



## Revision of the genera *Parviturbo* and *Pseudorbis* (Gastropoda, Skeneidae)

### Revisión de los géneros *Parviturbo* y *Pseudorbis* (Gastropoda, Skeneidae)

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*Recibido el 13-II-2015. Aceptado el 14-VI-2015*

#### ABSTRACT

A revision of the genus *Parviturbo* Pilsbry & McGinty, 1945, distributed in the Atlantic Ocean, the American Pacific, and the Tropical South Pacific, is presented for the first time. In total 33 species were studied, of which 12 were already known (5 in the Eastern Atlantic, 5 in the Western Atlantic, and 2 in the American Pacific); 20 more are described as new species (4 in the Eastern Atlantic, 12 in the Western Atlantic, and 4 in the Tropical South Pacific) and one more from the Mediterranean is presented without a name. We provide new data on the radula for *Parviturbo insularis*, and the morphology of the shell is described and illustrated for all the species using scanning electron microscopy. Data on their distribution and habitat are also provided, and their generic allocation is discussed. The presence of species *Parviturbo* in the Tropical Pacific is confirmed.

The type material of several species (*Parviturbo rehderi* Pilsbry & McGinty, 1945, *Cyclostrema granulum* Dall, 1899 and *Delphinula tuberculosa* d'Orbigny, 1842 is illustrated and a lectotype is designated for the latter species.

*Parviturbo dibellai* Buzzurro & Cecalupo, 2007 is excluded from the genus, and considered a junior synonym of *Fossarus eutorniscus* Melvill, 1918; the species is transferred to Vitrinellinae but without a definite generic assignment.

The two known Recent species of *Pseudorbis*, a genus close to *Parviturbo*, are studied for comparison and the differences and similarities between these two genera are discussed.

#### RESUMEN

Se hace por vez primera una revisión del género *Parviturbo* Pilsbry & McGinty, 1945, que se encuentra distribuido en el Océano Atlántico, el Pacífico americano y el Pacífico Tropical sur. En total se estudian 33 especies actuales, de las que ya eran conocidas 12 (5 en el Atlántico oriental; 5 en el Atlántico occidental y 2 en el Pacífico Americano); 20 especies se describen como nuevas (12 en el Atlántico occidental, 4 en el Atlántico oriental y 4 en el Pacífico Tropical) y una más, del Mediterráneo, se presenta sin nombre.

Se aportan nuevos datos sobre la rádula de *Parviturbo insularis*, y la morfología de la concha se describe e ilustra para todas las especies usando microscopía electrónica de barrido. Se aportan datos sobre su distribución y hábitat, y se discute su asignación genérica. Se confirma la presencia de especies de *Parviturbo* en el Pacífico Tropical.

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Se figura el material tipo de varias especies (*Parviturbo rehderi* Pilsbry & McGinty, 1945, *Cyclostrema granulum* Dall, 1899 and *Delphinula tuberculosa* d'Orbigny, 1842) y se designa un lectotipo para esta última.

Se considera que *Parviturbo dibellai* Buzzurro & Cecalupo, 2007 se debe de excluir del género, y es un sinónimo más reciente de *Fossarus eutorniscus* Melvill, 1918; se transfiere a la familia Vitrinellinae aunque sin concretar género.

Como comparación, por ser un género muy próximo, se estudian las dos especies actuales del género *Pseudorbis* y se discuten las similitudes y diferencias entre ambos géneros.

## INTRODUCTION

The genus *Parviturbo* was created by PILSBRY & MCGINTY (1945) for a number of small gastropods with a rhipidoglossate radula, a multispiral operculum and an animal with tapering, ciliated cephalic tentacles, an elongate foot with two anterior lobes, and three pairs of epipodial tentacles. They included this genus in the family Cyclostrematidae P. Fischer, 1885, now considered a junior synonym of Liotiidae but at that time equivalent to Skeneidae. KEEN (1971) placed *Parviturbo* in the family Skeneidae Clark, 1851, and transferred to this genus some species previously known from the Panamic Province and previously included in *Liotia*, *Homalopoma* or *Fossarus*.

This view has not been challenged so far, but BOUCHET & ROCROI (2005) treated the Skeneinae as a subfamily of the family Turbinidae Rafinesque, 1815, which would include *Parviturbo* Pilsbry & McGinty, 1945 and *Haplocochlias* Carpenter, 1864 among others. WILLIAMS, KARUBE & OZAWA (2008), in their systematic study of Vetigastropoda based on molecular characters, published the data supporting this treatment of Skeneinae as a subfamily of the Turbinidae, in the superfamily Trochoidea Rafinesque, 1815.

*Parviturbo*, as well as *Haplocochlias*, are shallow-water genera of Skeneinae with thickened lips, distributed in the eastern and south Pacific and Atlantic coasts. Both genera share anatomical and radular characters, which led HICKMAN & MCLEAN (1990) to place them in a group which called "*Parviturbo* – *Haplocochlias* group" within the family Skeneidae.

RUBIO, FERNÁNDEZ-GARCÉS & ROLÁN (2013) revised the genus *Haplocochlias* and moved to it *Parviturbo calidimaris* Pilsbry & McGinty, 1945, *Parviturbo francesae* Pilsbry & McGinty, 1945, *Parviturbo turbinus* (Dall, 1889), *Parviturbo concepcionensis* (Lowe, 1935) and *Parviturbo erici* (Strong & Hertlein, 1939).

The main characters which differentiate the genera *Parviturbo* and *Haplocochlias* are mentioned in Table I.

The *Parviturbo*-*Haplocochlias* group of species is interstitial, sublittoral or infralittoral, like other European skeneid species in the genera *Skenea*, *Skeneoides*, *Dikoleps* or *Pseudorbis*. These tend to live in shallow waters, in the interstices of the gravel on the rocky beaches, in the interstices of coarse sediments under stones, in mærl, coral bottom and in bottoms with *Laminaria* on rocks; a common element to many of their habitats is the presence of calcareous algae.

Their tiny size makes them very difficult to spot in their natural environment, so that they can only be obtained by processing samples of sediments, calcareous algae, coralline sands, etc. In most cases, only empty shells are found.

The purpose of this work is to study all known species of *Parviturbo* and provide a comprehensive view of this genus in relation to shell morphology, habitat, bathymetric and geographic distribution range. At the same time and in accordance with the considerations made by PILSBRY & MCGINTY (1945), we made a generic comparison between *Pseudorbis* Monterosato, 1884 and *Parviturbo* (see page 253 for further details).

Table I. Main shell characters used to distinguish the genera *Haplocochlias* and *Parviturbo*.*Tabla I. Principales caracteres diferenciales de las conchas de los géneros Haplocochlias y Parviturbo.*

Characters	<i>Haplocochlias</i>	<i>Parviturbo</i>
Spiral sculpture	Numerous spiral cordlets: 10-72 at the end of the spire	Usually less numerous and more evident spiral cords: 5-8 at the end of the last whorl
Axial sculpture	May be non-existent. When it exists is usually more dense than the spiral sculpture	Presence of axial lamellae in the interspaces; sometimes few axial as strong as the spiral cords
Nodose spiral cords	Absence of nodose cordlets both subsutural and periumbilical	Presence of nodose cords or cordlets mainly subsutural or periumbilical
Umbilicus	Obliterated in some species, like a fissure or, exceptionally, a little wider in few ones	Evident, deep, narrow, bordered by few spiral cords at the base
External lip of the aperture	Usually strongly thickened	Only exceptionally thickened
Inner part of the outer lip	Smooth or crenulated by numerous spiral threads	Smooth, with a small number of nodulose teeth, or with depressions coincident with the spiral cords

## MATERIAL AND METHODS

The material studied largely comes from existing museum collections (AMNH, ANSP, LACM, MHNS, MNHN and MCZ) and private collections (CHL, CCR, CEG, CMK, among others). Several museums have provided material in loan or photographs of type material. Material from the following MNHN expeditions was studied: SANTO 2006 (Global Biodiversity Survey) in the waters of Espiritu Santo Island in Vanuatu, MUSORSTOM 10 cruise (1998) on board R/V *Alis* around the Fijian Archipelago, ATIMO VATAE (2012) expedition to Madagascar "Deep South" marine fauna & flora, and KARUBENTHOS (2012), first inventory of marine invertebrates of Guadeloupe. The authors have also collected sedimentary material through dredging, by snorkelling and scuba diving, subsequently sorting the samples under the stereomicroscope.

Due to their small size the shells were essentially studied under the scanning electron microscope (SEM), mostly in the University of Vigo, in the Centro de Apoyo Científico y Tecnológico

a la Investigación (CACTI) using a XL30 microscope and a Quanta200. The species have been arranged mainly according to the geographic areas and, within these, according to morphological affinities or in chronological order of their description when groupings were not obvious.

### Abbreviations:

AMNH American Museum of Natural History, New York, USA  
 ANSP Academy of Natural Sciences, Philadelphia, USA  
 CASP California Academy of Sciences Paleontology, San Francisco, USA  
 CZL Centro de Zoologia do IICT, Lisbon, Portugal  
 DBUA Malacological collection of the Department of Biology of the University of the Azores, Portugal  
 FLMNH Florida Museum of Natural History, Gainesville, USA  
 HUJ Department of Zoology, Hebrew University, Jerusalem, Israel  
 IES Instituto de Ecología y Sistemática, Havana, Cuba  
 LACM Los Angeles Country Museum, Los Angeles, USA  
 MCZ Museum of Comparative Zoology, Philadelphia, USA

- MCZR Museo Civico di Zoologia,  
Roma, Italy
- MNHST Museo de la Naturaleza y el  
Hombre, Santa Cruz de Tenerife,  
Canarias, Spain
- MHNS Museo de Historia Natural,  
University of Santiago de Com-  
postela (coll. E. Rolán), Spain
- MNCN Museo Nacional de Ciencias  
Naturales, Madrid, Spain
- MNHM Museo Civico di Storia Natu-  
rale, Milano, Italy
- MNHN Muséum National d'Histoire  
Naturelle, Paris, France
- MPH Museo Poey, Havana, Cuba
- NHHUK Natural History Museum  
United Kingdom, London, England
- NMW National Museum of Wales,  
Great Britain
- SDSNH San Diego Society of Natural  
History, San Diego, USA
- SMNH Swedish Museum of Natural  
History, Stockholm, Sweden
- ZMA Zoologisch Museum, Amsterdam,  
Netherlands
- ZMB Museum für Naturkunde, Berlin,  
Germany
- ZSM Zoologischen Staatssammlung  
Museum, München, Germany
- CAC collection of Alberto Cecalupo,  
Milano, Italy
- CAP collection of Anselmo Peñas,  
Vilanova i la Geltrú, Spain
- CCR collection of Colin Redfern, Boca  
Raton, Florida, USA
- CEG collection of Emilio Garcia,  
Louisiana, USA
- CFG collection of Raúl Fernández-  
Garcés, Cienfuegos, Cuba
- CFR collection of Federico Rubio, Valen-  
cia, Spain
- CFS collection of Frank Swinnen,  
Lommel, Belgium
- CHL collection of Harry G. Lee, Florida, USA
- CHO collection of José María Hernán-  
dez (†), Gáldar, Canary Is.
- CJL collection of Jean Letourneux,  
French Polynesia
- CMK collection of Marlo Krisberg,  
Florida, USA
- CPM collection of Pasquale Micali,  
Fano, Italy
- CWE collection of Winfried Engl, Dus-  
seldorf, Germany
- sp specimen with soft parts  
s empty shell  
j juvenile  
f fragment

## SYSTEMATIC PART

Superfamily TURBINOIDEA Rafinesque, 1815

Family TURBINIDAE Rafinesque, 1815

Subfamily SKENEINAE Clark, 1851

Genus *Parviturbo* Pilsbry & McGinty, 1945

*Parviturbo* Pilsbry & McGinty, 1945. *The Nautilus*, 59: 54. [Type species by original designation: *Parviturbo rehderi* Pilsbry & McGinty, 1945].

*Diagnosis:* Original description in PILSBRY & MCGINTY (1945): "The very small shell is solid, perforate or narrowly umbilicate, turbinate or globose-conic, of few strongly convex whorls, with one to two smooth nuclear whorls, the rest sculptured with subequal spiral ridges, the intervals crossed by axial threads. Aperture rounded, the concave columella somewhat thickened. Operculum thin, corneous and multispiral. The living animal has a rather long narrow foot, expanding in narrow auricles in front, bearing three pairs of long, cili-

ated epipodial cirri and a much shorter pair forward. Tentacles tapering, ciliated. Radula rhipidoglossate".

*We add:* Protoconch with  $\frac{3}{4}$  nuclear whorl (measured by the Verduin method), smooth or with spiral cords. Teleoconch sculptured with subequal spiral cords, smooth or nodulose; spaces between the cords crossed by axial threads and/or lamellae and its surface covered by microgranules. Outer lip modified by the spiral cords.

*Remarks:* PILSBRY & MCGINTY (1945) noted: "This group of Florida, the West Indies and the Panamic province will probably prove to be rather numerous in species. *Cyclostrema turbinum* Dall, from off Havana in 80 fms (146 m), and *C. granulum* Dall, Samana Bay, Santo Domingo, apparently belong here. *Parviturbo* needs comparison with the Mediterranean genus *Pseudorbis* Monterosato (1884, *Nomencl. Gen. e Specif. Conch. Medit.*, p. 109), founded on *Fossarus granulum* Brugnone (1873), *Miscellanea Malac.* 1: 13, fig. 25), of which the animal and operculum are unknown, and the shell lacks interstitial cross-threads. The living animal and the radula of *Parviturbo* will be illustrated in a future paper". However, neither the radula nor the description of the animal were eventually published.

RUBIO & RODRÍGUEZ BABÍO (1991) described and figured by first time the radula of *Pseudorbis granulum*, and on this basis, together with the characters

of the operculum and shell, placed the genus in the family Skeneidae. WARÉN (1992) after the examination of this radula, confirmed its systematic position. In the Notes (p.192) he indicates: "Serge Gofas has recently examined living specimens of *Pseudorbis granulum* and could confirm its position in Skeneidae s. str. since the species has a well-developed propodial penis". This drawing will be reproduced herein (Fig. 44).

Currently, there are 13 accepted species of the genus *Parviturbo*, living in the Atlantic and Pacific coasts and these will be here studied in detail, one of them being here excluded from the genus. We have grouped the species according to their area of distribution in the West Atlantic and East Atlantic species, Panamic Province and Tropical Pacific.

In the Genus *Pseudorbis* only 2 Recent species were known, which are distributed in the Mediterranean, in West Africa and in the Canary Islands.

## 1. EASTERN ATLANTIC SPECIES

This section includes all the species assigned to the genus *Parviturbo*, having a distribution in the Mediterranean, European Atlantic coast, West African coast and Macaronesian islands. WARÉN (1992: 154) noted that "These species may ultimately need a new genus since the tropical species of *Parviturbo* all live in shallow water and have a dominant spiral sculpture (McLean pers. comm.), but I find it unwise to introduce a new genus for the European species before any soft parts are known". Due the difficulty to obtain living individuals of these species which could allow to study anatomy and radula, we conservatively keep them in the genus *Parviturbo*.

Ten species are here studied, of which four are new for science. Those 5 previously known are *P. elegantulus* (Philippi, 1844), *P. alboranensis* Peñas & Rolán, 2006, *P. fenestratus* (Chaster, 1896), *P. insularis* Rolán, 1988; *P. rolandi*

Engl, 2001. The new species are *Parviturbo ergasticus* spec. nov. (long known as *P. cf. sphaeroideus* (*sensu* Jeffreys, 1883): *P. azoricus* spec. nov., *P. multispinalis* spec. nov., and *P. seamountensis* spec. nov. One more is presented without a name.

WARÉN (1992: 192) also wrote: "It is very likely that the genus *Pareuchelus* Boettger, 1906 is a better placement for the species I have classified in *Parviturbo*, but a decision will have to await examination of actual specimens of the type species *P. excellens* Boettger, 1906". *Euchelus* (*Pareuchelus*) was named by BOETTGER (1906) as a subgenus and raised to genus level by LADD (1972), PACAUD & LE RENARD (1995) and Harzhauser (2002). This being a genus name which has been employed in fossil species with an uncertain family placement, we prefer to keep the European species in the genus *Parviturbo*, as did WARÉN (1992).

*Parviturbo elegantulus* (Philippi, 1844) (Figure 1A-F)

*Delphinula elegantula* Philippi, 1844. *Enumeratio molluscorum Siciliae*, vol. 2: 146, pl. 25 fig. 3. [Type locality: Pezzo near Reggio Calabria (fossil)].

*Parviturbo elegantulus* (Philippi, 1844) - WARÉN, 1992. *Boll. Malac.*, 27 (10-12): 154, figs. 1D, 3D.

**Type material:** Not known.

**Material examined:** (3 s): One shell identified as *Delphinula elegantula* Philippi, 1844, collected by Monterosato, in SMNH, Stockholm, on photograph (WARÉN, 1992: fig. 1D, 3D; reproduced in GIANNUZZI-SAVELLI, PUSATERI, PALMIERI & EBREO, 1994: fig. 363 and herein Fig. 1A); 2 s, Alboran island, from sediments of a bottom with abundance of *Madrepora oculata* in 200 m depth.

*Description (based on our shell from Alboran):* Shell very small, turbiniform, formed by about 3 whorls, umbilicate.

Protoconch bulbous, with a little more than 0.8 whorls, 290 µm in diameter; although apparently smooth it is covered by microperforations. Teleoconch of 2 ¼ whorls separated by a moderately impressed suture; periphery rounded.

Ornamentation formed by spiral cords, axial ribs and microgranules. In apertural view, 4 cords can be seen on the first whorl, and 8 on the last one between the suture and the umbilicus; basal cord more prominent and the umbilical one somewhat finer. Axial ribs and spiral cords much narrower than the interspaces, forming a reticulate pattern with small tubercles at the intersections.

In the last whorl, the space between the suture and the first cord is a little wider than between the other cords, and there the axial ribs are thicker. The entire surface of the teleoconch is covered by microgranules.

Umbilicus of medium size, deep, delimited by an angled thick cord, inside with marked growth lines. Aperture rounded, prosocline (more than in the specimen figured in WARÉN, 1992); parietal callus very thin, continued into the columella which is also very thin, is

curved and slightly reflected at its base; outer lip with a bevelled edge, on which the termination of spiral cords is projecting; without tubercles on its inner side.

**Dimensions:** Our largest adult shell measures 1.08 mm in height and 1.27 mm in diameter. According to WARÉN (1992; figs. 1D, 3D) the shell has 1.7 mm maximum diameter, with a protoconch 350 µm in diameter, apparently smooth.

**Habitat:** The shells from Alboran Island were collected in a bottom with abundance of *Madrepora oculata* at 200 m in depth. Probably it is a fossil or subfossil specimen.

**Distribution:** Recent shells from Alboran Island.

**Remarks:** *Parviturbo elegantulus* is a Plio-Pleistocene fossil originally described from Pezzo, in Calabria, southern Italy. MARGELLI, COPPINI & BOGI (1995: 42, figs. 1-3) listed this species showing a shell dredged between 120 and 160 m in the Alboran coralligenous, but this figure probably represents a *P. alboranensis*.

The most similar species is *P. alboranensis*, from which it can be differentiated because *P. elegantulus* has the periumbilical area delimited by well-marked spiral cords, whereas in *P. alboranensis* the periumbilical cord is weak and it interferes with the axial sculpture to form a zigzag pattern.

*Parviturbo alboranensis* Peñas & Rolán, 2006 (Figure 2A-F)

*Parviturbo alboranensis* Peñas & Rolán, 2006, in PEÑAS, ROLÁN, LUQUE, TEMPLADO, MORENO, RUBIO, SALAS, SIERRA & GOFAS (2006). *Iberus*, 24 (1): 23-151. [Type locality: Alboran Island, Spain].

*Parviturbo elegantulus* - MARGELLI, COPPINI & BOGI, 1995. *La Conch.*, 275: 42, figs. 1-3.

