-2000-32819.

**Material examined.** South of Madagascar, ATIMO VATAE: 1 s, Baie des Galions, Stn TS16, 25°09.5'S-46°44.9'E, 9-10 m, rock surface with caves.

**Type locality.** Baie des Galions, 25°09.5'S-46°44.9'E, 9-10 m, rock surface with caves [ATIMO VATAE: Stn TS16].

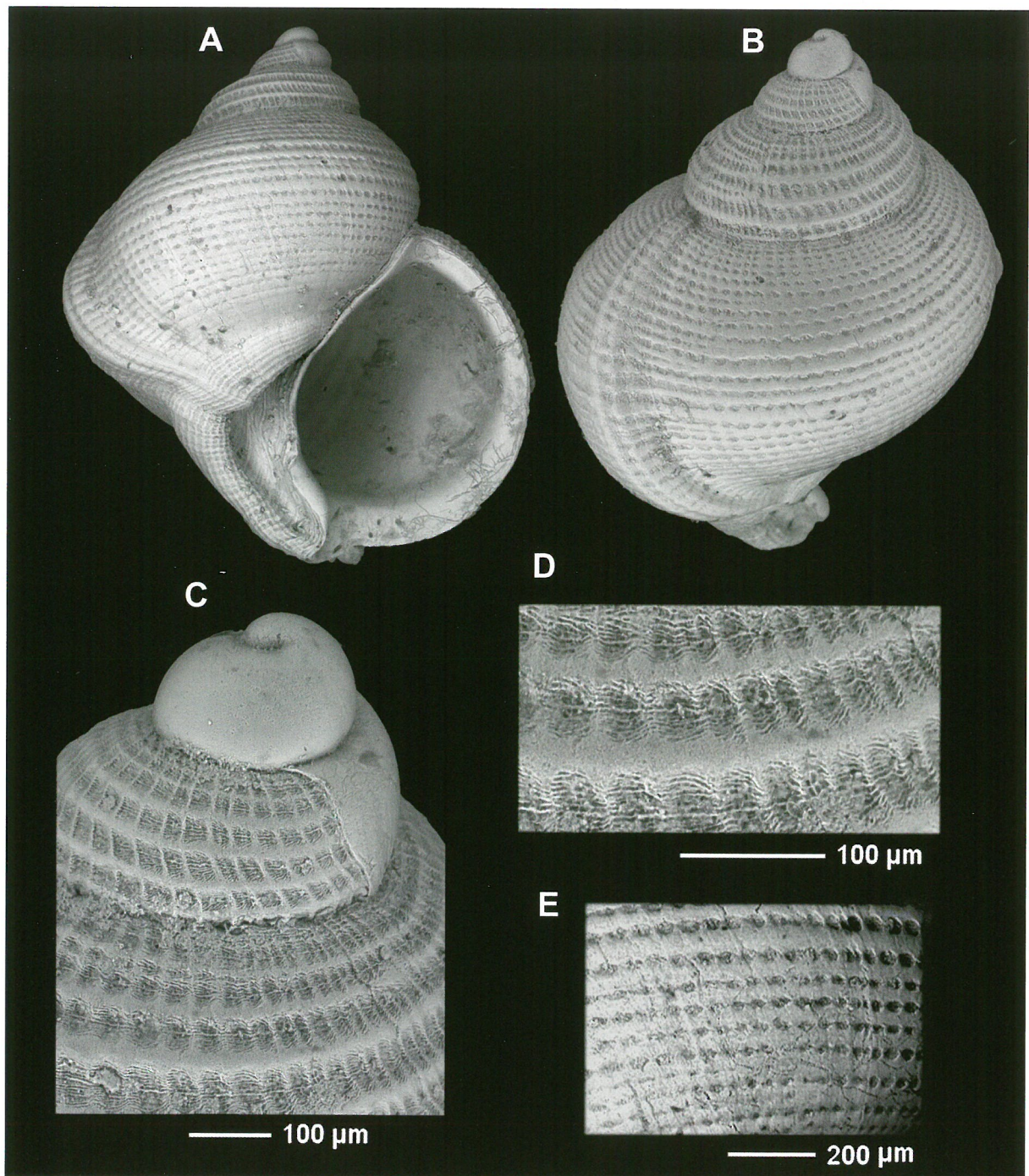
**Description.** Shell of small size (<3.00 mm), globose to turbate, with a high spire formed by slightly more than 4 whorls separated by a shallow suture with an axial varix and a narrow umbilicus.

The protoconch is smooth, has 1.5 whorls and measures 330 µm in diameter. The teleoconch has 2.5 whorls and its periphery is rounded. Ornamentation formed by spiral cords and marked growth lines that by crossing each other form in the interspaces an irregular reticulate pattern, composed of quadrangular-rectangular spaces on the first whorl and oval spaces on the last one, resulting in a coarsely pitted shell surface; inside of these spaces a fine spiral thread is present in the center as well as a filiform network around it, which is characteristic of the species. The cords are thick in the first whorl and somewhat flattened in the last; in apertural view there are 5 cords



**Figure 1**

**A-F.** *Crosseola ordinata* n. sp.; **A-C.** Holotype, 1.2 mm in height, Papua New Guinea, Hargun Island, Stn PB22, 05°01.4'S-145°48'E, 22 m, outer slope (MNHN); **D.** protoconch; **E-F.** microsculpture in two places of the last whorl.



**Figure 2**

**A-E.** *Crosseola madagascariensis* n. sp.; **A-B.** Holotype, 2.7 mm in height, South of Madagascar, Baie des Galions, Stn TS16, 25°09.5'S-46°44.9'E, 9-10 m (MNHN); **C.** Protoconch; **D-E.** Sculpture and detail.

at the beginning of the teleoconch and 28 at the beginning of the last whorl. There is a variciform axial thickening in the middle of the last whorl and another one at the end of the spire in the outer lip. A prominent, rounded spiral ridge formed by 10-12 fine punctate cords borders and delimits the umbilicus.

Umbilicus narrow and deep formed between the periumbilical cord and the columellar lip; inside, there is a wide cord which forms the shallow anterior notch prominently developed and projecting from the base of the columella. Aperture oval, slightly prosocline; columella arched, reflected towards the umbilicus, with an anterior canal at the base and a shallow anterior notch. Outer lip sinuous; edge modified by spiral cords; external margin thickened, variciform; with a parietal angle.

Dimensions: the holotype measures 2.3 mm in diameter and 2.7 mm in height (H/D: 1.15).

**Habitat.** Infralittoral species dredged at 9-10 m from a rocky bottom with caves.

**Distribution.** Only known from the type locality.

**Remarks.** *Crosseola madagascariensis* n. sp. is characterized by its high spire; its decoration consisting of quadrangular-rectangular spaces in the first whorl and oval spaces in the last one; a fine spiral thread in the center and a thread-like structure inside these spaces and the axial variciform thickening in the middle of the last whorl.

**Etymology.** Refers to the island where it was collected.

*Crosseola marquesensis*

Rubio, Rolán & Letourneux n. sp.

Fig. 3A-F

**Type material.** Holotype MNHN IM-2000-32820 and two paratypes MNHN IM-2000-32821.

**Material examined.** French Polynesia, Marquesas Islands: 3 s, Ua Pou Island, Haakuti Bay, Pointe Punahukua, 68 m, sediments.

**Type locality.** Marquesas Islands, Ua Pou Island, Haakuti Bay, Pointe Punahukua, 68 m.

**Description.** Shell of small size (<2.00 mm), turbiniform, with a high spire formed by 3 whorls separated by a shallow suture with an axial varicose outer lip and a narrow umbilicus.

Protoconch of 1.25 whorls with a maximum diameter of 380 µm; it has a strong spiral cord that begins in the nucleus and continues as a keel until near the end of the protoconch; its surface is covered by irregular micro-granules. The teleoconch has 1.75 whorls and its periphery is rounded. Ornamentation formed by spiral cords and marked growth lines which, when

crossing each other, form in the interspace an irregular reticulate pattern, composed of triangular to oval spaces, forming a coarsely pitted shell surface; inside the spaces there is a filiform lattice, characteristic of the species. The cords are thick in the first whorl and somewhat flattened in the last one; in apertural view there are 6 or 7 cords at the start of the teleoconch and 24 or 25 at the beginning of the last whorl. A variciform external thickening of the outer lip is present. A prominent, rounded spiral ridge formed by 5 or 6 fine cords, borders and delimits the umbilicus.

Umbilicus narrow and deep formed between the periumbilical cord and the columellar lip; inside there is a strong cord; this cord forms a shallow anterior notch prominently developed and projecting from base of the columella. Aperture oval, slightly prosocline; columella arched, reflected towards the umbilicus, with an anterior canal at the base and a shallow anterior notch. Outer lip sinuous; edge modified by the spiral cords; external margin thickened, variciform; with a parietal angle.

Dimensions: the holotype measures 1.22 mm in diameter and 1.5 mm in height (H/D: 1.15).

**Habitat.** Circumlittoral species dredged at a depth of 68 m.

**Distribution.** Only known from the type locality.

**Remarks.** *Crosseola marquesensis* n. sp. is characterized by its high spire; by the keeled shape of its protoconch where tubercles can be seen; by its ornamentation on the teleoconch composed of triangular to oval spaces; by the filiform microsculpture in those spaces without a central thread as observed in the other two species described above.

**Etymology.** Refers to the island where the species was collected.

*Crosseola similiter* n. sp.

Fig. 4A-F

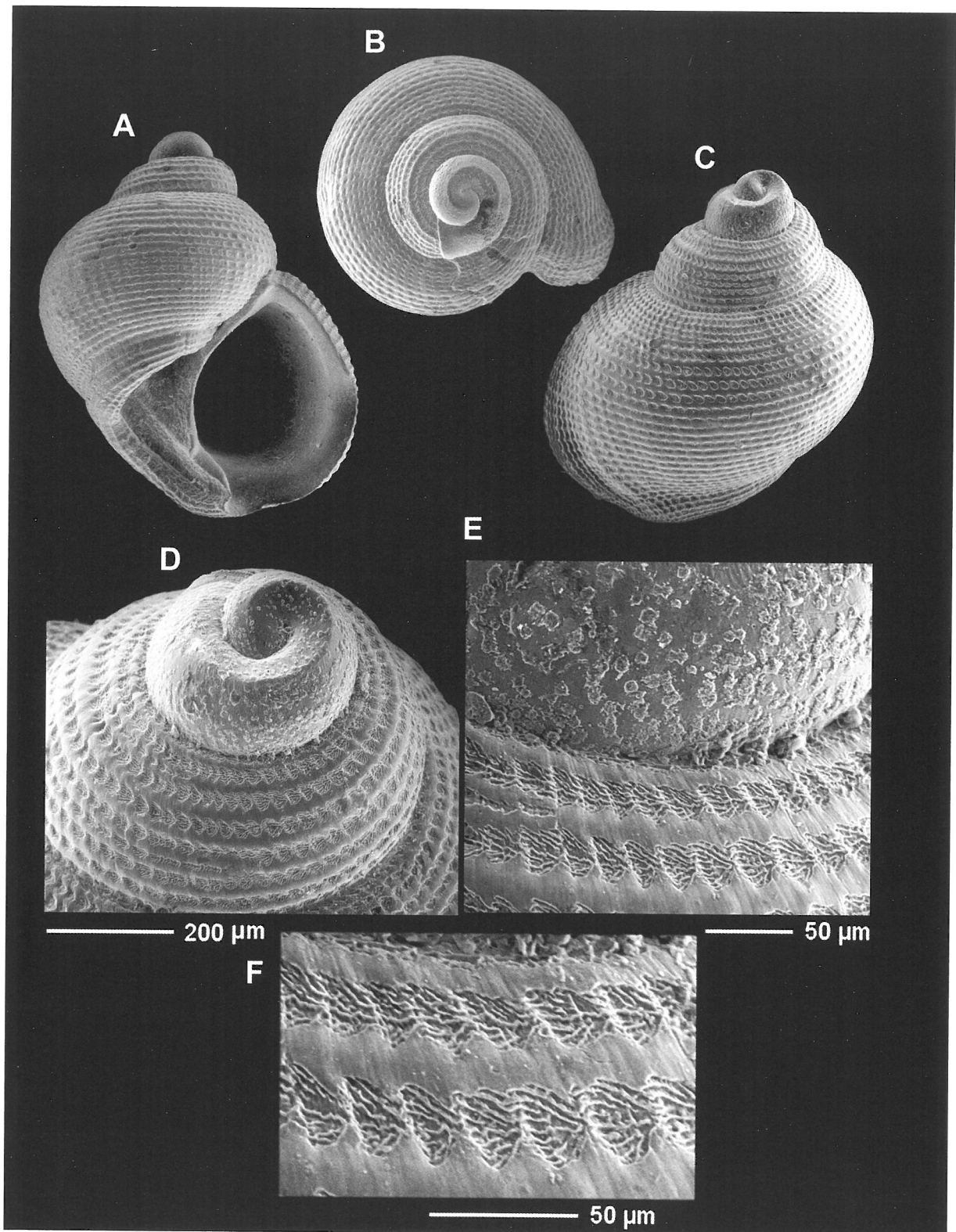
**Type material.** Holotype (Fig. 4A-C) in MNHN IM-2000-32822.