**Type material:** Holotype and 7 paratypes deposited in MNCN (15.05/46643).

**Other material examined:** (28 s): Spain: 20 s, Alboran island, coralligenous, 80-200 m (CAP).

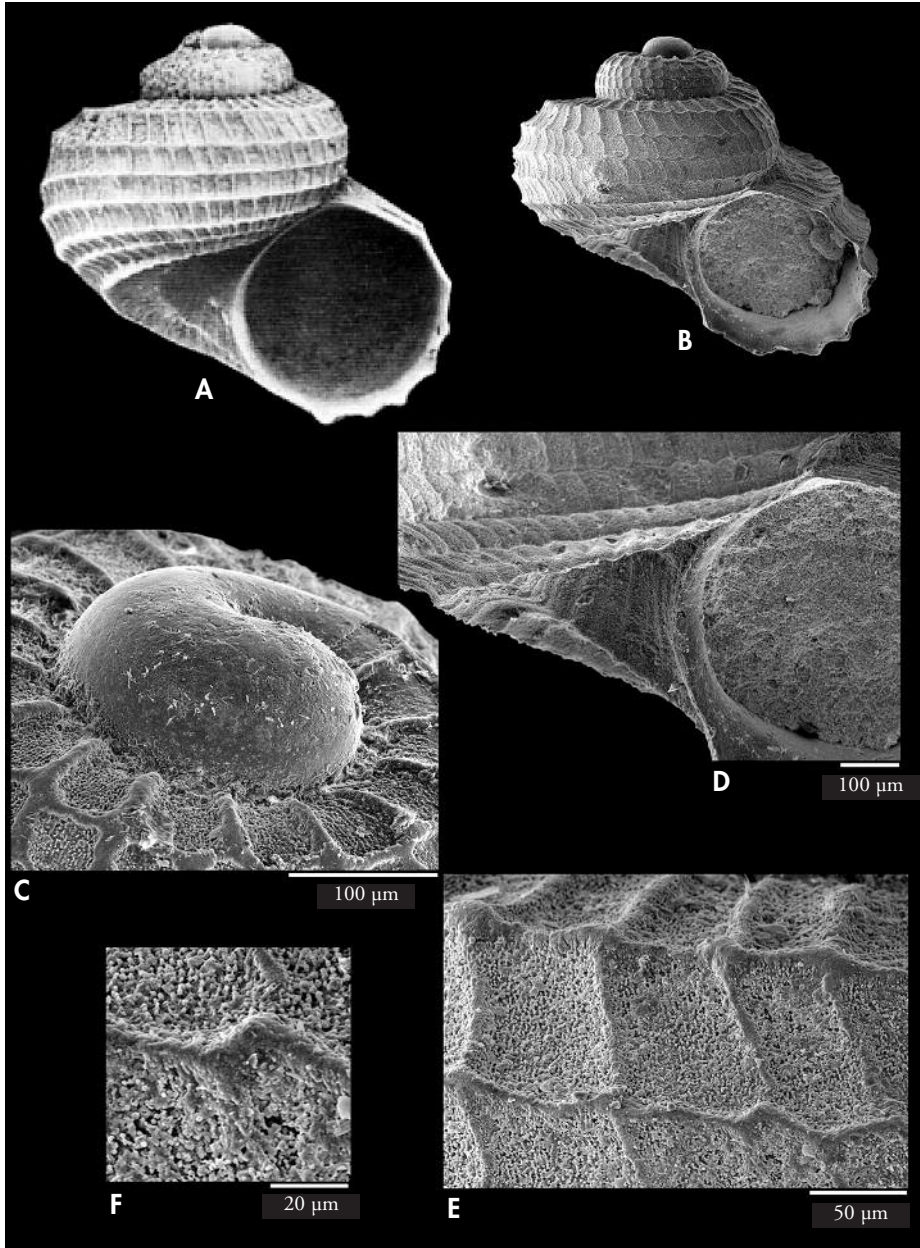


Figure 1. *Parviturbo elegantulus* (Philippi, 1844); A: shell, 1.7 mm in diameter, Canitello, Plio-Pleistocene of southern Italy, Monterosato collection (SMNH) (reproduced from WARÉN, 1992); B: shell, 1.27 mm in diameter, Alboran island (CFR); C: protoconch; D: detail of the umbilicus; E, F: microsculpture and detail.

*Figura 1.* *Parviturbo elegantulus* (Philippi, 1844); A: concha, 1,7 mm de diámetro, Canitello, Plio-Pleistoceno del sur de Italia, colección de Monterosato (SMNH) (por cortesía de WARÉN, 1992); B: concha, 1,27 mm de diámetro, Isla de Alborán (CFR); C: protoconcha; D: detalle del ombligo; E, F: microescultura y detalle.

*Description (based on the original description and new data):* Shell very small, whitish, robust, turbiniform, formed by 2.8 whorls, broadly umbilicate. Protoconch bulbous, of a little more than 0.8 whorls, about 280  $\mu\text{m}$  in diameter, apparently smooth but with its surface covered by circular depressions forming an irregular reticulate pattern, which can be seen under high magnification.

Teleoconch of 2 whorls separated by a moderately impressed suture; periphery rounded.

Ornamentation formed by spiral cords which are altered to form a zigzag pattern due the crossing of the axial ribs; microgranules not observed. In apertural view, 3 cords can be seen on the first whorl and 6 on the last one, between the suture and the umbilicus, all of similar size. Axial ribs and spiral cords much narrower than the interspaces, forming a regular mesh with small nodules at the intersections. In the last whorl, the space between the suture and the first cord is somewhat wider than between the other cords, and there the axial ribs are thicker.

Umbilicus broad, deep, not delimited by any angled or thickened cord, inside with marked axial ribs. Aperture rounded, prosocline; parietal callus very thin, continued into the columella which is also very thin and curved; outer lip

with a rounded edge without tubercles on its inner side.

*Dimensions:* The adult shell measures up to 0.9 mm in height and 1.2 mm in diameter.

*Habitat:* It was found on coralligenous bottoms of the Alboran Island, dredged between 80 and 200 m.

*Distribution:* Only known from Alboran Island, its type locality.

*Remarks:* PEÑAS ET AL. (2006) indicate that *Parviturbo alboranensis* differs from *P. elegantulus* by having both the shell and the protoconch smaller, and also the spiral cords less prominent and less numerous. Its main differential characteristics are (1) the spiral sculpture formed by 6 scarce prominent cords which tend to form zigzags, (2) the lack of a periumbilical cords, (3) the reticulate pattern with some hexagonal cells, as a consequence of the zigzag pattern of the cords and (4) the periphery rounded, not carinate.

*Parviturbo rolani*, described from the Canary Islands, differs by having a smaller protoconch, more whorls and being more elevated in profile.

*Parviturbo alboranensis* resembles *P. ergasticus* spec. nov. in having a similarly large protoconch, however it differs by the lesser number of spiral cords, which are also less prominent and form zigzags, and by lacking a periumbilical cord.

### *Parviturbo* sp. (Figure 3A-D)

**Material examined:** (1 s): A shell with broken protoconch collected at 5 Km north of Messina, Italy, on a gravel bottom about 40 m (CPM).

*Description:* Shell very small, not very robust, almost as high as wide, formed by 3 whorls separated by a marked suture, narrowly umbilicate. The studied specimen lacks the protoconch, but by its form, we can guess that it has about  $\frac{3}{4}$  whorls. Teleoconch formed by 2  $\frac{1}{4}$  whorls, ornamented with spiral cords, axial ribs, microgranules and growth lines. The spiral cords are hardly prominent. In apertural view, 4 cords can be seen on the first whorl and 8 on the last; these cords are crossed by the axial ribs, forming a regular reticu-

late pattern and tiny tubercles at the intersections.

The entire surface of the teleoconch is covered by microgranules, many of them with an elongate form and anastomosed among them. The periphery is rounded. The space between the suture and the first spiral cord is convex and widens gradually towards the labial edge; it is crossed by axial ribs that are somewhat shorter in the first whorl and more spaced between them, while in the last whorl they are more numerous, clearly prosocline and are more closely



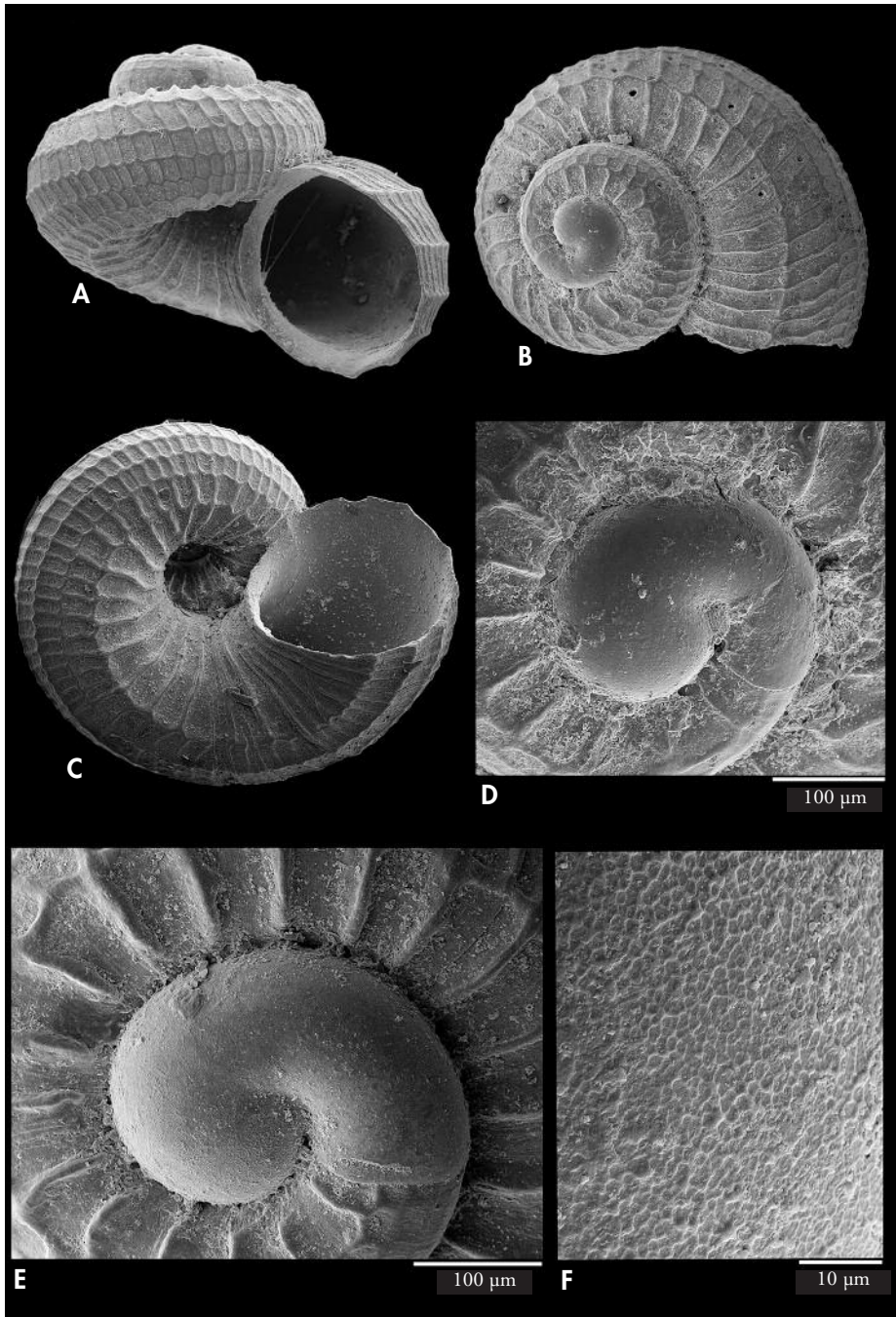


Figure 2. *Parviturbo alboranensis* Peñas & Rolán, 2006. A-C: shells, 1.1, 1.02, 1.1 mm, Alboran Island (CAP); D, E: protoconch; F: microsculpture of the protoconch.

Figura 2. *Parviturbo alboranensis* Peñas & Rolán, 2006. A-C: conchas, 1,1, 1,02, 1,1 mm, Isla de Alborán (CAP); D, E: protoconcha; F: microscultura de la protoconcha.

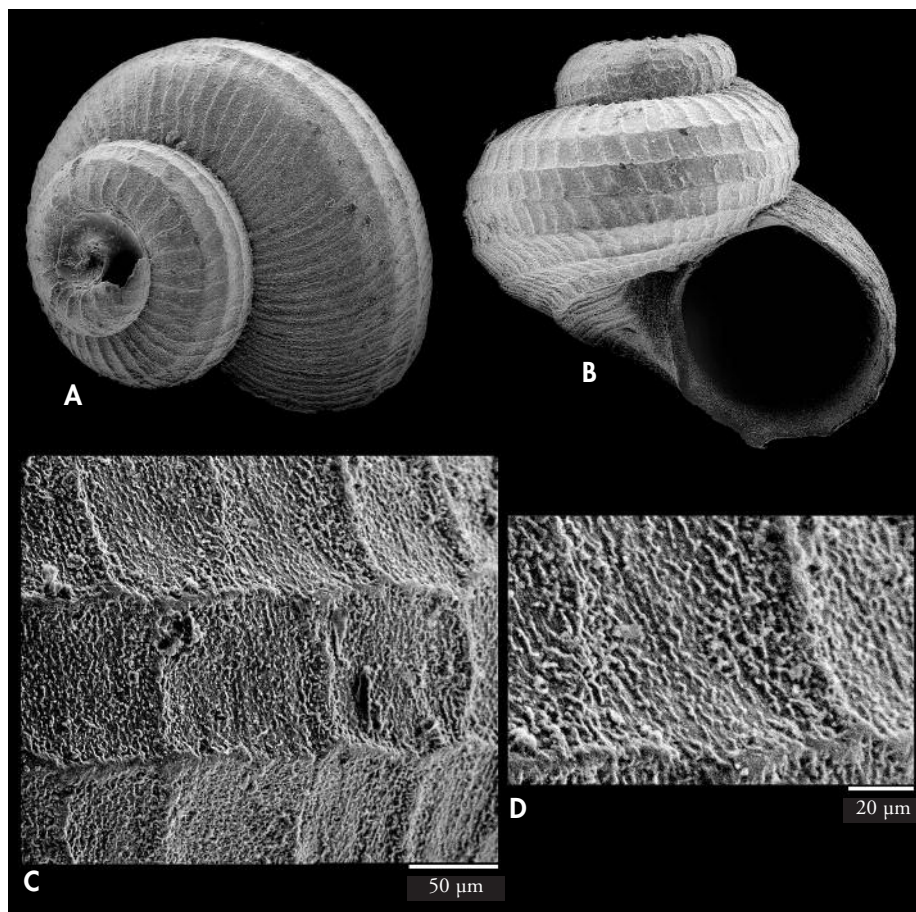


Figure 3. *Parviturbo* sp. A, B: shell, 1.44 mm, Messina, Italy, 40 m (CPM); C, D: microsculpture and detail.

Figura 3. *Parviturbo* sp. A, B: concha, 1,44 mm, Messina, Italia, 40 m (CPM); C, D: microescultura y detalle.

set. Umbilicus narrow and deep, bounded by a thick spiral cord which forms an angle, inside only with thick growth lines.

Aperture rounded, prosocline; parietal callus a very thin layer, continued into an arched columella, widened at the base and slightly reflected; outer lip with a thin, simple edge.

Dimensions: The shell studied measures 1.44 mm in maximum diameter.

Remarks: This species may be undescribed but lacking the protoconch we prefer to await for more material.

*Parviturbo* sp. is characterized by its rounded periphery; the spiral cords are not very elevated; the convexity of the space between the suture and the first spiral cord, the numerous and prosocline axial ribs, and by the thick and angled periumbilical and basal cords. In its general appearance, *Parviturbo* sp. somewhat resembles *Parviturbo alboraensis* in form, and in the number and size of the spiral cords; it also shares traits with *Parviturbo fenestratus* in relation to the position, shape and size of the basal and periumbilical cords.

*Parviturbo ergasticus* Rubio, Rolán & Gofas, spec. nov. (Figure 4A-E)

*Cyclostrema sphaeroideum* (S.V. Wood, 1842) - JEFFREYS, 1880. *Ann. Mag. Nat. Hist.*, (5) 6: 317 [Bay of Biscay, Travailleur Expedition, 1880].

*Cyclostrema sphaeroïdes* (S.V. Wood, 1842) - JEFFREYS, 1883. *Proc. Zool. Soc. London* 1883: 93 [in part, cited localities Bay of Biscay and "Porcupine" 1870 sta. 26-28 in the Ibero-Moroccan Gulf may be this species, others see under *Parviturbo fenestratus*] - LOCARD, 1898. *Exp. Travailleur Talisman*, vol. 2: 7 [Bay of Biscay].

"*Cyclostrema*" *sphaeroïdea* (S.V. Wood, 1842) *sensu* Jeffreys, 1883 - WARÉN, 1980: pl. 2 fig. 7-9; WARÉN, 1992. *Boll. Malac.*, 27 (10-12): 153.

**Type material:** Holotype, 1 shell from "Travailleur", Dr. 2, in MNHN (IM-2000-30474). Paratypes, 4 shells from the lot USNM - 181467, "Travailleur" Expedition, without locality, from Bay of Biscay. Examined on the photographs by Yolanda Villacampa (USNM).

**Type locality:** Bay of Biscay, Cap Breton canyon, 43°36'N - 01°55'W, 1019 m.

**Etymology:** The species is named in honour of "Le Travailleur", the ship which carried out the early deep-sea expedition in Bay of Biscay during which the species was collected.

*Description (based on the holotype and on Recent specimens from lot USNM - 181467):* Shell very small, robust, turbiniform, formed by 3 ¼ whorls, narrowly umbilicate. Protoconch apparently smooth, bulbous, of a little more than of ¾ whorls, 300-320 µm in diameter. Teleoconch of 2 ½ whorls, not carinate, separated by a well-marked suture; periphery rounded.

Ornamentation formed by spiral cords, axial ribs and microgranules. In apertural position there are 5 cords on the first 1 ½ whorl, and 11 on the last one between the suture and the umbilicus; basal cords more prominent and the umbilical one something finer.

Axial ribs crossing the spiral cords to form a regular mesh with a small tubercle at the intersections. Between the suture and the first cord there is a space twice as wide as between the other cords, in which the axial ribs are thicker.

Umbilicus of medium size, deep, delimited by a not very thick cord, inside with only marked growth lines. Aperture rounded, prosocline; parietal callus a very thin layer, continued into the columella which is also very thin, curved and slightly reflected in its base; outer lip with a bevelled edge, scalloped by the termination of spiral cords, without tubercles on its inner side.

**Dimensions:** The holotype measures 1.60 mm in height and 1.60 mm in diameter; the figured paratype measures 1.43 mm in height and 1.47 mm in diameter.

*Habitat:* Bathyal species, dredged in Bay of Biscay in 1000-1200 m, Travailleur exp. 1880-1881 (JEFFREYS, 1880, 1883; LOCARD, 1898); in several hundred of meters in depth (WARÉN, 1992: 153).

*Distribution:* Bay of Biscay ("Travailleur" Expeditions, 1880-1881) and possibly South of Portugal ("Porcupine" Expedition Stn. 1870-26, 36°44'N, 08°08'W, 364 fathoms) cited in JEFFREYS (1883).

*Remarks:* The first mention of this species was in JEFFREYS (1880: 317), in a list of the mollusca procured during the cruise of the "Travailleur" in the Bay of Biscay, 1880, under the name *Cyclostrema sphaeroïdeum* (S.V. Wood, 1842). This refers to *Turbo? sphaeroïdea* S.V. Wood, 1842, a species originally described as a fossil from the Coralline Crag of Sutton, England, of Pliocene age. The origin of the specimens mentioned by JEFFREYS (1880) can be qualified following DE FOLIN (1881: 156) who wrote: "L'exploration de 1880 s'était arrêtée, comme on le sait, à la hauteur du cap Peñas. C'est un peu au delà de ce point, mais beaucoup plus au large de la côte espagnole, que reprirent les opérations de 1881".

JEFFREYS (1883: 93) made an unjustified emendation of the name to *sphaeroïdes*, mentioned further records including several stations from Porcupine Exp. 1870, and indicated "Bay of Biscay (Travailleur Exp. 1881)" as the previously known locality. The specimens photographed in the present work (Fig. 4 F-I) and those figured by WARÉN (1980: figs. 7-9), are supposed to

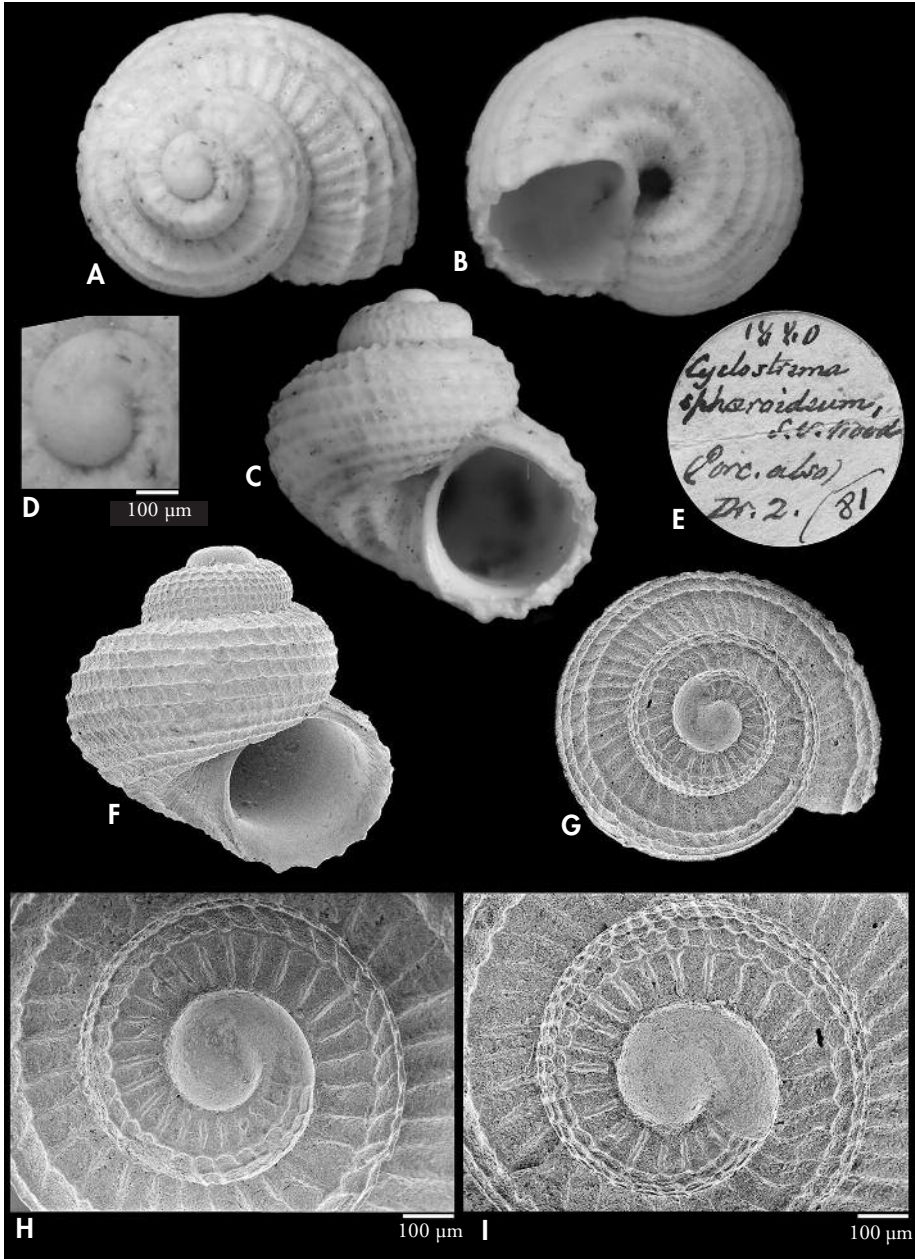


Figure 4. *Parviturbo ergasticus* spec. nov. A-C: holotype from Bay of Biscay, "Travailleur" St. 2, 1019 m, 1.6 mm in height and diameter; D: protoconch of the holotype; E: label, presumably of the hand of Jeffreys, reading "(Porc[upine]. also)"; F, G: shell (USNM 181467), 1.47 mm in diameter; H: protoconch; I: protoconch, same shell as G (photographs by Yolanda Villacampa, USNM).