**Material examined.** Solomon Islands, SALOMON 1: 1 s, Stn DW1767, 8°19'S-160°40'E, 98-200 m.

**Type locality.** Solomon Islands, north of Malaita, 8°19'S-160°40'E, 98-200 m [SALOMON 1: Stn DW1767].

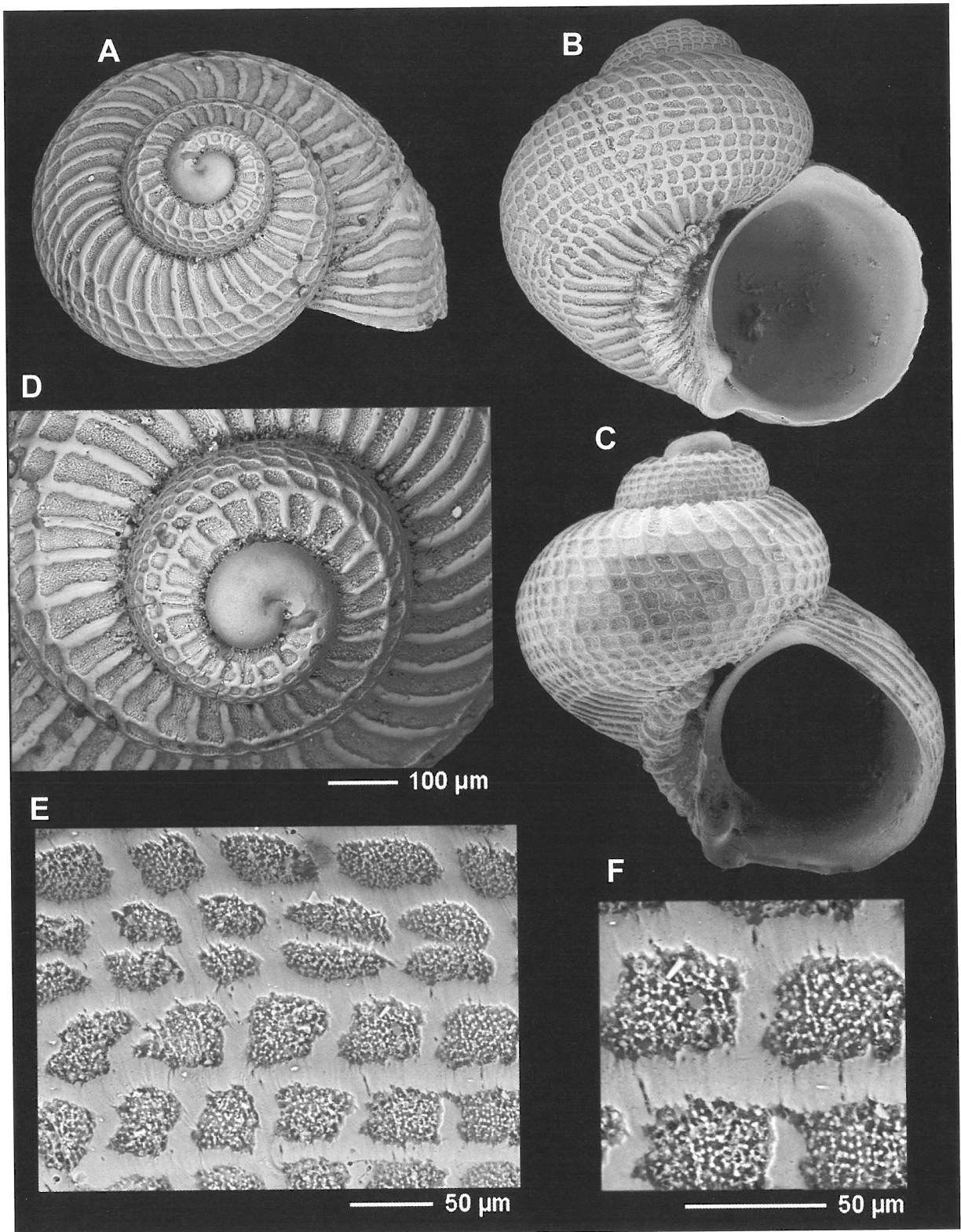
**Description.** Shell of small size (<1.50 mm), globose to turbinate, almost as high as wide, spire formed by about 3 ¼ whorls, separated by a marked suture; not variciform.

The protoconch is smooth, has more than 3/4 of whorl with a maximum diameter of 200 µm. The teleoconch has 2.5 whorls and its periphery is rounded.



**Figure 3**

**A-F.** *Crosseola marquesensis* n. sp.; **A-C.** Holotype, 1.5 mm in height, Marquesas Islands, Ua Pou Island, Haakuti Bay, Pointe Punahukua, 68 m (MNHN); **D.** Protoconch; **E.** Microsculpture of the protoconch; **F.** Microsculpture of the teleoconch.



**Figure 4**

A-F. *Crosseola similiter* n. sp.: A-C: holotype, 1.23 mm in height, Solomon Islands, Stn DW1767, 8°19'S-160°40'E, 98-200 m (MNHN); D. Apex and protoconch; E-F. Microsculpture.



Ornamentation formed of spiral cords, axial ribs and micro-granules. In apertural view 5 spiral cords are visible on the first whorl and 10 on the last one, all located on the periphery of the shell; they are in zigzag shape and are crossed by the sinuous axial ribs, forming an irregular reticulate pattern. Apically, between the suture and the first cord there is a wide space in which there are thick and long axial ribs; abapically, the space from the last peripheral cord until the umbilical keel is also occupied by thick and elongated axial ribs. The reticulate pattern is composed of quadrangular spaces on the periphery of the shell and rectangular lengthened spaces near the suture and the umbilical keel, forming a coarsely pitted shell surface; inside of these and the quadrangular depressions, the surface is fully covered by micro-granules. A prominent, rounded spiral ridge formed by transverse ribs borders and delimits the umbilicus like a keel. Umbilicus limited by a deep fissure formed between the periumbilical cord and the columellar lip.

Aperture rounded, prosocline; columella thin, arched, reflected towards the umbilicus, with a thick tubercle and a canal at base. Outer lip sinuous; smooth edge, not modified by the spiral cords; external margin not thickened or variciform.

Dimensions: the holotype size 1.23 mm in diameter and 1.2 mm in height (H/D: 0.97).

**Habitat.** Bathyal species dredged at a depth of 98-200 m.

**Distribution.** Only known from the type locality.

**Remarks.** *Crosseola similiter* n. sp. is characterized by the small size of its protoconch; the elongated rectangular spaces that form the suture and the umbilical keel; by an irregular quadrangular reticulate pattern of depressions. The surface inside these depressions is completely covered by micro-granules.

*Crosseola favosa* Powell, 1937 is similar but that species has fewer spiral cords (7 or 8 on the body whorl) and the rectangular spaces are more regular.

*Crosseola sinemaculata* (Laws, 1939) is a fossil species but it has a very similar aspect to *C. similiter* n. sp. Beu & Raine (2009) presented the information from Beu & Maxwell (1990): <https://www.gns.cri.nz/static/Mollusca/taxa/BM563.html> were the species is figured by a topotype of 2.9 mm in height; the protoconch diameter is 340 µm, and the number of spiral cords is 4 on the first two whorls, and 18 on the last one, while *C. similiter* n. sp. has 5 spiral cords on the first teleoconch whorl and 11 on the last one. Furthermore, that species is from New Zealand and has a short protoconch.

*Crosseola errata* Finlay, 1926 has 3 spiral cords on the first whorls and 6 on the last one.

**Etymology.** From the Latin *similiter* which means "similar", alluding to the similarity with other known

species as *C. errata* and *C. sinemaculata*.

***Crosseola solomonensis* n. sp.**

Fig. 5A-E

**Type material.** Holotype MNHN IM-2000-32823 and one paratype deposited in MNHN IM-2000-32824.

**Material examined.** Solomon Islands, SALOMON 1: 2 s, Stn DW1767, 8°19'S-160°40'E, 98-200 m.

**Type locality.** Solomon Islands, north of Malaita, 8°19'S-160°40'E, 98-200 m [SALOMON 1: Stn DW1767].

**Description.** Shell of small size (<2.50 mm), globose to turbinate, somewhat higher than wide, spire formed by weakly more than 3.25 whorls separated by a marked suture; not variciform.

The protoconch is smooth, has more than 3/4 of whorl and measures 220 µm. The teleoconch has 2.5 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs and micro-granules. In apertural view there are 3 spiral cords on the first whorl and 14-15 on the last one; the first cords on the 1.5 whorls are in zigzag shape crossing the axial ribs, and forming a reticulate pattern of pentagonal cells and a small thickening at the point of intersection; later, the axial ribs are thickened, raised and more widely separated from one another; the number of spiral cords increases, maintaining the same thickness as on the initial whorls; these spirals cross the axial ribs without forming nodules at the intersections. The reticulum is composed of pentagonal spaces; the inside of these spaces and the quadrangular ones are completely covered by micro-granules. A prominent, spiral ridge formed by successive axial folds, borders and delimits the umbilicus, forming a keel.

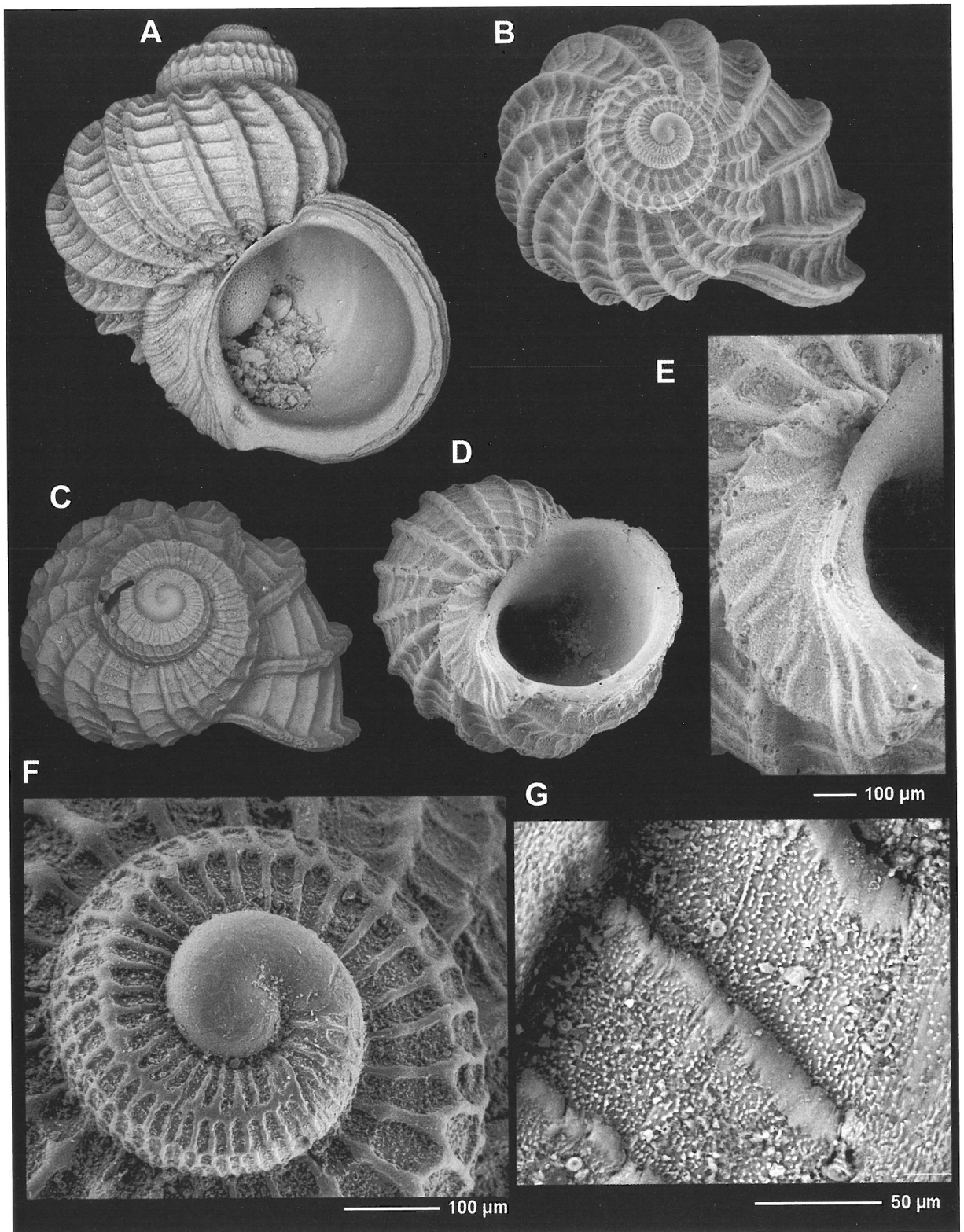
The umbilicus is limited to a deep cleft formed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, arched, reflected towards the umbilicus, with an anterior channel at base. Outer lip sinuous; smooth edged, not modified by the spiral cords; external margin thickened or variciform.

Dimensions: The holotype measures 1.9 mm in diameter and 2.25 mm in height (H/D: 1.18).

**Habitat.** Bathyal species dredged at 98-200 m depth.

**Distribution.** Only known from the type locality.

**Remarks.** *Crosseola solomonensis* n. sp. differs from the other described species by the ornamentation of the teleoconch, which is formed by a reticulate pattern of pentagonal spaces on the first whorls of the teleoconch; by the high axial ribs which are observed on its last whorl and by the prominent, spiral ridge formed by successive axial folds that delimit the umbilicus like a keel.



**Figure 5**

**A-E.** *Crosseola solomonensis* n. sp.; **A.** Holotype, 2.25 mm in height, Solomon Is, Stn DW1767, 8°19'S-160°40'E, 98-200 m (MNHN); **B.** Paratype, 1.1 mm, same locality, MNHN; **C.** Protoconch; **D-E.** Microsculpture and detail.

**Etymology.** Refers to the islands where the species was collected.

Genus *Conradia* A. Adams 1860

*Conradia* A. Adams, 1860: 409 [Type species (by monotypy): *Conradia cingulifera* A. Adams, 1860. Off Mishima, Shizuoka Prefecture, Sea of Japan, Japan, 113 meters, sand].

**Diagnosis** (from Hickman, 2013). Maximum adult shell size approximately 4 mm (type species). Umbilical keel well developed and crossed by transverse ridges. Aperture entire, ranging from ovate to circular in shape. Columellar lip thin and gently arcuate, reflected anteriorly over umbilical keel and terminating in a short anterior canal. Sculpture dominated by spiral ribs of varying number, crossed by finer, irregularly spaced axial ones. Outer lip scalloped at terminations of spiral ribs and slightly thickened in adults. Shell surface between spiral and axial ribs filled with granular microprotuberances in some species.