Figura 4. *Parviturbo ergasticus* spec. nov. A-C: holotipo del Golfo de Vizcaya, "Travailleur" Est. 2, 1019 m, 1,6 mm de altura y diámetro; D: protoconcha del holotipo; E: etiqueta, presumiblemente de la mano de Jeffreys, que reza "(Porc[upine]. also)"; F, G: concha (USNM 181467), 1,47 mm de diámetro; H: protoconcha; I: protoconcha, misma concha que G (fotografías de Yolanda Villacampa, USNM).

be from the same lot (USNM-181467, Travailleur Ex.; Jeffreys Coll.; De Folin) which does not keep track of the station number and may be 1880 or 1881. The specimens from some of the other localities cited by JEFFREYS (1883) are *P. fenestratum* (WARÉN, 1992: 154, see under that species).

LOCARD (1898: 7) in relation to *Cyclostrema spheroides* (S.V. Wood) comments: "Les échantillons que nous avons pu examiner avaient été déterminés par Jeffreys; ils sont bien conformes au type figuré par S.V. Wood", and indicates two localities ("Travailleur", 1880 sta. 2 [43°36'N - 01°55'W, Cap Breton canyon, 1019 m) and sta. 9 (43°37'N - 04°02'W, off Santander, 1190 m). The former specimen is still in MNHN, Paris and was selected as the holotype.

The species is considered possibly belonging to *Parviturbo* by WARÉN (1992), who wrote: "the relations to the fossil *Turbo sphaeroidea* S.V. Wood, 1842 are uncertain, and since it is known only from empty shells, the systematic position remains doubtful too". Comparing the figure of WOOD (1842: 533, pl. 5, fig. 3) with the specimens figured by WARÉN (1980) and in the present work, the number of spiral cords and the general appearance of the

shell are rather similar but the spire is much more elevated in the Recent specimens. Furthermore, the environment of the Recent specimens is radically different from that of the Crag fossil, which lived in a shallow shelf habitat.

The deep-water species described here is therefore probably an undescribed species of *Parviturbo*, but considering the uncertainty on the exact origin of the specimens in USNM and the lack of new material, we selected a specimen from a definite station cited by LOCARD (1898).

*Parviturbo ergasticus* spec. nov. differs from *P. fenestratus* in having a finer sculpture with eight spiral ribs and a larger protoconch, which is of about 300-320 µm in diameter (against 230-280 µm in *P. fenestratus*). The record of BOGI & NOFRONI (1986) of "*Parviturbo sphaeroideus*" for Bonifacio Strait (100-200 m) is to be referred to *P. fenestratus* (WARÉN, 1992: 154).

LANDAU, MARQUET & GRIGIS (1999: 38, pl. 9, figs. 1 - 2) figured two shells labelled as *Parviturbo* cf. *sphaeroidea* (Jeffreys, 1883) from the early Pliocene of Estepona, Southern Spain, that have a certain resemblance with the specimen represented by WARÉN (1980).

### *Parviturbo fenestratus* (Chaster, 1896) (Figure 5A-E)

*Cyclostrema fenestratum* Chaster, 1896. *J. Malacol.*, 5: 1-4, pl. 1 fig. 1. [Type locality: Bay of Tangier, Morocco].

*Parviturbo fenestratus* (Chaster 1896) - WARÉN, 1992. *Boll. Malac.*, 27 (10-12): 154; 193; 202, fig. 1B; 204, fig. 3B.

**Type material:** 2 syntypes (NMW-1910.029, Coll. G.W. Chaster), not examined.

**Material examined:** (6 s): Spain: 6 s, Barbate, Cadiz, 36°88.3'N, 05°53.6'W, 29 m, bioclastic sand (Málaga University).

*Description (from the original description in CHASTER (1896) and new data):* Shell very small, globose and conical, rather solid, turbiniform, formed by 3 very convex whorls, broadly umbilicate.

Protoconch apparently smooth, bulbous, of about 0.6 whorls, with 230-280 µm in diameter. Teleoconch of 2 ¼ whorls separated by a deep suture; periphery rounded.

Ornamentation formed by strong spiral cords, axial ribs and microgranules.

In apertural view, 4 cords can be seen on the first whorl, and 6 on the last one between the suture and the umbilicus; the basal cord is the most prominent and the umbilical one not so strong. Axial ribs and spiral cords equal in size on the first whorl, forming an irregular reticulate pattern; on the last whorl, the cords are thicker and the axial ribs somewhat finer and equidistant, occupying the concave spaces between the cords. Between the suture and the first major cord, the space is wider than

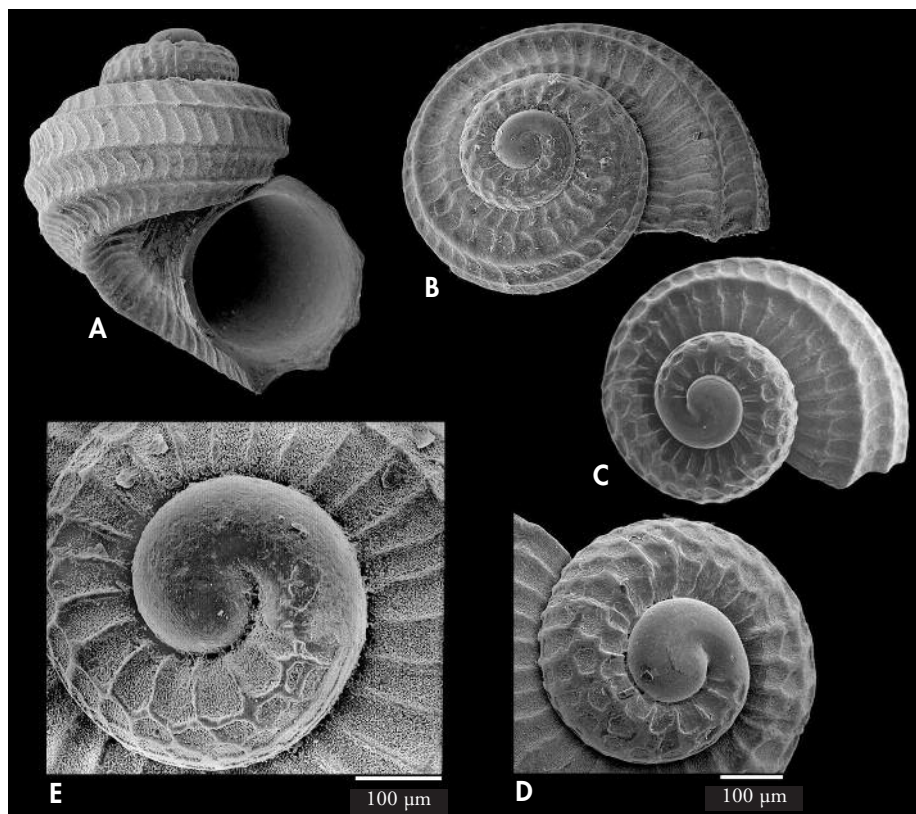


Figure 5. *Parviturbo fenestratus* (Chaster, 1896). A-C: shells, 1.05, 1.14, 0.8 mm, Barbate, Cadiz (University of Malaga); D, E: protoconch and microsculpture.

Figura 5. *Parviturbo fenestratus* (Chaster, 1896). A-C: conchas, 1,05, 1,14, 0,8 mm, Barbate, Cádiz (Universidad de Málaga); D, E: protoconcha y microescultura.

between other cords, and generally occupied by a smaller spiral cordlet. The entire surface of the teleoconch is covered by microgranules.

Umbilicus large, deep, delimited by a moderately thick cord, inside with marked growth lines. Aperture rounded, slightly prosocline; parietal callus thin, continued into the columella which is curved and slightly reflected towards the umbilicus; outer lip with a bevelled edge, on which the termination of the spiral cords are projected, except the umbilical cord; without tubercles on its inner side.

Dimensions: The adult shell measures 1 mm in height and maximum diameter.

Habitat: This is an infralittoral to outer shelf species, with a depth range between

13-200 m (WARÉN, 1992). The type specimen was dredged at 12.8 m deep in shell sand (CHASTER, 1896); the material examined comes from a bottom of bioclastic sand, located at 28.8 m in depth.

Distribution: Strait of Gibraltar: Bay of Tangier, Morocco (CHASTER, 1896; WARÉN, 1992); from Punta Almina, Ceuta, between 30-43 m (WARÉN, 1992) and from Barbate (RUEDA, SALAS & GOFAS, 2000). Western Portugal: "Porcupine" Expedition, stn. 1870-24 (37°19'N, 09°13'W, 292 fathoms) (WARÉN, 1992). Mediterranean Sea: between Corsica and Sardinia (BOGI & NOFRONI, 1986, as *Cyclostrema sphaeroidea*); Adventure Bank, Southern Sicily (Porcupine Exp. 1870) and off Tripoli (Shearwater Exp.)

(WARÉN, 1992); Aegean sea (KOUTSOUBAS, KOUKOURAS & VOULTSIADOU-KOUKOURAO, 1997).

*Remarks:* Species originally described in the genus *Cyclostrema* and transferred by WARÉN (1992) to *Parviturbo*. CHASTER (1896) wrote: "Another species described by Philippi, the fossil *Delphinula? elegantula* apparently differs only in having the longitudinal lines finer and closely crowded not giving rise to any decussation".

Besides this, another differential character is the size of the protoconch, which in *P. elegantulus* measures up to 350  $\mu\text{m}$  in diameter, against 230-280  $\mu\text{m}$  (240  $\mu\text{m}$  according to WARÉN, 1992) in *P. fenestratus*.

This species was encompassed in JEFFREYS' (1883) concept of "*Cyclostrema spheroides*" and the specimens from several localities including "Porcupine" sta. 1870-24, Tangiers Bay and Adventure Bank were reassigned to *P. fenestratus* by WARÉN (1992: 154).

### *Parviturbo rolani* Engl, 2001 (Figure 6A-G)

*Parviturbo rolani* Engl, 2001. *Novapex*, 2 (4): 141-143. [Type locality: Puerto del Carmen, Lanzarote, Canary Islands, 45 m].

**Type material:** (14 s): Holotype in SMNH (5098); paratypes in ZSM (20012151), NMW (2001.036.00001), ZMB (104.114), MHNS (examined) and nine in the collection of W. Engl.

**Material examined:** (2 s): Canary Islands: 1 s, Puerto del Carmen, Lanzarote.

*Description (from the original description and new data):* Shell small, solid, whitish, opalescent, turbiniform, globular in shape, formed by 3.4 whorls, narrowly umbilicate.

Protoconch bulbous, smooth, of about 0.6 whorls and 230  $\mu\text{m}$  in diameter. Teleoconch of 2.8 whorls, not carinate, separated by an impressed suture; periphery rounded.

Ornamentation formed by strong spiral cords, axial ribs and microgranules. Spaces between the cords a little concave. In apertural view, 2 cords can be seen on the first whorl, and 6 on the last one between the suture and the umbilicus, all of similar size. Axial ribs thinner than spiral cords, crossing these to form a rectangular reticulate pattern with small nodules at the intersections. In the last whorl, the space between the suture and the first cord is rather wider than between the other cords, and there the axial ribs are thicker. Microgranules axially aligned, occasionally merged but without forming threads, covering completely the teleoconch.

Umbilicus narrow, deep, delimited by a thick cord, inside with marked growth lines and a spiral cordlet. Aperture rounded, prosocline; parietal callus thick, continued into the columella which is also

very thick, curved and slightly reflected at its base; outer lip with a bevelled edge, on which the terminations of the spiral cords are projecting and reflected outward; without tubercles on its inner side.

**Dimensions:** The adult shell measures up to 1.9 mm in diameter.

**Habitat:** *P. rolani* was found in fine sediment at a depth of 40-45 m.

**Distribution:** Only known from Lanzarote and El Hierro islands, Canaries.

*Remarks:* ENGL (2001) mentions: "the most close species to it is *P. fenestratus*, which differs from *P. rolani* by having eight instead of six dominant spiral ribs on the body whorl. *Parviturbo fenestratus* actually has no more than six thick spiral cords, five are distributed from the suture to the base and one more delimits the umbilicus (Fig. 6A). However there are other differences, *P. rolani* is almost twice as large, lacks the intermediate spiral cord which is seen in *P. fenestratus* between the suture and the first large spiral cord, and the periumbilical cord is nearly as strong as the basal cord and not situated so deep inside the umbilical depression.

*Parviturbo rolani* may be differentiated from *P. azoricus* mainly by its size and the size of the protoconch, 310  $\mu\text{m}$  in *P. azoricus* and about 230  $\mu\text{m}$  in *P. rolani*.

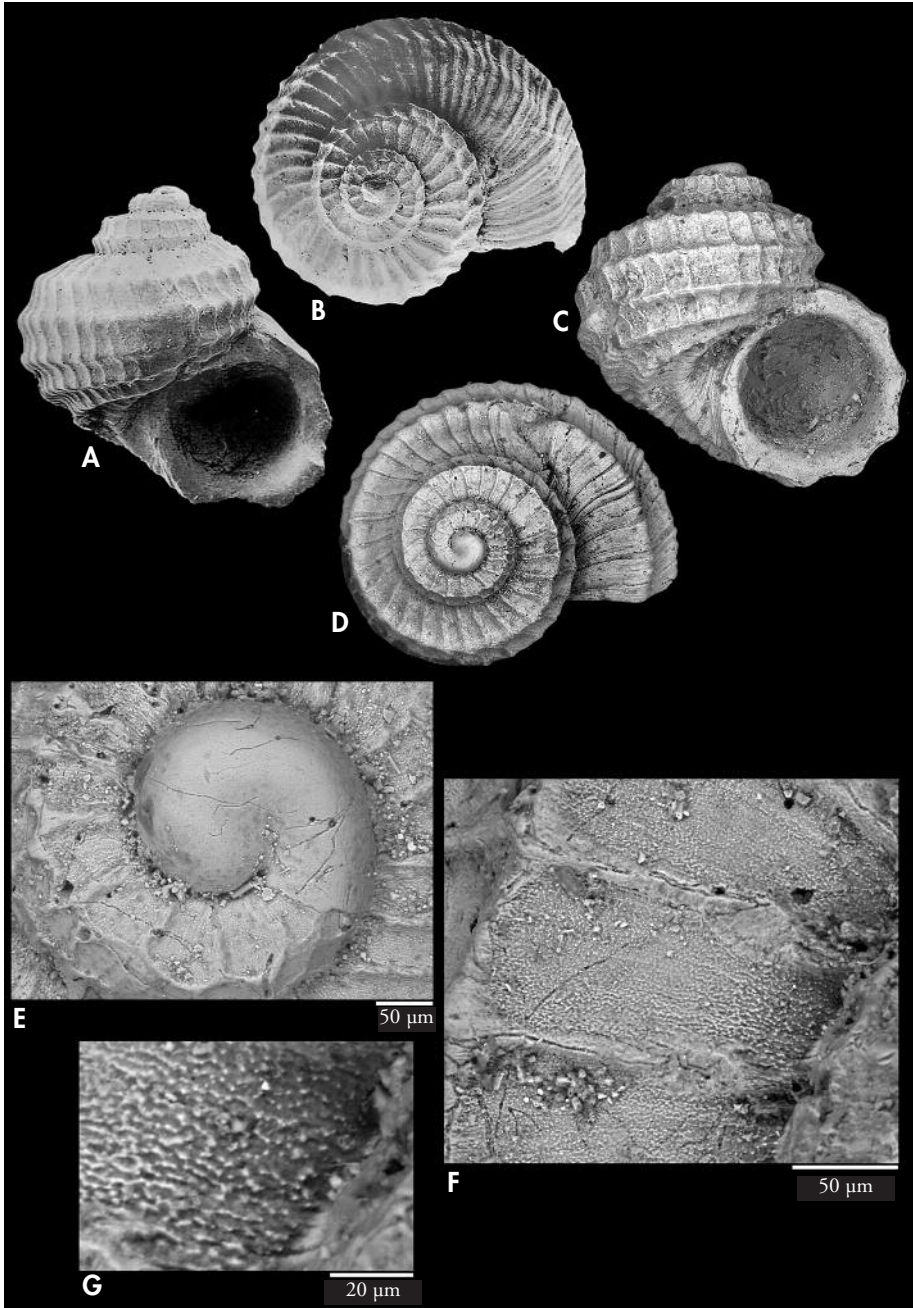


Figure 6. *Parviturbo rolani* Engl, 2001. A, B: paratype, 1.9 mm (reproduced from HERNANDEZ ET AL., 2011), Lanzarote, Canary Island (CWE); C, D: shell, 1.51 mm, Puerto del Carmen, Lanzarote, Canary Island (MHNS); E: protoconch; F, G: microsculpture and detail.

Figura 6. *Parviturbo rolani* Engl, 2001. A, B: paratipo, 1,9 mm (reproducido de HERNÁNDEZ ET AL., 2011), Lanzarote, Islas Canarias (CWE); C, D: concha, 1,51 mm, Puerto del Carmen, Lanzarote, Islas Canarias (MHNS); E: protoconcha; F, G: microescultura y detalle.



*Parviturbo azoricus* spec. nov. Rubio, Rolán & Segers (Figure 7A-G)

*Parviturbo* cf. *rolani* - SEGERS, 2002. *Gloria Maris*, 41: 86, figs. 6, 7.

**Type material:** (18 s): Holotype (Figs. 7A-C) in DBUA (1075); paratypes: one paratype in DBUA; one paratype (j) in MHNS (100617), both from type locality. Other paratypes in CWS: 8 s, São Roque, Pico, -5 m on sand; 2 s, Lajes, Pico, littoral between stones; 2 s, Porto Martins, Terceira, littoral in grit; 2 s, Madalena Islands, 30-35 m in grit.

**Type locality:** Azores, São Roque, Pico, 5 m, on sandy bottom.

**Etymology:** The specific name refers to the islands where the type material was collected.

*Description:* Shell very small, with a solid appearance, formed by 2 ½ whorls separated by a deep suture, carinate and widely umbilicate.

Protoconch ¾ of a whorl, slightly rough, about 310 µm in diameter with a nucleus of 120 µm. Teleoconch of only 1 ¾ whorls, with angled periphery.

Ornamentation formed by thick spiral cords, axial ribs and microgranules. In apertural view there are 3 cords, and an additional one coincident with the suture, on the first whorl, and 6 cords on the last whorl; the space between cords is concave; the ribs override the cords to form a flattened tubercles at the points of intersection. Between the suture and the first spiral cord there is a wide space, also concave, in which the axial ribs are undulating. Surface of teleoconch covered by microgranules.

Umbilicus narrow and deep, bound by a thick spiral cord which angles the edge; inside only with thick axial growth lines. Aperture rounded, slightly prosocline, peristome continuous; parietal callus very thin, continued into a columella which is slightly curved, and becomes wider and reflected in its base;

outer lip edge sharp, crenulated by the termination of the spiral cords.

**Dimensions:** The holotype measures 1.2 mm in diameter.

**Habitat:** In sediments on sandy bottom with rocks.

**Distribution:** Only known from type locality

**Remarks:** *Parviturbo azoricus* spec. nov. is very similar to *P. fenestratus* in its general shape and number of cords, although less elevated. However, there are constant morphological characters that distinguish both species: *P. azoricus* has a protoconch of 0.8 whorls and 310 µm, while *P. fenestratus* has 0.6 whorls only and 230-280 µm. Furthermore *P. azoricus* has no intermediate spiral cord between the suture and the first large spiral cord; It also lacks the zigzag pattern of the cords on the first whorl of the teleoconch, which forms six-sided cells in the case of *P. fenestratus*; in the external lip, all the spiral cords modify the external lip alike.

The great distance between the areas of distribution of both species (Barbata-Tangier *versus* Azores) without intermediate locations, has influenced our decision to consider them different species.

*Parviturbo insularis* Rolán, 1988 (Figure 8A-H, 9A-E)

*Parviturbo insularis* Rolán, 1988. *La Conchiglia*, 20 (232-233): 26-27, figs. 1-5 [Type locality: Brava, Cape Verde Islands].

**Type material:** Holotype and some paratypes deposited in MNCN (15.05/1029). Other paratypes in: CZL, MNHST, NHMUK, MNHN, ZMA, MHNS and AMNH.

**Other material examined:** (114 s) Cape Verde Islands: Sal: 25 s, Mordeira Bay, 5-10 m (MHNS); Rabo de Junco: 5 s, 2-4 m (MNHN); Boavista I.: 15 s, Sal Rei, 2-10 m (MHNS); Porto Ferreira: 5 s, 5 m (MHNS); Santiago I.: 23 s, Praia, Prainha, 2-8 m (MHNS); Brava I.: 32 s, Furna, 10-20 m (MHNS); 8 s, Pedrinha, 8 m (MHNS); São Vicente I.: 6 s, Matiota beach, 1-4 m (MHNS).

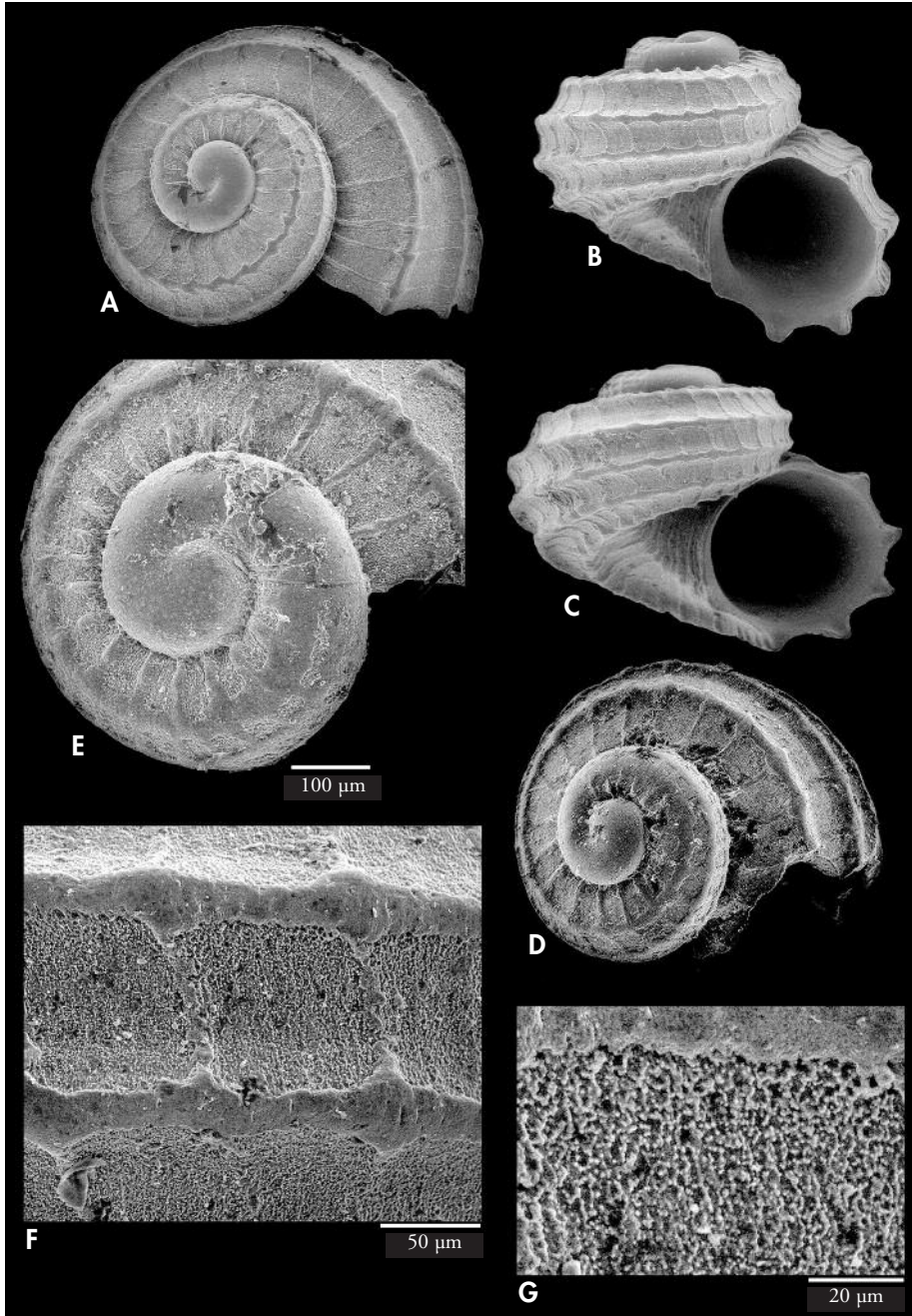


Figure 7. *Parviturbo azoricus* spec. nov. A-C: holotype, 1.2 mm in diameter, São Roque, Pico, Azores (DBUA); D: paratype juvenile, 0.8 mm (MHNS); E: protoconch of a paratype; F, G: microsculpture and detail.

Figura 7. *Parviturbo azoricus* spec. nov. A-C: holotipo, 1,2 mm de diámetro, San Roque, Pico, Azores (DBUA); D: paratipo juvenil, 0,8 mm (MHNS); E: protoconcha de un paratipo; F, G: microscultura y detalle.

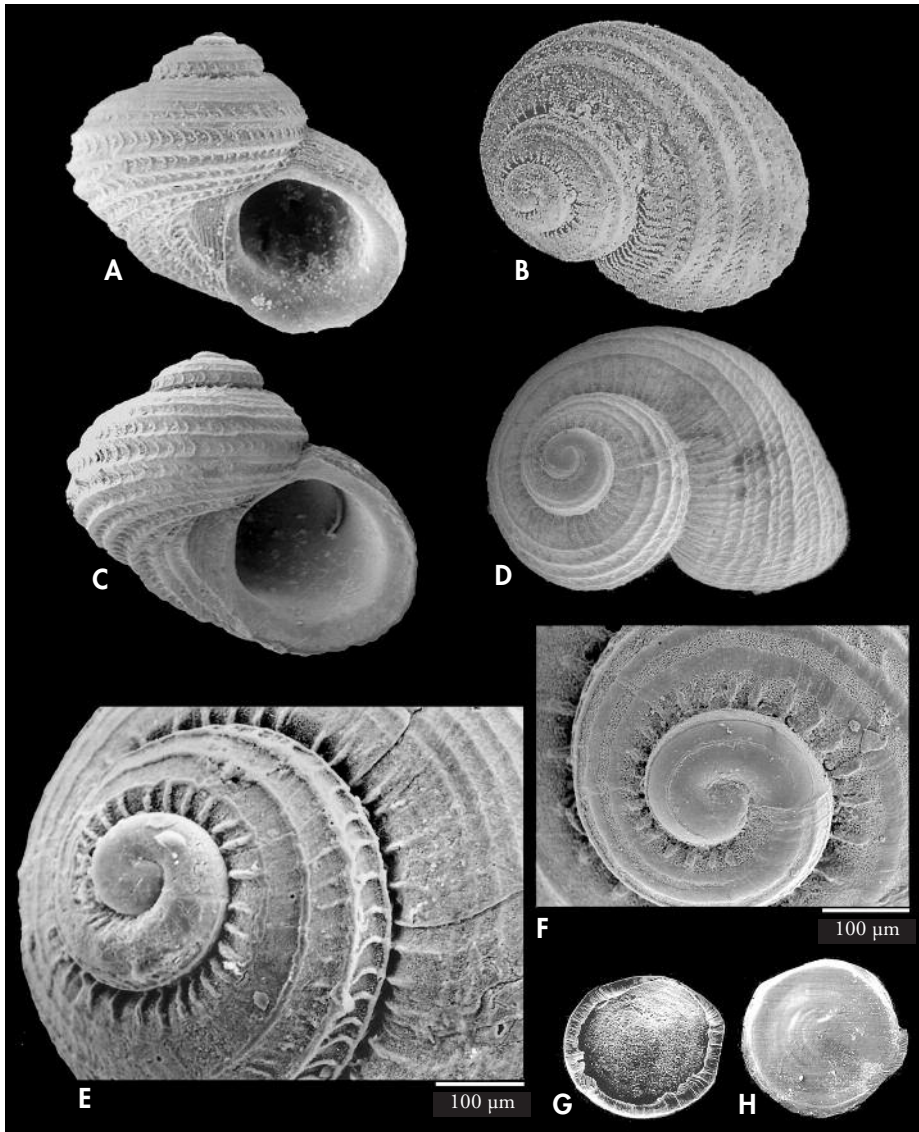


Figure 8. *Parviturbo insularis* Rolán, 1988. A: holotype, 1.17 mm (MNCN); B: paratype, 1.5 mm (MHNS); C: shell, 1.4 mm, Furna, Brava, 30 m (MHNS); D: shell, 1.23 mm, Parda, Sal, 3 m (MHNS); E, F: protoconchs, from Furna, Brava; G-H: opercula.

Figura 8. *Parviturbo insularis* Rolán, 1988. A: *holotipo*, 1,17 mm (MNCN); B: *paratipo*, 1,5 mm (MHNS); C: *concha*, 1,4 mm, Furna, Brava, 30 m (MHNS); D: *concha*, 1,23 mm, Parda, Sal, 3 m (MHNS); E, F: *protoconchas*, de Furna, Brava; G-H: *opérculos*.

*Description* (from the original description and new data in ROLÁN & RUBIO, 1999: 2, figs. 1-4): Shell very small, whitish, opalescent, robust, turritiform, formed by 3 whorls

of a slightly depressed globular shape, with a blunt apex, narrowly umbilicate.

Protoconch with a little more than  $\frac{3}{4}$  whorls, 210  $\mu$ m in diameter with three spi-

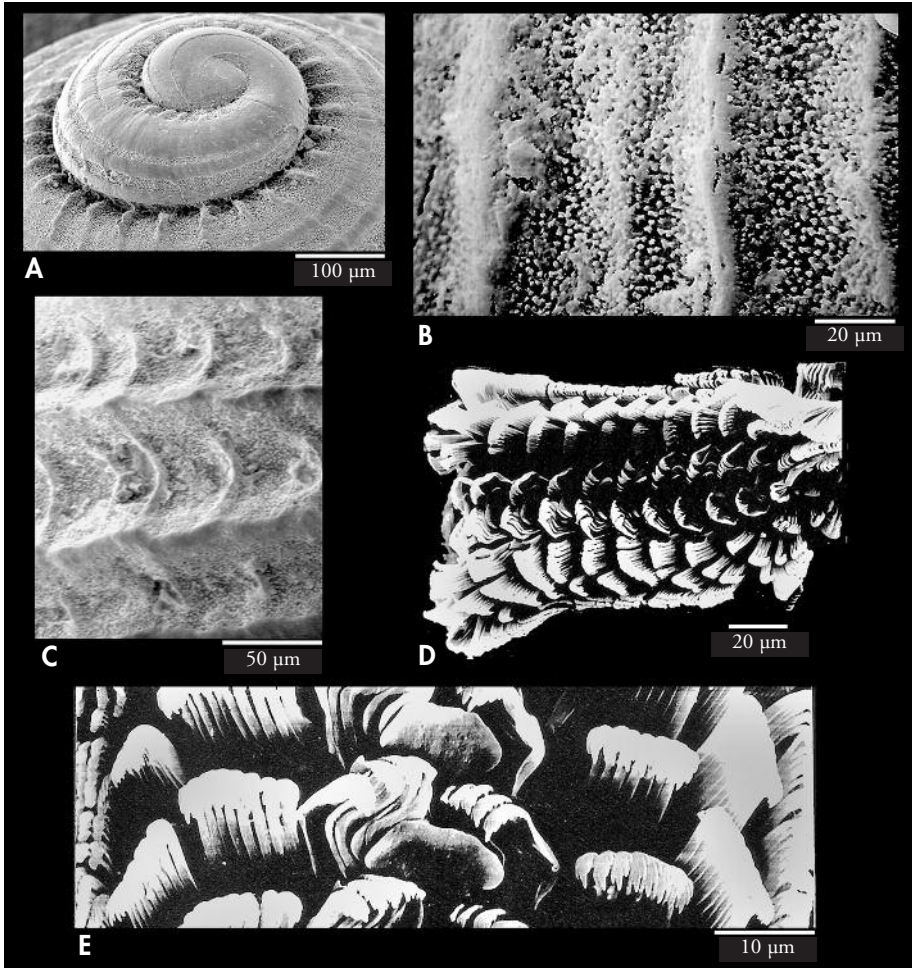


Figure 9. *Parviturbo insularis* Rolán, 1988. A: protoconch; B, C: microsculpture; D, E: radula.  
Figura 9. *Parviturbo insularis* Rolán, 1988. A: protoconcha; B, C: microescultura; D, E: rádula.

ral cordlets (seen only on fresh specimens). Teleoconch of 2 ¼ whorls, separated by an impressed suture; periphery rounded.

Ornamentation formed by spiral cords, axial ribs and microgranules. In apertural view, 4 cords can be seen on the first whorl, and 14-16 (occasionally up to 18) rather prominent ones on the last whorl between the suture and the umbilicus; spiral cords as wide as the interspaces, with the exception of those (4 to 9) in the upper part of the whorl which can be narrower. Towards the base, the fourth cord before the umbilicus is more prominent; the last one delimit-

its the umbilicus. Very fine axial threads start from the suture and reach the first spiral cord. They continue in the interspaces between the other cords, becoming more conspicuous towards the base, where they cross over the cords. Between the suture and the first cord there is a space twice as wide as between the other cords, in which the axial ribs are thicker. The entire surface of the teleoconch is covered by microgranules irregularly scattered between the spiral cords.

Umbilicus narrow, deep, delimited by a moderately thick cord, inside with

only marked growth lines. Aperture rounded, prosocline; parietal callus thin, continued into the columella which is thick, curved and slightly reflected in its base; outer lip with a sharp edge, without tubercles on its inner side.

The operculum is corneous, yellowish, rounded; the edge is very thin. It is multispiral, but its spire is not easily visible and only then in its inner part, being uniform on the outer part.

The animal is cream-white with elongate ciliated cephalic tentacles; small black eyes and a big parapodial tentacle in the right side, between the eye and the epipodium; mouth bilobed; epipodium with three pair of tentacles, not very long, being two of them on the opercular lobe.

The radula has a formula N.5.1.5.N. The rachidian tooth is very broad with quadrangular shape and the lateral edges strongly expanded and with a smooth

cusps. The lateral teeth are of similar size, overlapping on the inner part, with a characteristic bend in the middle shaft and with long denticulate cusps overhanging the outer part. A well-developed latero-marginal plate is visible. This plate extends behind and in front of the inner margins. The marginal teeth are long and narrow with denticulate cusps which are strongly overhanging.

Dimensions: The adult shells measure about 1.5 mm in diameter.

*Habitat*: Under stones in the intertidal level, in all the islands of the Cape Verde Archipelago.

*Distribution*: Only known from Cape Verde Archipelago (ROLÁN, 2005). Practically in all the islands.

*Remarks*: The radula of *P. insularis* is very similar to that of *Parviturbo acuticostatus* (Carpenter, 1864), figured by HICKMAN & MCLEAN (1990).

### *Parviturbo multispiralis* spec. nov. (Figure 10A-F)

*Parviturbo* sp. - ROLÁN, 2005. *Malac. Fauna Cape Verde Archipelago, part 1*: 49, pl. 12 figs. 169-172.

**Type material**: Holotype (Figs. 10A-B) in MNCN (15.05/60158).

**Type locality**: Sal Rei, Boavista, dredged at 30 m, Cape Verde Archipelago.

**Etymology**: The name alludes to the conspicuous spiral sculpture which predominates over the axial.

*Description*: Shell small, trochoid, with an elevated spire, formed by 3 ¼ whorls; periphery rounded.

Protoconch of ¾ of whorl, with a maximum diameter of about 240 µm, with a slightly rough surface and 3 spiral cordlets; there is no thickened varix in its transition to the teleoconch. Teleoconch formed by 2 ½ whorls of globose aspect.

Ornamentation consisting of spiral cords of even size crossed by axial threads which give it a reticulate appearance. In apertural view, 4-5 cords can be observed on the first whorl and between 21 and 24 cords on the last whorl, distributed 20 on the margin of the outer lip and 3-4 more at the base; the more internal cord delimits the umbilicus with an angle. Spaces between the cords covered by microgranules.

Umbilicus narrow and deep, delimited by a spiral cord, inside with numerous and fine axial threads. Aperture

rounded; parietal callus simple, hardly adherent to the previous whorl, forming a slight angle with the columella which is thick and arched; outer lip with the peristome not thickened, reflected outwards.

Dimensions of the holotype: 4.0 mm in diameter.

*Habitat*: Dredged at 30 m.

*Distribution*: Only known from the type locality.

*Remarks*: *Parviturbo multispiralis* spec. nov. differs from *P. insularis*, the most similar species, by its larger size, by the more numerous spiral cords, more uniformly distributed over the entire shell and by the reticulate pattern formed by the crossing of the spiral cords and the axial ribs. There are however common characters to both species such as size and ornamentation of the protoconch, and the surface between cords fully covered by microgranules.

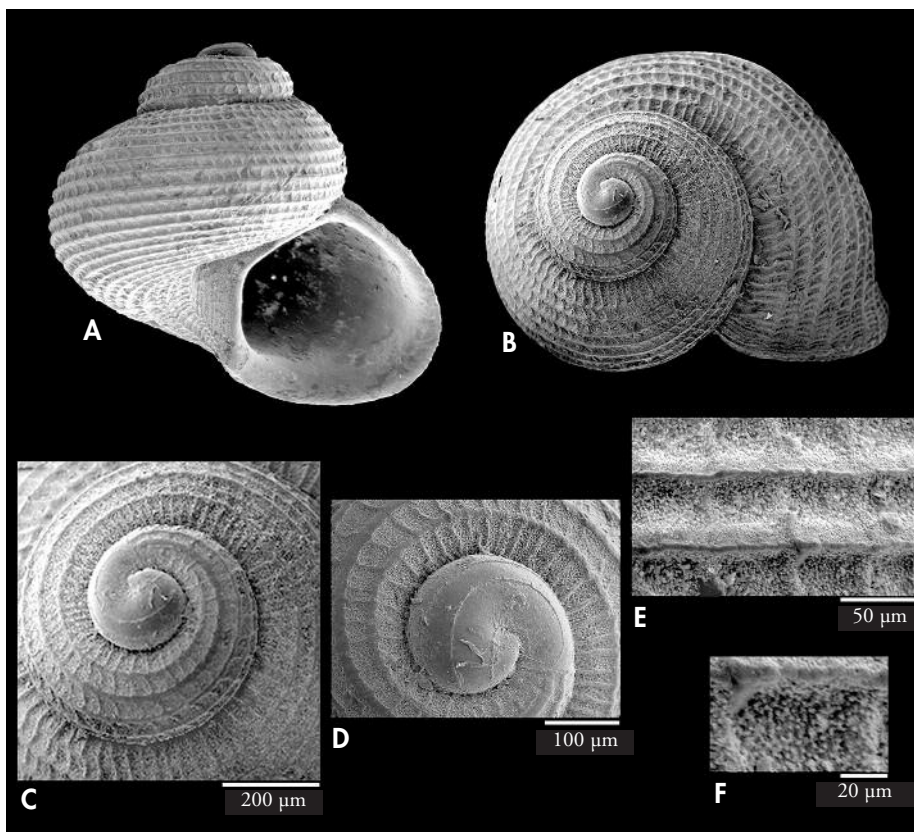


Figure 10. *Parviturbo multispiralis* spec. nov.; A, B: holotype, 4.0 mm, Sal Rei, Boavista (MNCN); C, D: protoconch; E, F: microsculpture and detail.

Figura 10. *Parviturbo multispiralis* spec. nov.; A, B: holotipo, 4,0 mm, Sal Rei, Boavista (MNCN); C, D: protoconcha; E, F: microscultura y detalle.

*Parviturbo seamountensis* spec. nov. Rubio, Rolán & Gofas (Figure 11A-B, 12A-F)

**Type material:** Holotype in MNHN IM-2000-30345 (Figs. 11A-B) and 58 paratypes (Figs. 12A) (MNHN IM-2000-30346).

**Material studied:** (72 s): Great Meteor Seamount, SEAMOUNT 2: 58+1 s, Stn. DW152, 30°02'N-28°22'W, 470 m (type material); 1 s, Stn. DE 174, 30°02'N-28°43'W, 620 m; 1 s, Stn. DW 136, 30°02'N-28°28'W, 305 m; 4 s, Stn. DW 143, 30°10'N-28°28'W, 330 m; 1 s, Stn. DW 179, 30°10'N-28°42'W, 730 m. Irving Seamount, SEAMOUNT 2: 2 s, Stn. DW 215, 31°54'N-28°03'W, 275 m. Hyères Seamount, SEAMOUNT 2: 3 s, Stn. DW 188, 31°30'N-28°00'W, 310 m. Plato Seamount, SEAMOUNT 2: 2 s, Stn. DW 242, 32°12'N-28°57'W, 710 m.