**Habitat.** Intertidal to 10 m, sand (*C. doliaris*), 40 to 120 m, sand (*C. cingulifera*); 50 to 160 m, sand (*C. clathrata*); 30 to 160 m, sand or coarse sand and stones (*C. perclathrata*) (Higo, Callomon & Goto, 1999). Species of *Conradia* are distributed from shallow to middle subtidal zones, and all are rarely collected alive (Sasaki, 2008).

**Remarks.** Hickman (2013) wrote: "Monophyly of the genus *Conradia* is here considered questionable, although, the type species, shares diagnostic features of Crosseolidae that include the prominent umbilical keel, pseudo-umbilicus, reflected columellar lip, short anterior canal, entire peristome, and terminal thickening of the adult outer lip." Specimens of *Conradia perclathrata* Sakurai, 1983 share some diagnostic features with the type species. Specimens identified as "*Conradia* sp. cf. *clathrata*" by Kano (2008), have an entire peristome, umbilical keel, reflected columellar lip, and faintly developed anterior canal. However, they lack a terminal apertural thickening. The lack of terminal thickening may be attributable to immaturity, and more specimens are required to resolve this question. Sasaki (2008): *Conradia doliaris* A. Adams, 1863, is variable in sculpture (see Ekawa, 1989).

The radula is unknown for all the species of the genus.

Eight species are previously known as being included in *Conradia*:

*Conradia carinifera* A. Adams, 1860.  
*Conradia cingulifera* A. Adams, 1860.  
*Conradia clathrata* A. Adams, 1860.  
*Conradia pulchella* A. Adams, 1861.

*Conradia doliaris* A. Adams, 1863.  
*Conradia sulcifera* A. Adams, 1863.  
*Conradia tornata* A. Adams, 1863.  
*Conradia perclathrata* Sakurai, 1983.

Most of them were described from Japan by A. Adams (1860, 1861, 1863) and no type specimens were figured; perhaps for this reason, the genus has been overlooked.

*Conradia discreta* n. sp.  
 Fig. 6A-D

**Type material.** Holotype MNHN IM-2000-32825.

**Material examined.** Solomon Islands, SALOMON 1: 1 s, Stn DW1767, 8°19'S-160°40'E, 98-200 m.

**Type locality.** Solomon Islands, north of Malaita, 8°19'S-160°40'E, 98-200 m [SALOMON 1: Stn DW1767].

**Description.** Shell of small size (<1.50 mm), globose to turbanate, almost as high as it is wide, spire solid formed by 3.75 whorls separated by a marked suture; not variciform.

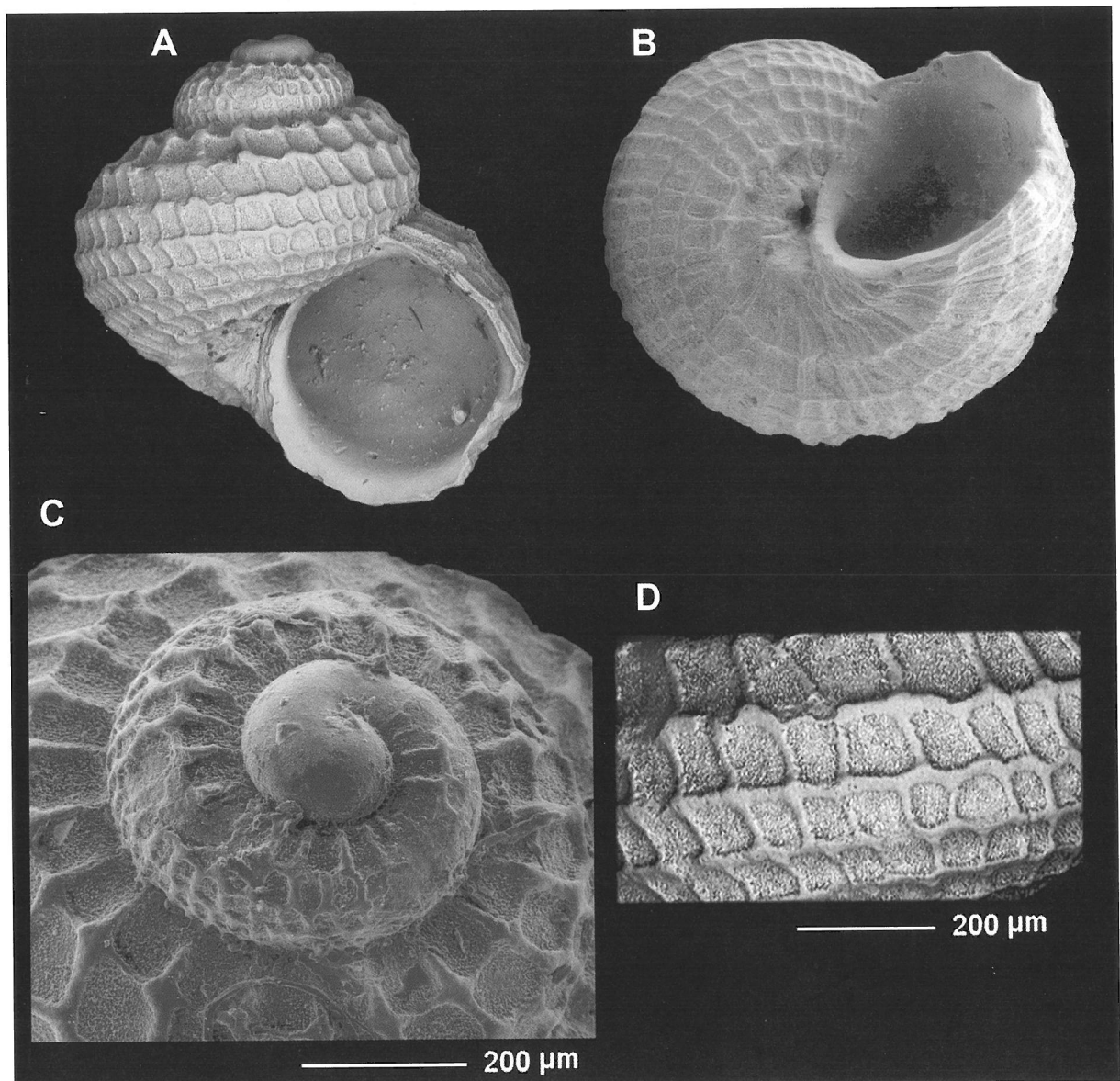
The protoconch is smooth, with almost 3/4 of whorl with a diameter of about 160 µm. The teleoconch has 3 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs and micro-granules. In apertural view there are 4 spiral cords on the first whorl and 8 on the last, distributed between the suture and the umbilicus; spiral cords in zigzag shape, crossing the axial ribs, irregular reticulate pattern, and forming pentagonal spaces in the first two whorls, and pentagonal and quadrangular ones in the last whorl; they form more or less prominent tubercles at the intersection points. The interior of the depressed areas of the quadrangular spaces are fully covered with micro-granules.

The umbilical keel is scarcely developed, being formed by sharp axial folds which border and delimit the umbilicus. This is formed by a deep groove placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columellar lip thin, arched, reflected towards the umbilicus, with an inconspicuous anterior channel at the base. Outer lip slightly scalloped at the end of the spiral ribs; it is not thickened or variciform. Aperture round, prosocline. Dimensions: the holotype measures 1.48 mm in diameter and 1.4 mm in height (H/D: 0.94).