**Type locality:** Great Meteor seamount, 30°02'N-28°22'W, 470 m [SEAMOUNT 2: Stn. DW 152].

**Etymology:** The specific name is after the "Seamount" expeditions of MNHN, Paris, during which the species was collected.

**Description:** Shell small, robust, turbiniform, with the apex not very

prominent, formed by 4 whorls of rapid growth separated by a marked suture.

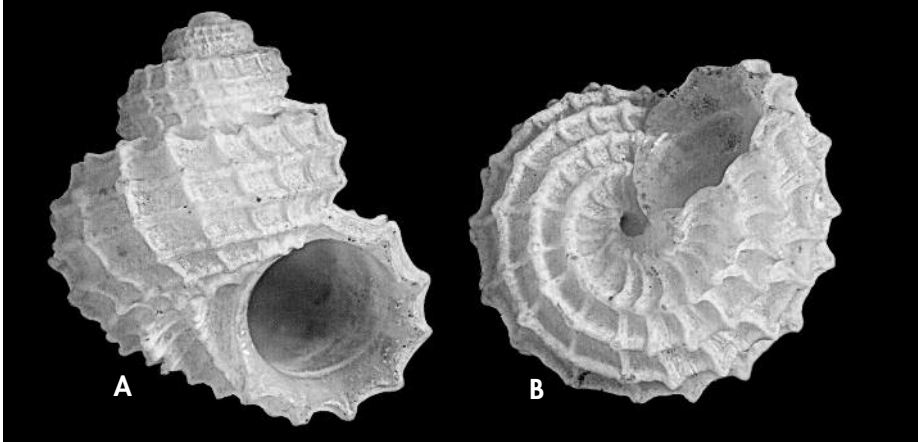


Figure 11. *Parviturbo seamountensis* spec. nov. A, B: holotype, 1.75 mm in diameter, Great Meteor Seamount, Stn. DW 152 (MNHN).

Figura 11. *Parviturbo seamountensis* spec. nov. A, B: holotipo, 1,75 mm de diámetro, Gran Banco Meteor, Stn. DW 152 (MNHN).

Protoconch of  $\frac{3}{4}$  whorl, totally smooth, measuring about 220  $\mu\text{m}$  in diameter. Teleoconch with 3 whorls.

Ornamentation formed by spiral cords and axial ribs, elevated and much narrower than the interspaces, forming a coarse quadrangular mesh with small tubercles at the intersections, more pointed on the last whorl. In apertural view 3 cords can be observed on the 1st and 2nd whorls and 7 on the last one. Under great magnification a microsculpture of crisp granules can be seen on first and second teleoconch whorl; on the last whorl these granules become of a vermiculate aspect.

Umbilicus narrow and deep, delimited by a cord bearing small tubercles, inside with strong axial growth lines and also a very fine spiral line. Aperture rounded, prosoclinal; parietal callus rather thin, continued into a columella which is arched, enlarged on its base and reflected towards the umbilicus, and lacking any denticle or bulge at its base; outer lip scalloped by the termination of the spiral cords, with a crenulated margin slightly reflected outwards, without denticles on its internal margin.

Dimensions of the holotype: 1.75 mm in height and 1.65 mm in diameter (H/D: 1.06).

*Habitat*: This species has a bathyal distribution, dredged between 275 and 730 m.

*Distribution*: NE Atlantic seamounts: Great Meteor, Hyères, Plato and Irving.

*Remarks*: *Parviturbo seamountensis* spec. nov. is similar in its ornamentation to some European species, being reticulate with the axial ribs crossing the spiral cords as typical of these species. However contrary to the new species, most are wider than high. The presence of strong axial ribs, and the reticulate pattern instead of the fine lamellae in the interspaces between cords distinguish it from any of the Western Atlantic and Pacific species.

In its general appearance also it recalls some Mediterranean species of the genus *Aloania*, being differentiated by its lower spire, the presence of an umbilicus and its paucispiral protoconch.

*Parviturbo seamountensis* spec. nov. could be included in the genus *Vaceuchelus* Iredale, 1929 (Vetigastropoda, Chilodontidae) considering the similarity of some of its morphological characters with those given for this genus by HERBERT (2012) as: "Shell small (adult diameter <10 mm) and predomi-

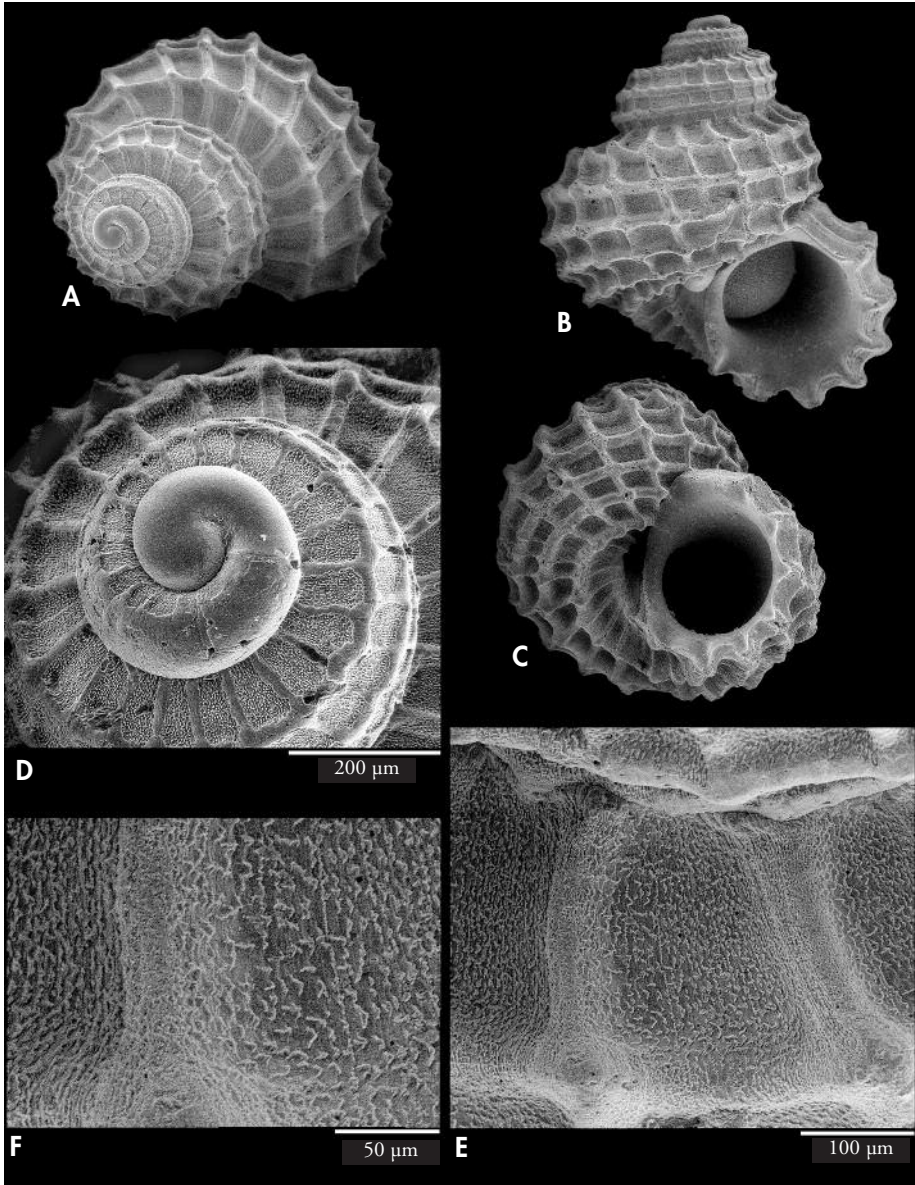


Figure 12. *Parviturbo seamountensis* spec. nov. A-C: paratypes 1.7, 1.87, 1.7 mm in diameter, Great Meteor Seamount, Stn. DW 152 (MNHN); D: protoconch; E, F: microsculpture and detail.

Figura 12. *Parviturbo seamountensis* spec. nov. A-C: paratipos 1,7, 1,87, 1,7 mm de diámetro, Gran Banco Meteor, Stn. DW 152 (MNHN); D: protoconcha; E, F: microescultura y detalle.

nantly white, turbiniform; sculpture cancellate or foveolate and columella lacking any form of dentition or with at most a low rounded bulge at its base".

Nevertheless *P. seamountensis* lacks the typical ornamentation of *Vaceuchelus* species, with an axial sculpture of numerous ribs, having instead a broad



rectangular mesh. Only a radular and/or anatomical studies would allow a definitive placement in one or another genus. Thus considering the shell morphology closer to *Parviturbo*, we placed it in this genus.

*Minolia tabakotanii* Poppe, Tagaro & Dekker, 2006 is morphologically similar

to *P. seamountensis* although differing mainly by the presence of nacre inside the shell, absent in all the species of Skeneidae and therefore of the genus *Parviturbo*. HELWERDA, WESSELINGH & WILLIAMS (2014) placed that species in the genus *Zetela* Finlay, 1926 (Solariellidae).

## 2. WEST ATLANTIC SPECIES

In this group we included all the species occurring from Cape Hatteras to Brazil. For a correct identification of the species, we have compared our material with that from the McGinty collection currently deposited in MCZ, as well as with the types of some species deposited in USNM.

Among these species from the Western Atlantic, there are two morphological patterns that allow us the separation into two groups, and on this basis we will present them and one more for the species which are not included in these groups:

(1) Group of *Parviturbo rehderi* Pilsbry & McGinty, 1945. It is formed by 2 known species: *P. rehderi* Pilsbry & McGinty, 1945 and *P. granulum* (Dall, 1889); and 5 new species: *P. guadeloupensis* spec. nov., *P. billfranki* spec. nov., *P.*

*boucheti* spec. nov., *P. dengyanzhangii* spec. nov. and *P. annejoffeae* spec. nov.

(2) Group of *Parviturbo weberi* Pilsbry & McGinty, 1945. It is formed by 3 known species: *P. weberi* Pilsbry & McGinty, 1945, *P. comptus* (Woodring, 1928) and *P. tuberculosus* (d'Orbigny, 1842); more 4 new species: *P. marcosi* spec. nov., *P. rectangularis* spec. nov., *P. gofasi* spec. nov. and *P. fortius* spec. nov.

Three more species do not belong to any of the previously mentioned two groups, all them new: *P. brasiliensis* spec. nov., *P. zylmanae* spec. nov. and *P. robustior* spec. nov.

RUBIO ET AL. (2013) transferred *Parviturbo calidimaris* Pilsbry & McGinty, 1945, *Parviturbo francesae* Pilsbry & McGinty, 1945 and *Parviturbo turbinus* (Dall, 1889) to *Haplocochlias*.

### 2.A. GROUP OF *P. REHDERI*

#### *Parviturbo rehderi* Pilsbry & McGinty, 1945 (Figure 13A-H)

*Parviturbo rehderi* Pilsbry & McGinty, 1945. *The Nautilus*, 59: 54-55, pl. 6, fig. 8. [Type locality: North Inlet of Lake Worth, Palm Beach].

**Type material:** Holotype in ANSP (181312), examined on a photograph (Fig. 13A). Paratypes: 2 s, N inlet in Lake Worth, Singer Island rocks, from McGinty collection (MCZ 226800); 2 s, Inlet - Lake Worth, McGinty collection (MCZ 207087), examined.

**Other material examined:** (14 s): Cuba: 2 s, Maria la Gorda, Guanahacabibes, Pinar del Rio, 30 m; 1 s, Hotel Comodoro Beach, La Habana, 8-10 m; 1 s, Baracoa (North Cuba), 6 m; 8 s, Jibacoa Beach, 12 m. Lesser Antilles: 1 s, east side Petit St. Vincent, Windward Is., drift high tide line (CHL). Santa Lucia: 1 s, entrance to Port Castries, S of Tapion Rock (MCZ 251605).

*Description (from the original description and new data):* Shell small, solid, white, turbiniform, formed by 3 ½ whorls of rapid growth, narrowly umbilicate.

Protoconch of a little more than ¾ whorls, 230 µm in diameter, with 3 spiral cordlets on its surface. Teleoconch of 2 ¾ whorls, separated by a deep suture; periphery carinate.

Ornamentation formed by spiral cords, axial ribs and microgranules in the interspaces. The spiral cords are large and sharp, like keels, being 3 on the first whorl and 7 on the last one. In apertural view, 3 cords can be seen on the first whorl and 11 on the last one between the suture and the umbilicus. The spaces between cords are occupied by strongly prosocline axial threads which, in the central zone, are raised into small lamellae, spirally aligned over the deepest part of the groove. Between the suture and the first cord the axial ribs are fine and elongated; between the first and second cords the interspaces are much wider than in the others, and there two such series of lamellae. The axial threads do not cross the cords. The entire surface of the teleoconch is covered by microgranules.

Umbilicus small, deep, delimited by the seventh spiral cord; inside there are not cordlets. Aperture rounded, prosocline; parietal callus thin continued into the columella which is very thick, arched and not reflected; outer lip with a bevelled edge, on which the termination of spiral cords is projecting; without tubercles on its inner side.

Dimensions: The holotype measures 1.7 mm in diameter and 1.6 mm in height. The shell photographed measures 1.6 mm in diameter and 1.5 mm in height (H/D: 0.94).

*Habitat*: Under rocks (PILSBRY & MCGINTY, 1945); under rocks, inter-

tidally (ABBOTT, 1974); associated with *Halimeda opuntia* in coral reefs (GARCÍA-RÍOS, SOTO-SANTIAGO, COLÓN-RIVERA & MEDINA-HERNÁNDEZ, 2008). Bathymetric range: 0 to 40 m deep.

*Distribution*: USA, Florida, North Inlet of Lake Worth, Palm Beach, Fisher Island, Biscayne Bay and Ft. Myers Beach (PILSBRY & MCGINTY (1945); South half of Florida to Panama (ABBOTT, 1974); Colombia; Cuba: Pinar del Rio, Havana Province (AGUAYO & JAUME, 1951); Brazil: Amapa, Fernando de Noronha (LEAL, 1991b); Puerto Rico (ORTIZ-CORPS, 1985; GARCIA-RIOS ET AL., 2008). Lesser Antilles, Windward Is: Petit St. Vincent and Sta. Lucia, in the present work. Range: 26.8°N to 4°S; 83°W to 32.5°W.

*Remarks*: PILSBRY & MCGINTY (1945) comment: "*P. rehderi* is characterized by the strength and small number of subequal spiral ridges or carinae. "*Cyclostrema*" *granulum* Dall (1889, Blake Rep., Gastropoda, *Bull. Mus. Comp. Zool.* 18: 395, from Samana Bay, Santo Domingo) has more numerous spirals, the lower ones smaller, and it is relatively higher".

*Parviturbo rehderi* is characterized by the sharp spiral cords; by two rows of lamellae between the cords 1 and 2 on the last whorl; by the outer lip scalloped by the termination of the spiral cords, and without denticles on its inner side.

### *Parviturbo guadeloupensis* spec. nov. (Figure 14A-F)

**Type material**: Holotype in MNHN IM-2012-7798 (Figs. 14A-C) and 19 paratypes in MNHN IM-2012-37353.

**Other material studied**: (3 spm, 17 s) Guadeloupe, KARUBENTHOS (all in the MNHN): 1 s, Petite-Terre, Stn. GB34 (16°10.45'N-61°08.16'W), 10 m, (IM-2012-7798), Holotype; 1 spm, Petit Cul-de-Sac Marin in front to the Marine Biology Laboratory, Stn. GM01 (16°13.41'N-61°31.83'W), intertidal (IM-2012-7804); 2 spm, Grand-Terre, Pointe de la Vigie (grotte Amédier), Stn. GS25 (16°30.57'N-61°28.45'W), 12 m, rocky bottom (IM-2012-7808); 6 s, Basse-Terre, Ilet Fortuna, Stn. GM06 (16°09'N-61°33.67'W), intertidal (IM-2012-7801); 2 s, Grand Cul-de-Sac Marin, Port Louis (les 3 Arches), Stn. GS17 (16°23.26'N-61°31.79'W), 3 m, rocky bottom (IM-2012-7806); 1 s, Grande-Terre, Lagon de Saint-Francois, Stn. GB35 (16°15.17'N-61°15.42'W), 2 m (IM-2012-7802); 2 s, Grande-Terre, Vaisseaux Bank, Stn. GD66 (16°08.17'N-61°17.32'W), 33 m (IM-2012-7805); 1 s, Grand-Terre, Vieux Habitants (Mamalier), Stn. GM23 (16°04.24'N-61°46.16'W), 6 m (IM-2012-7800); 1 s, Petite-Terre, Stn. GS37 (16°10.45'N-61°08.16'W), 10 m (IM-2012-7809); 1 s, Grand Cul-de-Sac Marin, Chenal Ilet à Colas, Stn. GS02 (16°20.94'N-61°34.39'W), 15 m (IM-2012-7799); 2 s, Grand Cul-de-Sac Marin, Anse Bertrand (Chapelle Beach), Stn. GM17 (16°28.32'N-61°30.88'W), intertidal (IM-2012-7803).

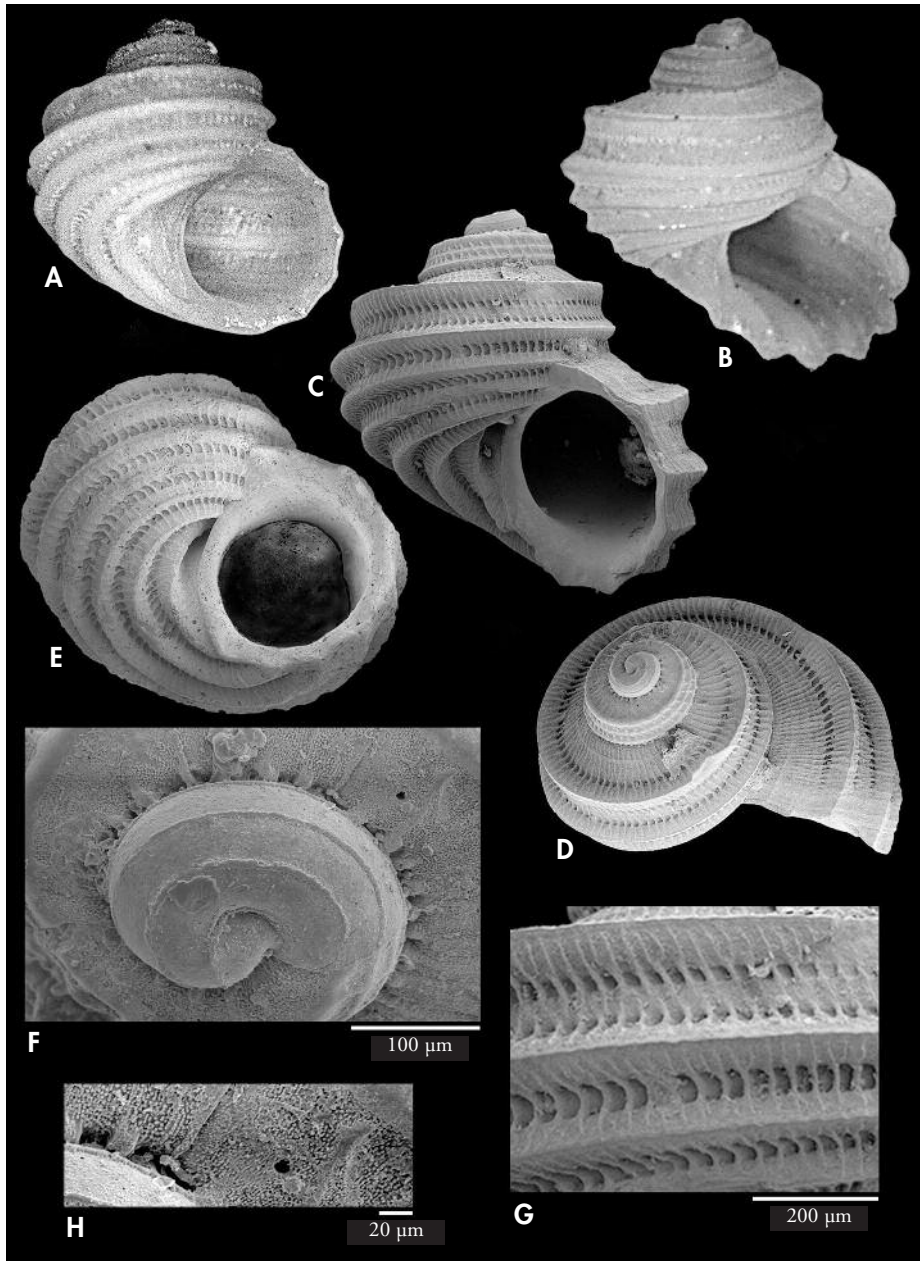


Figure 13. *Parviturbo rehderi* Pilsbry & McGinty, 1945. A: holotype, 1,6 mm, North Inlet of Lake Worth, Palm Beach, Florida (ANSP); B: shell, 1,8 mm, St. Lucia, entrance to Port Castries, S. Tapion Rock (MCZ); C-E: shells, 1,9 (Figs. C and D), 1,8 mm in diameter, Virgin Island (CHL); F: protoconch; G: microsculpture; H: microsculpture of tubercles.