**Habitat.** Bathyal species dredged at a depth of 1036-1138 m.

**Distribution.** Only known from the type locality.

**Remarks.** *Conradia discreta* n. sp. has no variciform thickenings either in the development of the teleoconch or on the outer lip; the umbilical keel, is



**Figure 6**

**A-D.** *Conrardia discreta* n. sp.; **A-B.** Holotype, 1.4 mm in height, Solomon Islands, 8°19'S-160°40'E, 98-200 m [SALOMON 1: Stn DW1767] (MNHN); **C.** Protoconch; **D.** Detail of the sculpture.

scarcely developed, limited to a thick periumbilical cord and the outer lip is slightly scalloped at the end of the spiral ribs.

In its general appearance it is very similar to *Conrardia* cf. *clathrata* figured by Sasaki (2006) and Hickman (2013), but differs from the latter by the shape of the depressed spaces (pentagonal and quadrangular).

**Etymology.** From the Latin *discretus*, participle of the verb “discern”, alluding to the lack of specific differences.

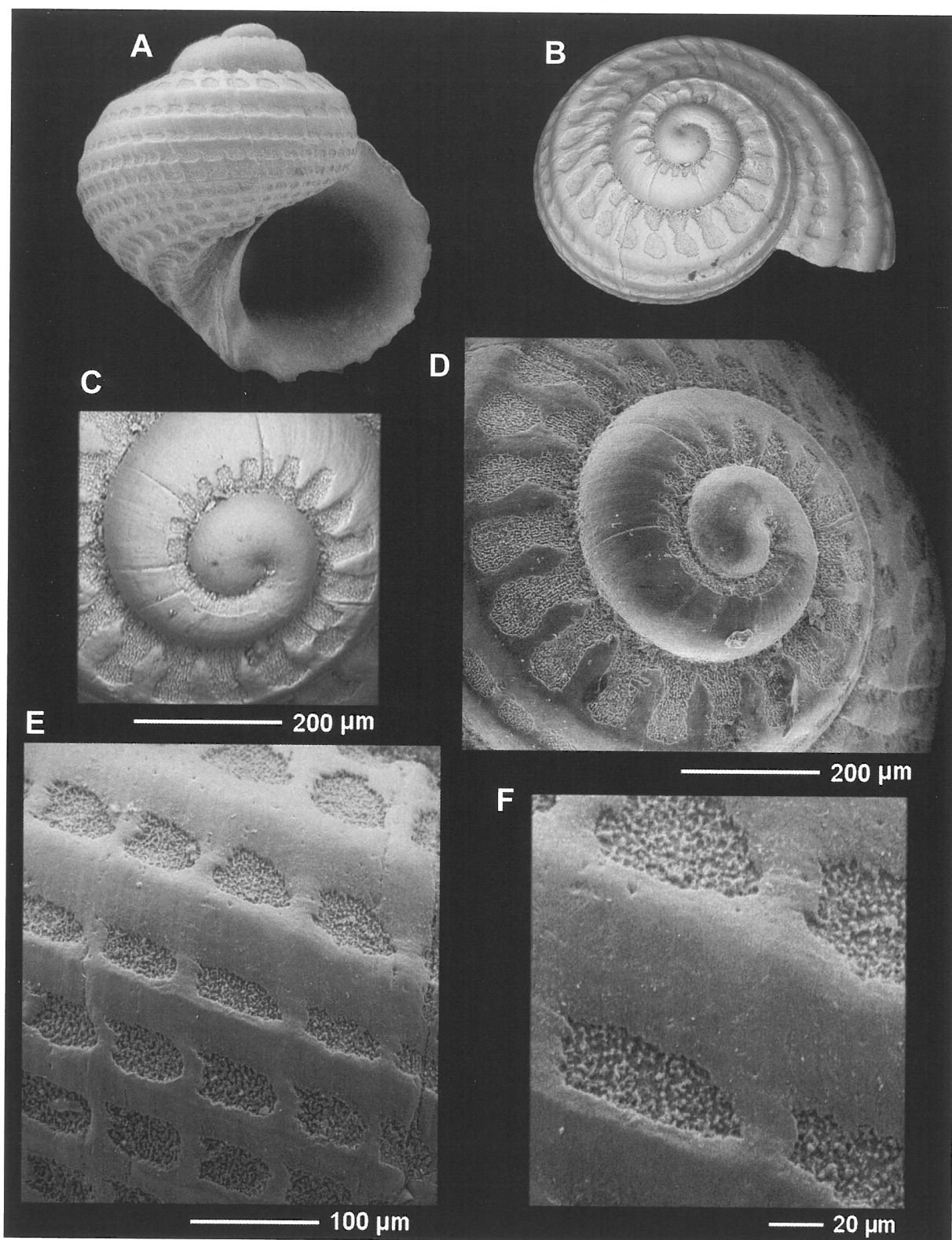
*Conrardia minor* n. sp.

Fig. 7A-F

**Type material.** Holotype MNHN IM-2000-32826.

**Material examined.** Solomon Islands, SALOMON 1: 1 s, Stn DW1767, 8°19'S-160°40'E, 98-200 m.

**Type locality.** Solomon Islands, north of Malaita, 8°19'S-160°40'E, 98-200 m [SALOMON 1: Stn DW1767].



**Figure 7**

**A-F.** *Conrardia minor* n. sp.; **A-B.** Holotype, 1.20 mm in height, Solomon Islands, 8°19'S-160°40'E, 98-200 m [SALOMON 1: Stn DW1767] (MNHN); **C-D.** Protoconch and apex; **E-F.** Sculpture and detail.

**Description.** Shell of small size (<1.50 mm), globose to turbinate, as high as it is wide, spire solid formed by 3.25 whorls separated by a marked suture; not variciform.

The protoconch is smooth, has 3/4 of whorl and a diameter of about 200 µm. The teleoconch has 2.5 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs and micro-granules. In apertural view no spiral cords are observed in the first whorl, its surface being completely smooth, except for a narrow subsutural strip that is covered by micro-granules and in which the first axial ribs from the first 1/2 whorl originate; there are 8 spiral cords, distributed between the suture and the umbilicus on the last whorl. Axial ribs are thinner, crossing the spiral cords to form slightly depressed rectangular squares; there are no tubercles at the intersection points. The insides of the rectangles are completely covered with micro-granules. The umbilical keel is scarcely developed, being formed by a periumbilical nodulose cord.

The umbilicus is narrow, partially occluded by the expansion of the columellar lip and it is located between the periumbilical cord and the columellar lip. Aperture rounded, slightly prosocline; columellar lip thin, arched, wide at the base, reflected towards the umbilicus but without occluding it, with an anterior channel also at base. Outer lip scalloped by the ends of the spiral ribs; not thickened or variciform.

Dimensions: the holotype measures 1.15 mm in diameter and 1.20 mm in height (H/D: 1.04).