Figura 13. *Parviturbo rehderi* Pilsbry & McGinty, 1945. A: holotipo, 1,6 mm, Ensenada Norte del Lago Worth, Palm Beach, Florida (ANSP); B: concha, 1,8 mm, St. Lucia, entrada al Port Castries, S. Tapion Rock (MCZ); C-E: conchas, 1,9 (Figs. C y D), 1,8 mm de diámetro, Islas Virgenes (CHL); F: protoconcha; G: microescultura; H: microescultura de tubérculos.

**Type locality:** Guadeloupe, Petite-Terre (16°10.45'N-61°08.16'W), 10 m [KARUBENTHOS: Stn. GB34].  
**Etymology:** The specific name is referred to the island where the species was collected.

*Description:* Shell small, turbiniform, bicarinate, narrowly umbilicate, formed by 4 whorls separated by a marked suture.

Protoconch of a little more than  $\frac{3}{4}$  whorl, about 240  $\mu\text{m}$  in maximum diameter and bearing up to 4 spiral cordlets. Teleoconch with only 3 whorls strongly angled by two prominent spiral cords which are forming like carinae.

Ornamentation formed by strong spiral cords, fine axial threads or lamellae, and microgranules in the interspaces between the cords. In apertural view, 2 cords can be seen on the first and second whorls and 7 on the last one between the suture and the umbilicus. On the area between the suture and the first carina, there are up to 5 spiral cordlets; between the fifth cordlet and the carina, the axial threads are raised to form fine lamellae. Between the first and the second carinae there is a wide space with two spiral cordlets and two rows of raised lamellae next to them. The space between the abapical cords (2nd to 7th) is occupied by fine axial threads which are raised into lamellae in the central part of the grooves.

Umbilicus narrow and deep, delimited by a strong spiral cord, and with fine spiral striae inside. Aperture

rounded, prosocline; parietal callus very thin and continued into a thin, arched columella which is slightly wider towards its base and is slightly reflected towards the umbilicus, but without forming a callus nor occluding it. Outer lip scalloped by the termination of the thick spiral cords, not denticulate inside.

Dimensions of the holotype: 1.71 mm in height and 1.82 mm in diameter.

*Habitat:* Infralittoral species living on rocky bottom between 0 and 33 m.

*Distribution:* Only known from Guadeloupe its type locality.

*Remarks:* *Parviturbo guadeloupensis* spec. nov. is very similar in its form to *P. rehderi*, type species of the genus, but can be differentiated by having two main cords which are widely separated and form sharp carinae at the periphery of the shell; by having additional spiral cordlets between the suture and the first carina and between the peripheral carinae, which crossing with the axial threads form a reticulate surface; by having one spiral cord less on the two first whorls of the teleoconch.

The constancy of these morphological differences in numerous shells examined of the new species convinced us to consider it a specific difference.

### *Parviturbo billfranki* spec. nov. Rubio, Rolán & Lee (Figure 15A-E)

**Type material:** Holotype (Fig. 15A) in FLMNH (478950); paratypes: 3 s + 3 j + 3 f in CHL.

**Type locality:** Deadmans's Chest Island, British Virgin Islands, 18 m.

**Etymology:** The specific name is after William Frank of Jacksonville, Fla., USA, webmaster of jaxshells.org, in recognition of his contributions to western Atlantic marine malacology.

*Description:* Shell very solid, turbiniform, as wide as high, formed by approximately 4 whorls of rapid growth, covered by thick spiral cords forming carinae.

Protoconch of a little more than  $\frac{3}{4}$  whorls, measuring about 240  $\mu\text{m}$  in diameter and bearing 3 spiral cordlets. Teleoconch with about three whorls.

Ornamentation of prominent spiral cords, with axial threads and microgranules in their interspaces. The spiral cords

are very thick, widened at their base and sharp on the edge, so as to have a triangular profile and the appearance of carinae. There are 3 cords on the first and second whorls, and 8 on the last one; of these, that located around the umbilicus is smaller and seems somewhat sunken in relation to the other basal cords. The axial threads do not cross the spiral cords; in the spaces between cords they are raised into small lamellae which extend between the bases

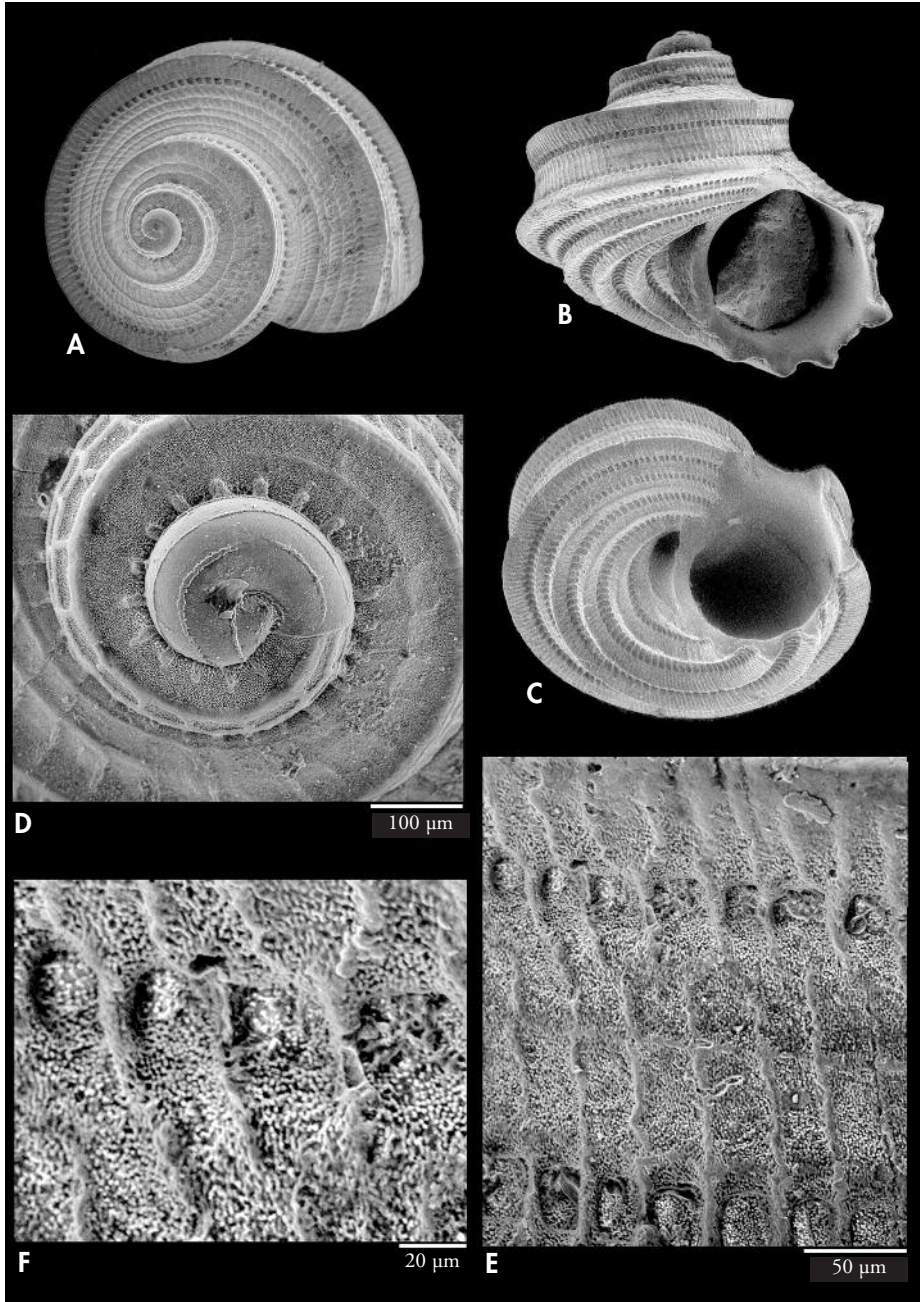


Figure 14. *Parviturbo guadelouensis* spec. nov. A-C: holotype, 1.71 mm in diameter, Guadeloupe, Petite-Terre, Stn. GB34 (16°10.5'N-61°08.2'W), 10 m (MNHN); D: protoconch; E, F: microsculpture and detail.

*Figura 14.* *Parviturbo guadelouensis* spec. nov. A-C: *holotipo*, 1,71 mm de diámetro, Guadalupe, Petite-Terre, Stn. GB34 (16°10.5'N-61°08.2'W), 10 m (MNHN); D: *protoconcha*; E, F: *microescultura y detalle*.

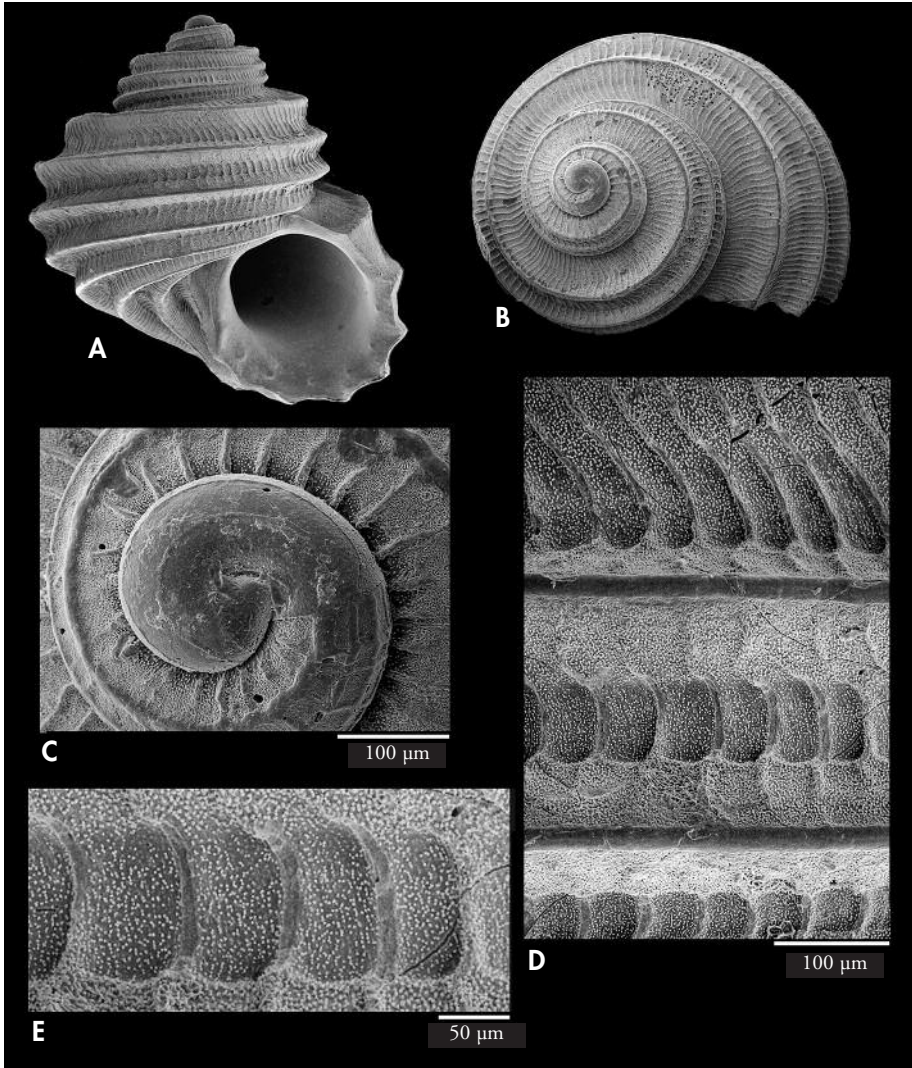


Figure 15. *Parviturbo billfranki* spec. nov. A: holotype, 1.6 mm in diameter (FLMNH); B: paratype, 1.5 mm (CHL), Dead Chest Island, British Virgin Islands; C: protoconch; D, E: microsculpture.

Figura 15. *Parviturbo billfranki* spec. nov. A: holotipo, 1,6 mm de diámetro (FLMNH); B: paratipo, 1,5 mm (CHL), Dead Chest Island, Islas Virgenes Británicas; C: protoconcha; D, E: microescultura.

of the cords. In apical view, mainly in the area between the suture and the first spiral cord, the axial threads can be seen to change from rather wide and separate on the first whorl, to smaller and more numerous on the following. All the teleoconch is covered by microgranules.

Umbilicus narrow and deep, inside with fine axial grooves and a faint spiral cordlet. Aperture rounded; outer lip very thick, with a bevelled edge scalloped by the termination of the spiral cords; on the inner side 6-7 thick and sharp denticles can be observed; the columella is almost

straight, and is widened at its base where it meets the periumbilical cord.

Dimensions of the holotype: 1.67 mm in height and 1.6 mm diameter (H/D: 1.04).

*Habitat*: Infralittoral species, found in a coralline bottom at 18 m deep.

*Distribution*: Only known from Dead Chest Island, British Virgin Islands, its type locality.

*Remarks*: *Parviturbo billfranki* spec. nov. is very similar to *P. rehderi*, from which it differs by having one more spiral cord on the last whorl (8 instead of 7); between the first and the second cord of the last

whorl there is a single series of lamellae spirally aligned (instead of two separated by a shoal in *P. rehderi*); the outer lip is denticulate internally and the cordlets in the protoconch are much less marked.

Another very similar species in the form of the spiral cords and axial threads is *P. acuticostatus* (Carpenter, 1864), which can be distinguished by having only 6 spiral cords in the last whorl, without lamellae in the interspaces and by lacking denticles inside the outer lip; in addition, its distribution is limited to zoogeographic Panamic Province, extending from Lower California to Peru.

### *Parviturbo boucheti* spec. nov. (Figure 16A-E)

**Type material**: Holotype in MNHN IM-2012-7807 (Fig. 16A-C) and 2 paratypes in MNHN IM-2012-7797.

**Material studied**: (3 s): Guadeloupe, Exp. KARUBENTHOS: 1 s, Petite-Terre, Stn. GS34 (16°09.71'N-61°07.73'W), 15 m (IM-2012-7807) (holotype); 2 s, Basse-Terre, Sec Paté, Stn. GB24 (15°54'N-61°39.3'W), 25 m (IM-2012-7797) (paratypes).

**Type locality**: Guadeloupe: Petite-Terre, (16°09.7'N-61°07.7'W), 15 m [KARUBENTHOS: Stn. GS34].

**Etymology**: The specific name is after Philippe Bouchet in recognition of his cooperation in all of our works.

*Description*: Shell very small, white, robust, turbiniform, formed by 3  $\frac{3}{4}$  whorls of rapid growth separated by a moderately impressed suture.

Protoconch of  $\frac{3}{4}$  whorl, about 240  $\mu$ m in diameter and with 3 fine spiral cordlets. Teleoconch with 3 whorls.

Ornamentation formed by wide spiral cords, fine axial threads, small lamellae and microgranules. In apertural position, 4 spiral cords can be seen on the first whorl of the teleoconch, 3 on the second and 7 on the last one between the suture and the umbilicus.

Adapically the axial threads are strong and short on the first whorl and finer and more numerous on the 2nd and 3rd. The spaces between cords are occupied by fine axial threads which on the first whorls of the teleoconch form a reticulate pattern; on the second whorl they form small lamellae along the central area between cords and tend to disappear on the last whorl, changing to be very delicate in some areas and almost not forming lamellae.

Umbilicus narrow and deep, delimited by a strong spiral cord, on its inner part fine axial ribs and several spiral cordlets are observed. Aperture rounded, slightly prosocline; parietal callus thin, continued into the columella which is almost straight, widened on its base and reflected towards the umbilicus; outer lip very strong, with the termination of the spiral cords projecting on the edge, and with 8 prominent denticles on its inner part.

Dimensions of the holotype: 1.84 mm in diameter, 1.72 mm in height.

*Habitat*: Infralittoral species collected alive at 15-25 m.

*Distribution*: Only known from Guadeloupe Island.

*Remarks*: *Parviturbo boucheti* spec. nov. is similar in its morphology to *P. billfranki* spec. nov., but being different by having one less spiral cord and more concretely the cord which delimits the umbilicus here reduced to a fine spiral cordlet, resulting in that the umbilicus is wider; it also lacks small lamellae in the spaces between the cords of the last whorl of the teleoconch.

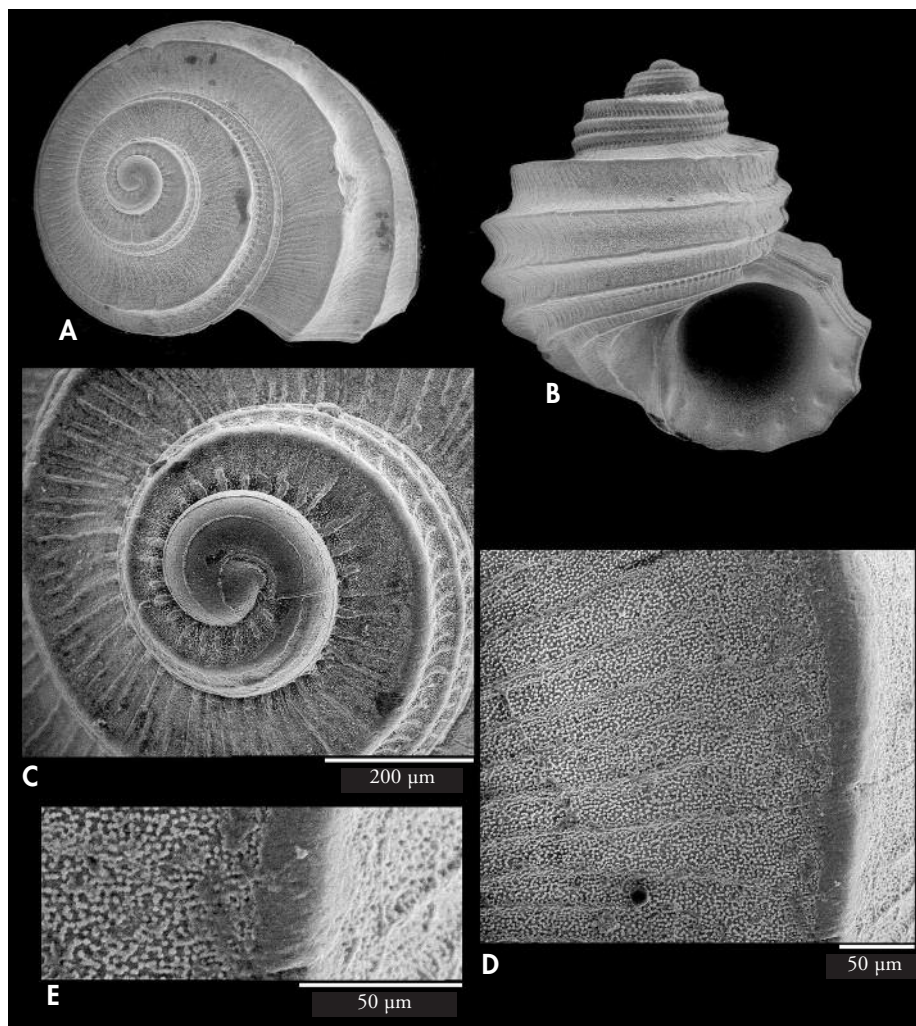


Figure 16. *Parviturbo boucheti* spec. nov. A, B: holotype, 1.84 mm in diameter, Guadeloupe, Petite-Terre, Stn. GS34, 15 m (MNHN); C: protoconch; D, E: microsculpture and detail.

Figura 16. *Parviturbo boucheti* spec. nov. A, B: holotipo, 1,84 mm de diámetro, Guadelupe, Petite-Terre, Stn. GS34, 15 m (MNHN); C: protoconcha; D, E: microescultura y detalle.

*Parviturbo dengyanzhangii* spec. nov. Rubio, Rolán & Lee (Figure 17A-D)

**Type material:** Holotype (Figs. 17A-B) in FLMNH (478952); paratypes, 6 s, in CHL.

**Type locality:** Falmouth Harbour, Antigua, dredged in seagrass on sandy bottom, 1 – 2 m.

**Etymology:** The specific name is for Deng Yan Zhang in acknowledgement of his valuable work on the study of the malacofauna of that island.

*Description:* Shell solid, globose, turritiform, almost as wide as high, formed by 4 whorls of rapid growth.

Protoconch with 1 ½ whorls measuring about 200 µm in diameter and due to its bad condition we can not specify if it





Figure 17. *Parviturbo dengyanzhangii* spec. nov. Rubio, Rolán & Lee. A, B: holotype, 1.4 mm in diameter, Falmouth Harbour, Antigua (FLMNH); C: juvenile paratype, 1.0 mm (CHL); D: protoconch. *Figura 17. Parviturbo dengyanzhangii spec. nov. Rubio, Rolán & Lee. A, B: holotipo, 1,4 mm de diámetro, Falmouth Harbour, Antigua (FLMNH); C: paratipo juvenil, 1,0 mm (CHL); D: protoconch.*

is smooth or have spiral cordlets. Teleoconch with 3 whorls; periphery rounded.

Ornamentation with spiral cords of triangular section, wide at their base and sharp at their crest, not nodulose, except for the subsutural cord in its distal portion; the interspaces between

the cords have axial threads and microgranules. In apertural view, 3 cords can be seen in the penultimate whorl and 8 in the last one; the periumbilical cord is smaller, sunken, and broadens in the area close to the columella. The axial threads, as in the preceding species, are

thin, do not cross the cords and, in the middle of the spaces between cords, become raised into curved lamellae spirally aligned; in apical view they are better seen in the space between the suture and the first cord.

Umbilicus small and deep, delimited by a periumbilical cord and with only fine growth lines inside. Aperture rounded, slightly prosocline; peristome continuous; outer lip very thick, crenulated by the termination of the spiral cords and denticulated internally; columella thin, almost straight, not reflected.

Dimensions of the holotype: 1.53 mm in height and 1.40 mm in diameter (H/D: 1.09).

*Habitat:* This is a shallow water species that lives in seagrass bottoms on sand, to 1-2 m deep.

*Distribution:* Only known from Falmouth Harbour, Antigua, its type locality.

*Remarks:* *Parviturbo dengyanzhangii* spec. nov. differs from *P. rehderi* by

having spiral cords of similar size but with a rounded outline. *Parviturbo billfranki* spec. nov. is distinguished by its rounded outline and, in the spaces between cords, having fewer lamellae which also are different in form.

From *P. comptus*, *P. weberi* and *P. marcosi* spec. nov., it can be distinguished by the absence of nodules on the cords close to the suture and on the basal cords.

By its rounded profile it resembles *Parviturbo granulum*, differing by having lamellae in the spaces between cords instead of axial threads.

*Parviturbo dengyanzhangii* spec. nov. belongs to a group of species whose common character is the fine and dense axial threads, more evident in apical view in the area between the sutures and the first spiral cord and in the spaces between cords; in the centre of the interspaces these are raised into spiral rows of lamellae.

### *Parviturbo granulum* (Dall, 1889) (Figure 18A-I, 19A-E)

*Cyclostrema granulum* Dall, 1889. *Bull. Mus. Comp. Zool.*, 18: 395. [Type Locality: Samana Bay, Dominican Republic] - PILSBRY & MCGINTY, 1945. *The Nautilus*, 59: 55, pl. 6, figs. 3-3a.

**Type material:** Two specimens registered as syntypes deposited in USNM (54751), examined on photographs (Figs. 18A-E). However PILSBRY & MCGINTY (1945: 55) by referring to the figured specimen as "the type" are deemed to have designated a lectotype under ICZN art. 74.6.

**Other material examined:** (5 s): Turks & Caicos: 2 s, French Cay, (CHL); 3 s, Amphitheatre, Grand Turk Island, (CHL). Virgin Islands: 2 s, Deadman's Chest (CHL).

*Description (based on syntype USNM 54751, now lectotype):* Shell very small, very robust, turbiniform, formed by 3 ¼ whorls, narrowly umbilicate. Protoconch of ¾ whorls, 220-230 µm in diameter, with marked spiral cords on its surface. Teleoconch of 2 ½ whorls, separated by a moderately impressed suture; periphery rounded.

Ornamentation formed by spiral cords, axial ribs and microgranules in the interspaces. The cords are elevated and narrower than the interspaces; in apertural view, 3 cords can be seen on the first whorl, and 9-11 on the last one between the suture and the umbilicus. A common character to all the examined

shells is the undulating on the last half whorl of the 2-3 first peripheral cords, but not reaching to form nodules. Axial ribs finer than the spiral cords, equidistant and regularly distributed in the interspaces which are wide and relatively concave. The entire surface of the teleoconch is covered by microgranules.

Umbilicus narrow and deep, delimited by a moderately thick cord, inside with marked growth lines and a fine cordlet. Aperture rounded, prosocline; columella straight, not thickened neither reflected; outer lip with a bevelled edge, on which the termination of spiral cords is projecting; without tubercles on its inner side.

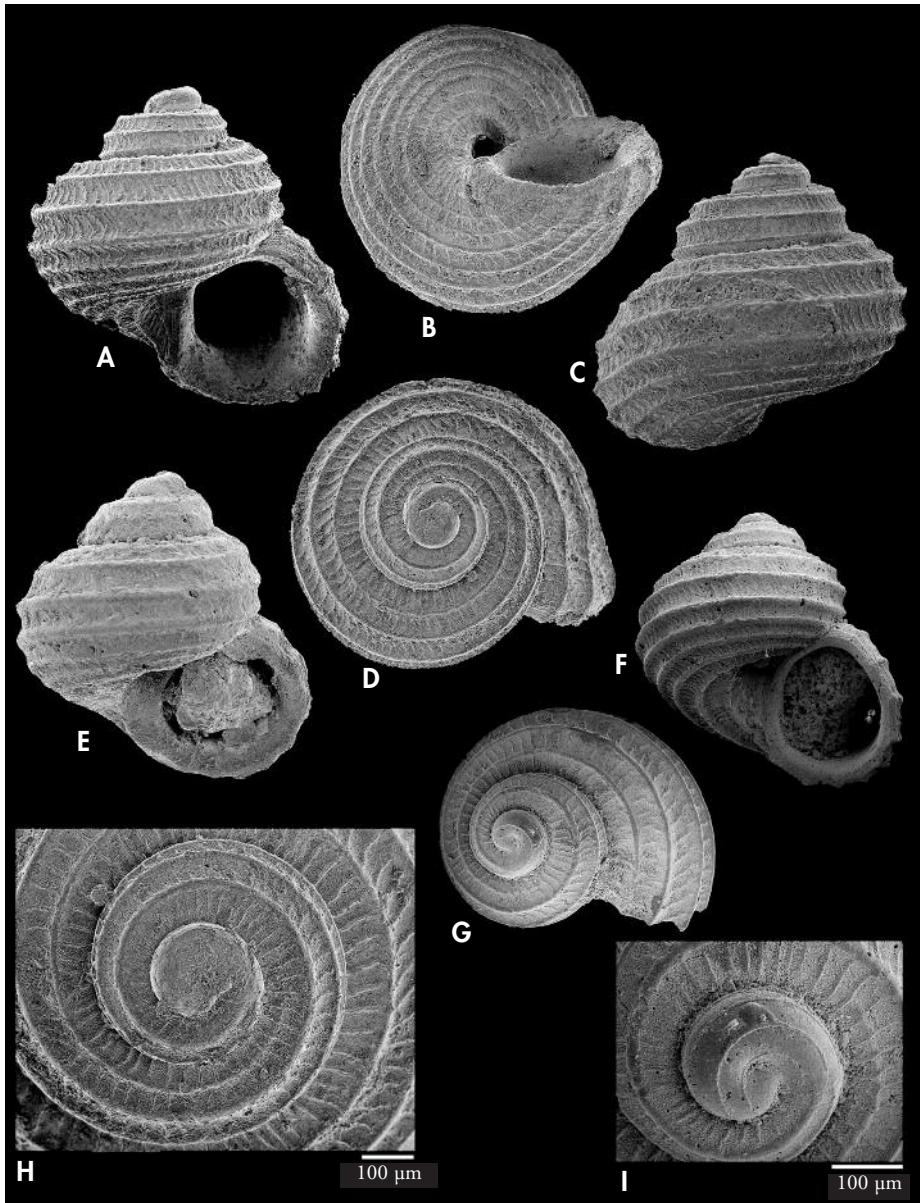


Figure 18. *Parviturbo granulum* Dall, 1897. A-D: syntype (lectotype from Pilsbry & McGinty, 1945), 1.2 mm in diameter, from Samana Bay, Dominican Republic (USNM 54751); E: other syntype (now paralectotype), 1.15 mm in diameter, same locality (USNM 54751); F, G: shells, 1.0, 0.87 mm in diameter, French Cay, Turks & Caicos (CHL); H: apical view, from Dominican Republic; I: protoconch from Turks & Caicos.

*Figura 18. Parviturbo granulum Dall, 1897. A-D: sintipo (lectotipo por Pilsbry & McGinty, 1945), 1,2 mm de diámetro, de Bahía Samana, República Dominicana (USNM 54751); E: otro sintipo (ahora paralectotipo), 1,15 mm de diámetro, la misma localidad (USNM 54751); F, G: conchas, 1,0, 0,87 mm de diámetro, Cayo Francés, Turks & Caicos (CHL); H: vista apical, de República Dominicana; I: protoconcha, de Turks & Caicos.*

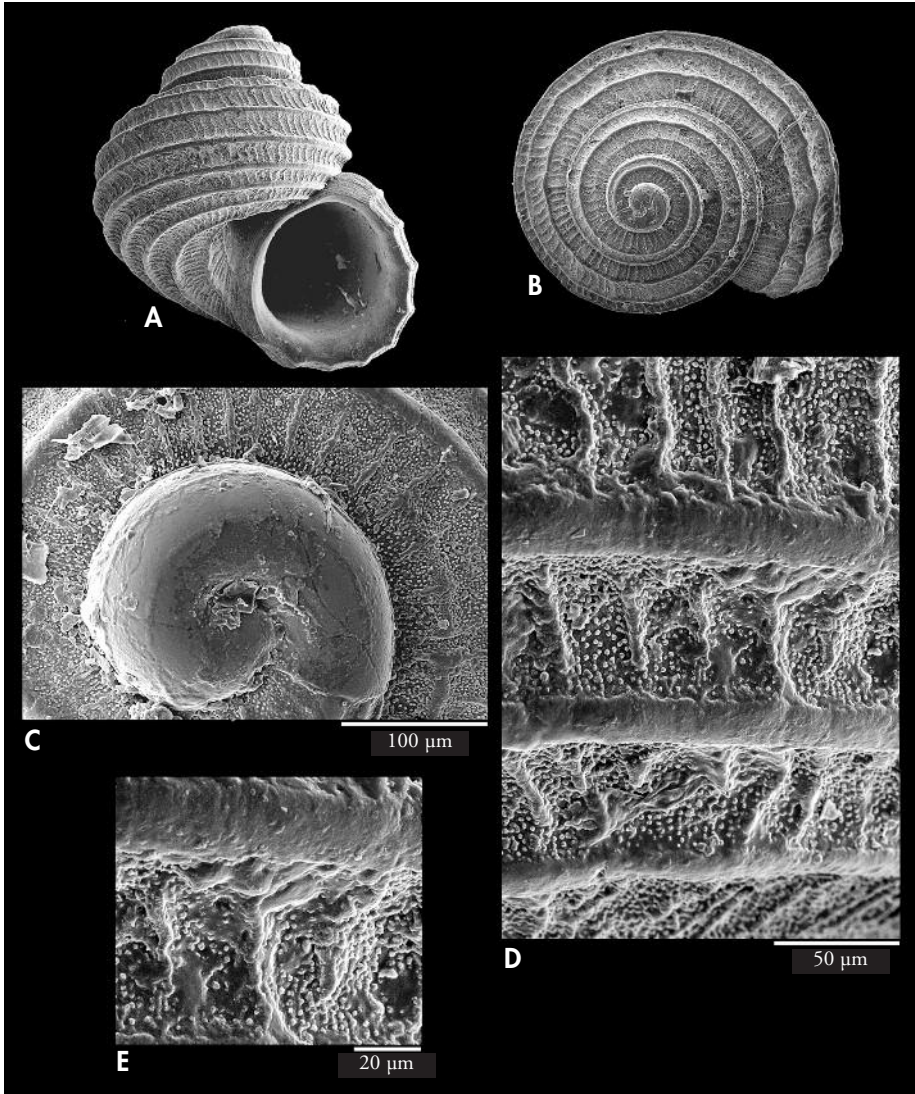


Figure 19. *Parviturbo granulum* (Dall, 1897). A, B: shell, 1.2 mm in diameter, from British Virgin Island (CHL); C: protoconch; D, E: ornamentation.

Figura 19. *Parviturbo granulum* (Dall, 1897). A, B: concha, 1,2 mm de diámetro, de las Islas Vírgenes Británicas (CHL); C: protoconcha; D, E: ornamentación.

Dimensions: The largest syntype (now lectotype) is 1.2 mm high and 1.2 mm in diameter. The other syntype (now paralectotype) is 1.03 mm high and 1.11 mm in diameter.

Turks & Caicos: 1.08 mm high, 1.05 mm in diameter (H/D: 1.03).

Turks & Caicos: 1.22 mm high, 1.14 mm in diameter (H/D: 1.07).

Virgin Islands: 1.32 mm high, 1.2 mm in diameter (H/D: 1.07).

*Habitat:* It is apparently an infralittoral species, and the deepest collecting place in Samana Bay is 31 m.

*Distribution:* Dominican Republic (19°N; 69°W; DALL, 1889; PILSBRY & MCGINTY, 1945b). Virgin Islands and Turks & Caicos in the present work. The presence of *P. granulus* in Turks & Caicos and in Virgin Islands must be considered normal due the geographic proximity of these islands.

*Remarks:* Since its original description, *P. granulum* has not been recorded by any author. From the material studied only the shells from Turks & Caicos and Virgins Islands, are similar to the type specimens. The species is

remarkable for its very small size, very strong and robust.

Comparing the shells of the two syntypes, we will observe that the number of spiral cords in the teleoconch is variable between 8 and 10, which makes more difficult the identification of the species. Other characters to be considered are the undulating of the 2-3 first peripheral cords on the last half whorl and the fact that they do not form nodules, the cordlet inside the umbilicus and the protoconch with spiral cordlets.

*Parviturbo annejoffeae* spec. nov. Rubio, Rolán & Lee (Figure 20A-D)

**Type material:** Holotype (Fig. 20A) in FLMNH (478949) ex-CHL. Paratipos: 1 in CHL (Fig. 20B).

**Type locality:** Pigeon Point Beach, Patrick Co., Tobago, mid-surf zone, 9 m.

**Etiymology:** The specific name is after Anne Joffe of Sanibel, FL, USA in recognition of her abiding support and leadership of the American Malacological Society and Conchologists of America.

*Description:* Shell very small, solid, turbiniform, a little wider than height, formed by scarcely 3 ½ whorls of rapid growth. Protoconch measuring about 190 µm in diameter, with remains of spiral cordlets scarcely visible due to erosion. Teleoconch with 2 ¾ whorls.

Ornamentation of strong cords, equidistant axial threads which cover the interspaces between cords, and microgranules. In apertural view, three spiral cords can be seen on the first whorl and 8 on the last one, the peripheral one more prominent and the periumbilical the smallest. Cords have a triangular profile, forming keels with a sharp edge. Only the periumbilical cord has hints of nodules. As in other species of this genus, from the first whorl of the teleoconch onwards, the axial striae in the space between the suture and the first spiral cord change from wider and more separated, to progressively finer and curved.

The axial threads cover the interspaces between cords and only between the basal cords raise to form lamellae.

Umbilicus of medium size, delimited by a spiral cord, with wide growth lines inside. Aperture ovoid, a little prosocline; peristome continuous; co-

lumella strong, not reflected, widened basally in the insertion point with the periumbilical cord; outer lip thick, not denticulate inside and crenulated on its external margin by the termination of the cords.

Dimensions of the holotype: 1.43 mm in diameter and 1.35 mm in height (H/D: 0.94).

*Habitat:* Sublittoral species found at 0.3 m, in sand bottom, mid-surf zone.

*Distribution:* Only known from its type locality.

*Remarks:* The presence of fine and very numerous axial threads in the space between the suture and the first spiral cord, besides the presence of triangular cords as carinae, make the new species resemble to others such as *P. rehderi*, *P. billfranki* spec. nov. and *P. dengyanzhangii* spec. nov., but it can be distinguished from them because the axial cords are hardly raised into lamellae in the interspaces between cords, except on the base where these are thin. From *P. comptus*, *P. weberi* and *P. marcosi* spec. nov. can be differentiated by lack of nodules in the sutural and basal cords. From *P. granulum* it may be differentiated in being wider and having less spiral cords.

2.B. GROUP OF *P. WEBERI*

*Parviturbo weberi* Pilsbry & McGinty, 1945 (Figure 21A-H)

*Parviturbo weberi* Pilsbry & McGinty, 1945. *The Nautilus*, 59: 55-56, pl. 6, fig. 1. [Type locality: One and one-half miles off Cape Florida].

**Type material:** Holotype deposited in ANSP (181313), examined by photograph; paratypes in Weber and McGinty collections, not examined.

**Material examined:** (509 s): Bahamas Archipelago: 312 s, Abaco Island, 23 m, sediments (CCR); 166 s, Abaco Island, 7-10 m, sediments (CCR); 19 s, Abaco Island, 45-60 m, sediments (CCR). Florida, USA: 6 s, New Providence Island, Clifton Point, Florida, McGinty coll. (MCZ 207213). Cuba: 6 s, off Havana, Jaume coll. (MCZ 179780).

*Description (from the original description and new data):* Shell very small, solid, turbinata, with a rather high spire, formed by 4 ½ strongly convex whorls, with a deeply impressed suture, narrowly umbilicate.

Protoconch of little more than of ¾ whorls and 200 µm in diameter, with 3 fine spiral cordlets, although apparently smooth in adult and somewhat eroded shells. Teleoconch of 3 whorls.

Ornamentation formed by spiral cords, axial ribs and microgranules. In apertural view, 4 low spiral cords can be seen on the first whorl, 3 the penultimate and 8 on the last one. The cords are about as wide as their interspaces, the upper two rather strongly nodulose where they are crossed by very low axial ribs radiating from the suture; the basal cords and the periumbilical cords have thick rounded nodules. The axial ribs are obsolete in the peripheral region, but reappear weakly at the base, where one or two lower spirals are weakly nodulose. In the central area of the interspaces between the cords the axial ribs are transformed into small strong and slightly inclined lamellae, which turn into fine axial threads on the last half whorl of teleoconch. The entire surface of the teleoconch is covered by microgranules.

Umbilicus narrow, smooth within, bounded by the eighth spiral cord. Aperture rounded and slightly prosocline; parietal callus thick, continued into the columella which is curved and slightly reflected towards the umbilicus; outer lip thick, indented by the cords, with 8 tubercles on its inner side.

Operculum (Fig. 21H) corneous, multispiral with a central nucleus.

Dimensions. Type material:

Diameter 1.7 mm, height 1.75 mm (off Cape Florida).

Diameter 1.6 mm, height 1.65 mm (Fort Myers Beach).

Photographed shells:

Diameter 1.71 mm, height 1.55 mm (H/D: 1.10) (Bahamas, CHL)

Diameter 1.50 mm, height 1.56 mm (H/D: 1.04) (Abaco, Bahamas, CCR)

Diameter 1.54 mm, height 1.65 mm (H/D: 1.07) (Abaco, CCR)

*Habitat:* In shell sand at Fischer Island; Loggerhead Key, Tortugas and Ft. Myers Beach, Florida (PILSBRY & MCGINTY, 1945). Bathymetric range: 1 to 60 m (live 1 to 0 m).

*Distribution:* USA: Florida: East Florida, West Florida, Dry Tortugas (PILSBRY & MCGINTY, 1945; ABBOTT, 1974); Mexico: Yucatan Peninsula (VOKES & VOKES, 1984); Bahamas: Abaco (Great or Little) (REDFERN, 2001); Cuba: Pinar del Rio, Havana Province; Brazil: Vitoria-Trinidad Seamounds (LEAL, 1991).

We have seen *P. weberi* from off the coast of Florida, the Bahamas and the North coast of Cuba. The record of LEAL (1991) for Vitoria-Trinidad Seamounds, Brazil, according to the figured shell, could correspond to *P. gofasi spec. nov.* We have yet to confirm records in Yucatan Peninsula, Mexico and Costa Rica. Range: 26.5°N to 20.53°S; 87°W to 38.18°W if including the Brazilian records.

*Remarks:* PILSBRY & MCGINTY (1945) in relation to the protoconch indicate:

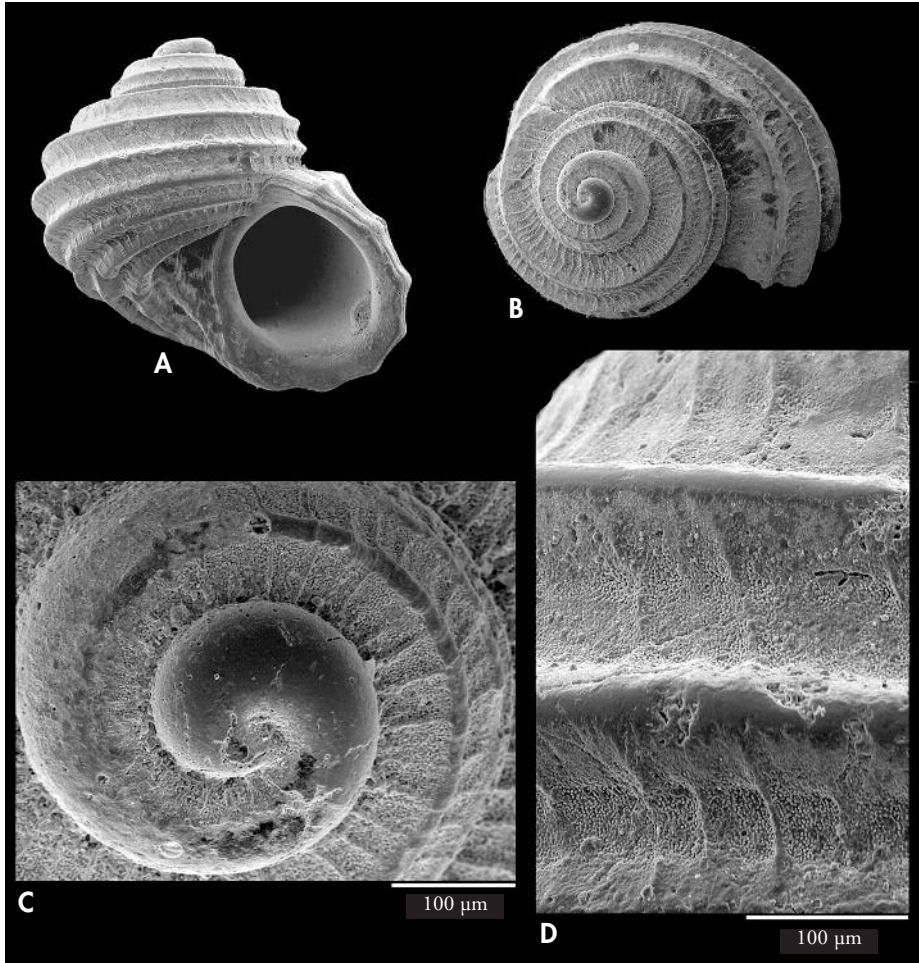


Figure 20. *Parviturbo annejoffeae* spec. nov. Rubio, Rolán & Lee. A: holotype, 1.43 mm in diameter (FLMNH); B: paratype, 1.35 mm in diameter (CHL); both from Pigeon Point Beach, Patrick Co., Tobago; C: protoconch; D: microsculpture.