**Habitat.** Bathyal species dredged at 98-200 m depth.

**Distribution.** Only known from the type locality.

**Remarks.** *Conradia minor* n. sp., just like *C. discreta* n. sp. and *C. abyssa* n. sp., has no variciform thickenings in the development of the teleoconch as on the outer lip; the umbilical keel, is scarcely developed, limited to a thick periumbilical nodulose cord and the outer lip is slightly scalloped at the end of the spiral ribs.

In its general appearance it is unlike any other known species and is characterized being as high as it is wide; by lacking the spiral cords on the first whorl of the teleoconch; by the number of spiral cords of the last whorl and the nodulose periumbilical cord.

**Etymology.** From the Latin *minor*, refers to the size of the specimens, actually the smallest in the studied species.

*Conradia abyssa* n. sp.  
Fig. 8A-D

**Type material.** Holotype MNHN IM-2000-32827 and one paratype MNHN IM-2000-32828.

**Material examined.** Solomon Islands, SALOMON 1: 2 s, Stn CP1781, 8°31'S, 160°38'E, 1036-1138 m.

**Type locality.** Solomon Islands, off NW Malaita, 08°31'S, 160°38'E, 1036-1138 m [SALOMON 1: Stn CP1781].

**Description.** Shell of small size (<2.50 mm), globose to turbinate, slightly higher than wide, solid, spire formed by 4 whorls separated by a deep wide suture; not variciform.

The protoconch is smooth, of nearly one whorl, with a diameter of about 270 µm. The teleoconch has 3 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs and micro-granules. In apertural view there are 3 spiral cords on the first whorl and 8 on the last, distributed between the suture and the umbilicus; spiral cords are initially in zigzag shape crossing the axial ribs, and forming an irregular reticulate pattern, with quadrangular or pentagonal spaces on the first whorl. On the two other whorls the axial ribs are thicker, and as they cross the spiral cords they form a reticulate pattern of wide quadrangular spaces with thick nodules at the crossing points. Inside the pentagonal and the quadrangular spaces, the surface is completely covered with micro-granules. The umbilical keel is limited to a periumbilical cord with wide nodules and the external lip is slightly scalloped by the end of the spiral ribs.

Aperture entire, ranging from ovate to circular in shape. Columellar lip thin and gently arcuate, reflected anteriorly over periumbilical cord and terminating in a short and not very prominent anterior canal. Outer lip scalloped at terminations of spiral ribs and slightly thickened.

In the holotype, the operculum is within the aperture, it is rounded, multispiral, with a central nucleus.

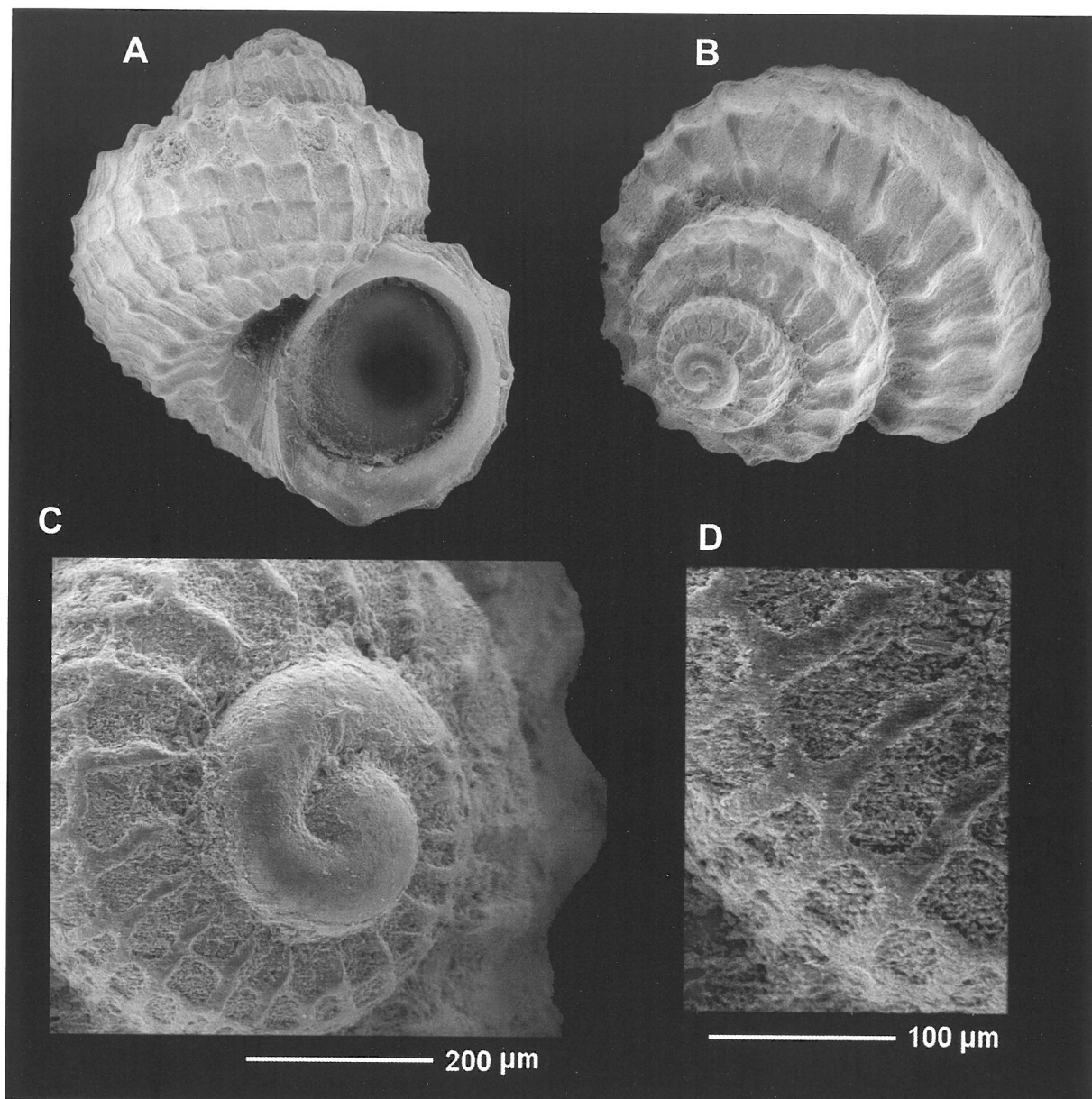
Dimensions: the holotype measures 2.0 mm in diameter and 2.27 mm in height (H/D: 1.14).

**Habitat.** Bathyal species dredged at a depth of 1036-1138 m.

**Distribution.** Only known from the type locality.

**Remarks.** *Conradia abyssa* n. sp., as well as *Conradia discreta* n. sp. and *Conradia minor* n. sp., lacks the variciform thickenings both in the development of the teleoconch and in the outer lip; the umbilical keel, is scarcely developed as such, being limited to a periumbilical cord of thick nodules and the external lip is slightly scalloped by the ending of the spiral ribs.

From *Conradia discreta* n. sp. and *C. minor* n. sp. it differs primarily by the thick nodules that are formed at the intersection of the axial ribs with the spiral cords, by the umbilicus, somewhat broader than in the other species, and by the periumbilical nodulose cord which replaces the umbilical keel.



**Figure 8**

**A-D.** *Conradia abyssa* n. sp.; **A.** Holotype, 2.27 mm in height, Solomon Islands, 08°31'S, 160°38'E, 1036-1138 m [SALOMON 1: Stn CP1781] (MNHN); **B:** Paratype, 2.07 mm in diameter; **C.** Apex and protoconch of the paratype; **D.** Detail of the microsculpture.

**Etymology.** From the Greek *abyssos*, which means “abyss” in allusion to its collection in very deep water.

#### SUMMARY AND COMMENTS

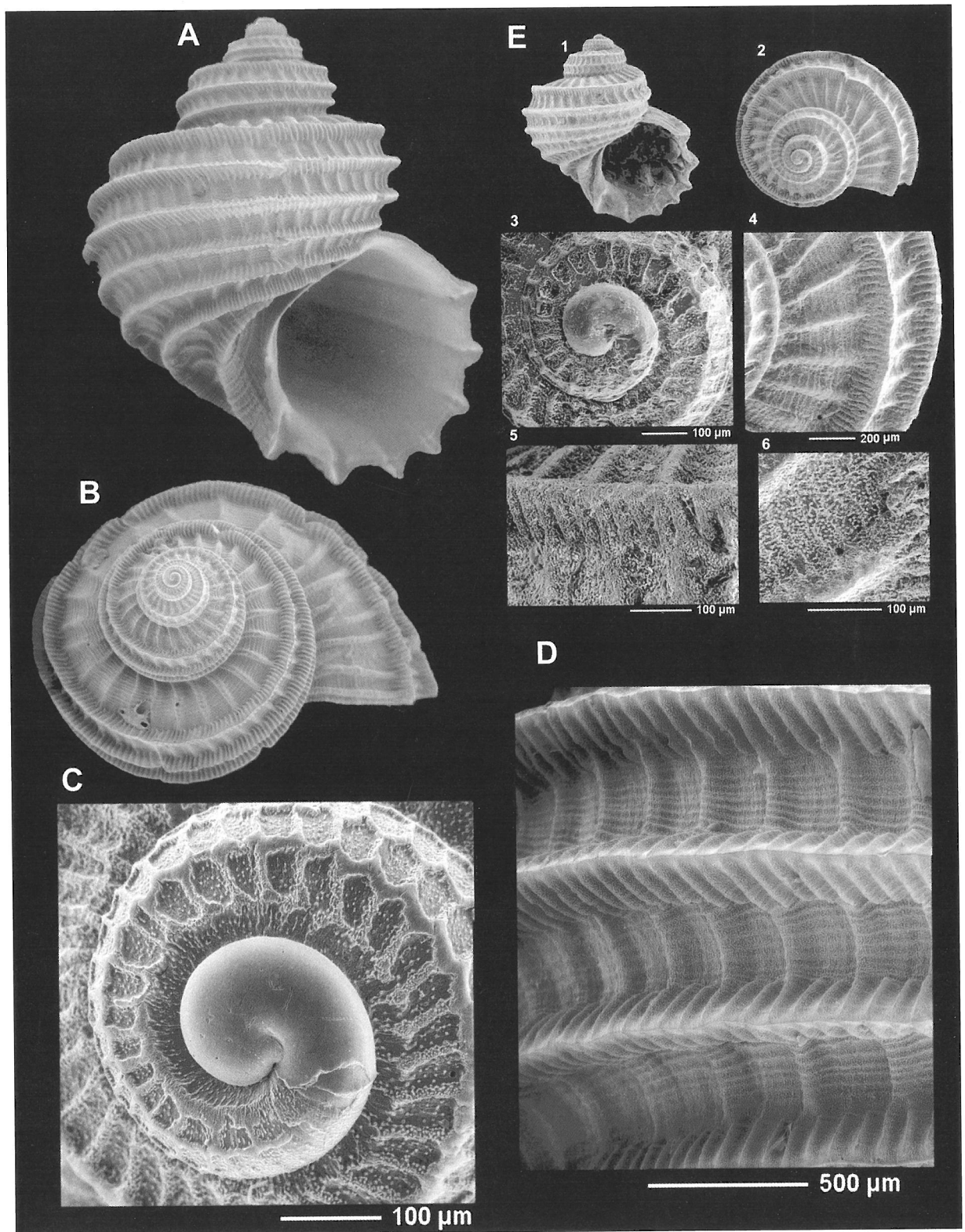
*Crosseola* appears to us as a variable genus, with species that are very different in their appearance, but with enough constant morphological characters for their inclusion in the genus.

The single species described from West Africa (Fig. 9) is rather different from the others. The protoconch

is of a different size, shape and ornamentation, not following any generic pattern.

A new micro-granulation pattern is illustrated which will be especially useful for diagnosing some of the new species.

The studied species in *Crosseola* are included in this genus because of the presence of the morphological characters described by Hickman (2013): shell robust, globose to turbanate; characteristic punctate or cancellate sculpture; the umbilical keel (periumbilical cord); the narrow pseudo-umbilicus; the distinctive



**Figure 9**

**A-E.** *Crosseola gorii* Rubio & Rolán, 2014; **A-B.** New shell, 5.6 x 4.6 mm, collected on Principe Island (Gulf of Guinea) (coll. Sandro Gori); **C.** Protoconch of the shell illustrated in A and B; **D.** Microsculpture; **E.** Plate of the original description.



channeled notch in the basal lip and the prosocline outer lip shallowly sinuate.

*Crosseola madagascariensis* n. sp. usually presents a variciform axial thickening in the middle of the last whorl, but it may not be present in all the shells.

*Crosseola similiter* n. sp. is the most similar species in shape compared to *C. concinna*, the type species of the genus, and has a simple outer lip, sharp and not thickened.

*Crosseola ordinata*, *C. madagascariensis* and *C. marquesensis* present a distinctive notch in the channeled basal lip.

The geographic distribution of the here studied species is:

*Crosseola ordinata* n. sp.: Papua New Guinea.

*Crosseola madagascariensis* n. sp.: Madagascar.

*Crosseola marquesensis* n. sp.: Marquesas.

*Crosseola similiter* and *Crosseola solomonensis* n. sp.;

*Conradia discreta* n. sp., *Conradia minor* n. sp. and

*Conradia abyssa* n. sp.: Solomon Islands.

The geographic distribution of the genus *Crosseola*, predominantly Australasian, is now extended to the Indian Ocean (Madagascar), its current distribution being Japan, Australasia, Indian Ocean, South Africa and West Africa.

The geographic distribution of the genus *Conradia*, apparently limited to Japan, is here extended to the Solomon Islands (Australasia).

About the depth of the collecting, all the *Crosseola* species are from shallow water or medium depth: *Crosseola ordinata*, at 22 m; *C. madagascariensis*, at 9-10 m; *C. marquesensis*, at 68 m; *C. similiter* and *C. solomonensis* were collected at 98-200 m.

In the genus *Conradia*, *C. discreta* and *C. minor* n. sp. were collected at 98-200 m, and only *C. abyssa* n. sp. was collected at very deep water: 1036-1138 m.

Nothing is known about the soft parts and radulae of the studied species.

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