Figura 20. *Parviturbo annejoffeae* spec. nov. Rubio, Rolán & Lee. A: holotipo, 1,43 mm de diámetro (FLMNH); B: paratipo, 1,35 mm de diámetro (CHL); ambos de Pigeon Point Beach, Patrick Co., Tobago; C: protoconcha; D: microescultura.

“First two whorls are smooth”. PILSBRY & MCGINTY (1950: 87), when describing the genus *Parviturbo*, redescribed the protoconch and comment: “*Parviturbo weberi* (*The Nautilus*, 59: 55) was said to have two nuclear whorls, but this was a mistake of observation due to imperfect preservation. The examination of several fresh, immature specimens

shows that there are not over one and one fourth embryonic whorls”. Actually, the protoconch of the *Parviturbo* species studied only has  $\frac{3}{4}$  of whorl, like the rest of congeneric species.

PILSBRY & MCGINTY (1945) also mention: “Distinct from otherwise similar Floridian species by the nodose upper spiral. It differs from the West

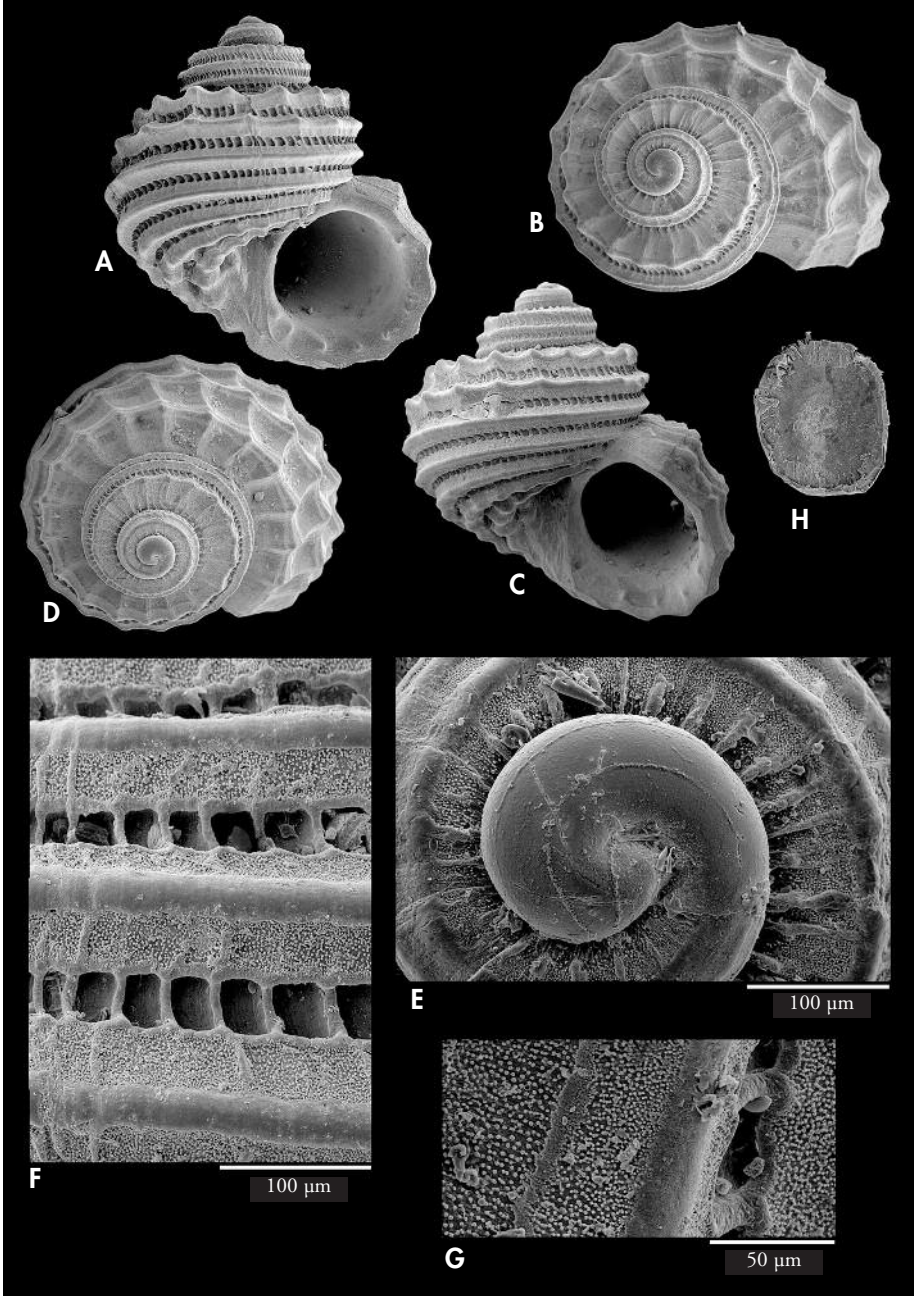


Figure 21. *Parviturbo weberi* Pilsbry & McGinty, 1945. A, B: shells, 1,43, 1,35 mm, Abaco, Bahamas (CCR); C, D: shells, Abaco, Bahamas (CCR); E: protoconch; F, G: microsculpture and detail; H: operculum.

Figura 21. *Parviturbo weberi* Pilsbry & McGinty, 1945. A, B: conchas, 1,43, 1,35 mm, Abaco, Bahamas (CCR); C, D: conchas, Abaco, Bahamas (CCR); E: protoconcha; F, G: microescultura y detalle; H: opérculo.



Indian *P. tuberculosus* d'Orbigny, by having a higher, more produced spire and much more prominent apical whorl. The apex of *P. tuberculosa* is obtuse, the tip being depressed, the spire is shorter and the form more globose. It is also thicker".

*Parviturbo weberi* is a species easily identifiable by having the first two cords of the teleoconch with sharp nodules, basal cords with thick rounded nodules, all spaces between cords with strong lamellae and thick denticles inside the outer lip.

*Parviturbo marcosi* spec. nov. (Figure 22A-E, 23A-C)

**Type material:** Holotype (Figs. 22A-B) in MNCN (15.05/60161). Paratypes in the following collections: MNHN (IM-2012-37352), MHNS (100618), IES, CHL, CFG.

**Other material studied:** (5 spm, 81 s): Cuba: 5 spm, 8 s, Los Laberintos, Cienfuegos, Cuba, 56 m, in coralline sand; 11 s, Hotel Comodoro Beach, Havana, 8-10 m; 2 s, Canarreos Archipelago, 20 m; 12 s, Baracoa (North Cuba), 6 m; 22 s, Jibacoa Beach, 12 m; 18 s, Faro de los Colorados, Cienfuegos, arenas coralinas, 40-65 m; 6 s, Rancho Luna Beach, coralline sand, 10-30 m. Bahamas: 2 s, Nassau, 10-20 m.

**Type locality:** Los Laberintos, Cienfuegos, Cuba.

**Etymology:** The specific name is after Marcos Fernández, son of the third author.

*Description:* Shell very small, turbiniform, formed by 4 ½ fast growing whorls separated by a marked suture. Apex acute.

Protoconch ¾ of whorl, completely smooth, about 220 µm in diameter, without any distal thickening. Teleoconch with more than 3 ¼ whorls.

Ornamentation formed by thick cords, axial ribs and fine axial threads, and microgranules. In apertural view, 3 cords can be seen on the first and second whorls and 8 in the last one, of which the upper two, those closest to the suture have rather prominent nodules; the 3rd to 6th are smooth and the 7th and 8th have thick rounded nodules. Axial ornamentation formed by fine threads regularly distributed and, from the second whorl onwards, thicker axial ribs evenly distributed and forming thick pointed nodules as they cross the spiral cords. Under high magnification, all the surface of the teleoconch appears covered by microgranules. Umbilicus narrow and deep, delimited by a thick nodulose cord, inside with fine axial growth striae, and in some shells also with a very fine spiral line. Aperture rounded, prosocline. Outer lip thick, with a sharp bevelled edge, with denticles on its inner margin; parietal callus very thin, continued into the columella which is

almost straight, widened at its base in the area of insertion of the umbilical cord.

Dimensions of the holotype: 2.1 mm in height and 2.0 mm in diameter (H/D: 1.05).

Operculum (Fig. 22J) corneous, multispiral with a central nucleus.

*Habitat:* This species has an infra- and circalittoral distribution, living in coralline sand, between 8 and 65 m.

*Distribution:* Primarily known from Cuba, we have seen two shells from Nassau, Bahamas, which appeared mixed with numerous specimens of *P. weberi*.

*Remarks:* The most similar species to *P. marcosi* spec. nov. is *P. weberi*, which shares the general appearance, the number of cords and the nodules on the cords; but from which it differs by lacking the spiral cordlets on the protoconch, and by the axial sculpture between cords which is not raised to form spirally aligned lamellae.

The lack of lamellae in the interspaces between the cords also differentiated *P. marcosi* spec. nov. from *P. rehderi*, *P. billfranki* spec. nov., *P. dengyanzhangii* spec. nov. and *P. brasiliensis* spec. nov.

Another similar species is *P. comptus* which differs in having the nodules on the first spiral cord not so sharp, the second cord nearly smooth and the 6th

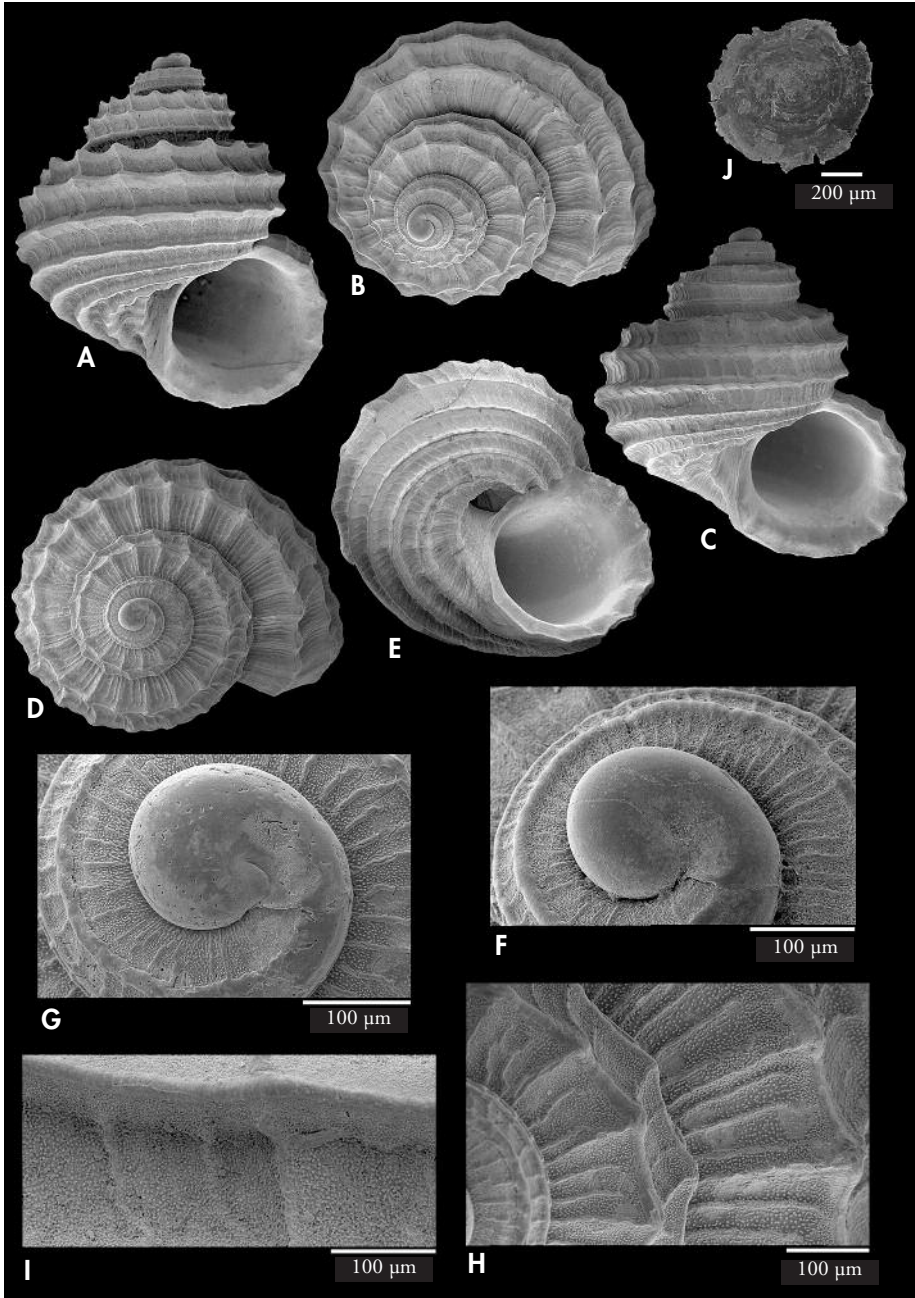


Figure 22. *Parviturbo marcosi* spec. nov. A, B: holotype, 2.0 mm in diameter, Los Laberintos, Cienfuegos, Cuba (MNCN); C-E: shells, 1.8 mm, Rancho Luna Beach (MHNS); F, G: protoconchs, from Los Laberintos and Rancho Luna Beach; H: sculpture; I: microsculpture; J: operculum.

Figura 22. *Parviturbo marcosi* spec. nov. A, B: holotipo, 2.0 mm de diámetro, Los Laberintos, Cienfuegos, Cuba (MNCN); C-E: conchas, 1,8 mm, Playa Rancho Luna (MHNS); F, G: protoconchas, de Los Laberintos y playa de Rancho Luna; H: escultura; I: microescultura; J: opérculo.

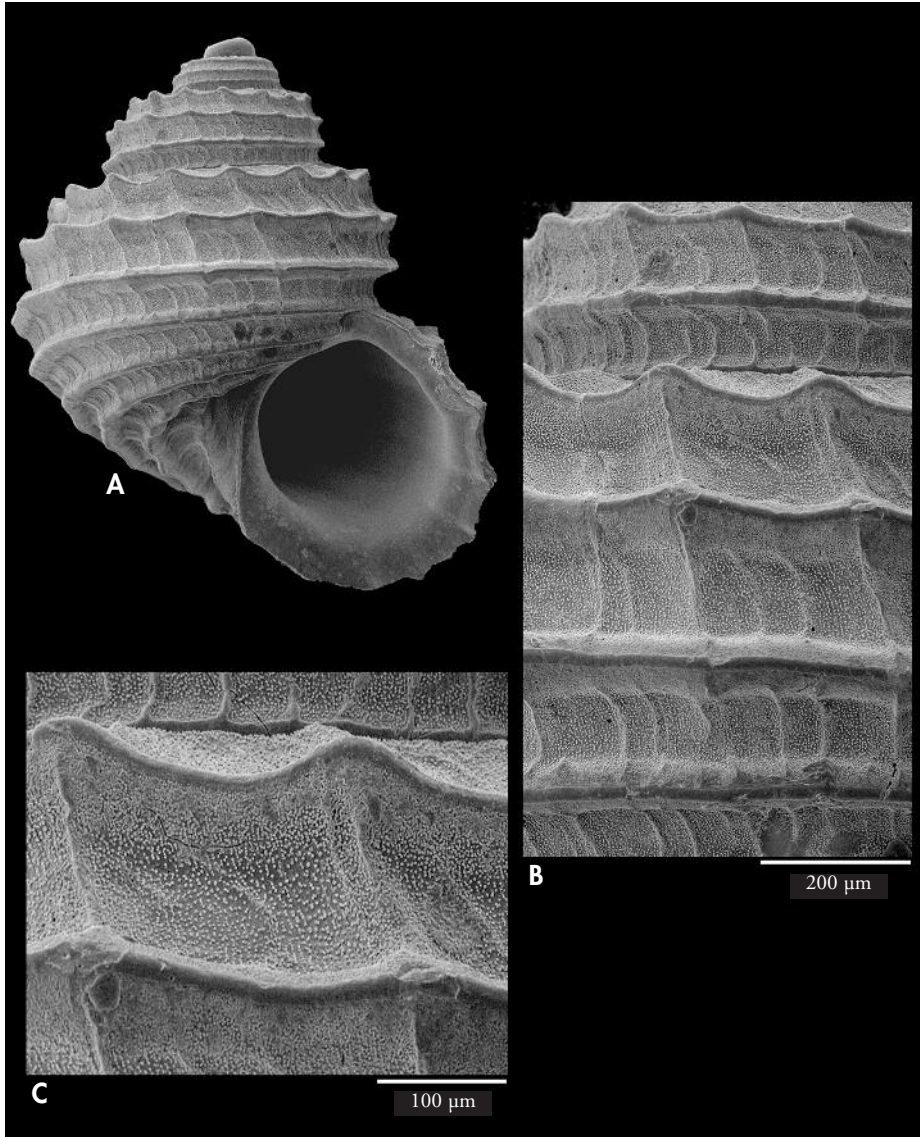


Figure 23. *Parviturbo marcosi* spec. nov. A: shell, 1.8 mm, NW Nassau, Bahamian Islands; B, C: microsculpture and detail.

Figura 23. *Parviturbo marcosi* spec. nov. A: concha, 1,8 mm, NW Nassau, Islas Bahamas; B, C: microescultura y detalle.

one nodulose; in having only fine axial threads and not thick ribs on the 2 first whorls of the teleoconch in apical view, and by the thicker denticles of the inner part of the external lip.

*Parviturbo granulum*, *P. annejoffeae* spec. nov. and *P. zylmanae* spec. nov. may be differentiated because these species lack the nodulose spiral cords characteristic of *P. marcosi*.

*Parviturbo rectangularis* spec. nov. (Figure 24A-F)

**Type material:** Holotype in MNHN IM-2012-7811 (Figs. 24A-B) and 3 paratypes in MNHN (as listed below).

**Material studied:** (4 s): Guadeloupe, KARUBENTHOS: 1 s, Grand Cul-de-Sac Marin, Port-Louis, Stn. GD25 (16°25'N-61°33'W), 160 m (MNHN IM-2012-7811), holotype; 2 s, Est Petite-Terre, Stn. GD60 (16°12.05'N-61°03.9'W), 95 m (MNHN IM-2012-7813); 1 s, Basse-Terre, Port-Louis, Stn. GB14 (16°23.74'N-61°32.07'W), 49 m, tombant (MNHN IM-2012-7812).

**Type locality:** Guadeloupe, Grand Cul-de-Sac Marin, Port-Louis (16°25'N-61°33'W), 160 m [KARUBENTHOS: Stn. GD25].

**Etymology:** The specific name alludes to the rectangular mesh formed by the crossing of cords and ribs.

*Description:* Shell small, almost as wide as high, white, turbiniform, formed by 4  $\frac{1}{4}$  whorls separated by a marked suture, narrowly umbilicate.

Protoconch of  $\frac{3}{4}$  whorls, about 220  $\mu$ m in diameter, totally smooth. Teleoconch with 3  $\frac{1}{2}$  whorls.

Ornamentation of strong spiral cords, narrower than their interspaces, strong axial ribs, axial threads and microgranules.

In apertural position, 3 cords can be seen on the 1st and 2nd whorls, and 8 on the last whorl between the suture and the umbilicus; on the 1st whorl the cords are smooth, on the 2nd and on the last one the spiral cords have sharp projections at their intersections with the axial ribs; these projections are more prominent in the three first cords, and become moderate nodules in the cords closer to the umbilicus; in the interspaces between the cords fine axial threads can also be observed. The microgranules cover the entire surface of the teleoconch.

Umbilicus very narrow and deep, delimited by a strong nodulose cord, inside only with some axial striae. Aperture rounded, prosocline; parietal callus

thin, continued into an arched columella, widened on its base and reflected towards the umbilicus; external lip thick, with the margin scalloped by the termination of the spiral cords, including in the area closest to the columella, without denticles inside.

Dimensions of the holotype: 2.23 mm in diameter and 2.30 mm in height.

*Habitat:* Circalittoral to outer shelf species, dredged at 49 - 160 m.

*Distribution:* Only known from Grand Cul-de-Sac Marin, Port-Louis, Guadalupe its type locality.

*Remarks:* *Parviturbo rectangularis* spec. nov. is most similar to *Parviturbo seamountensis* spec. nov., distinguishing from this mainly by the axial sculpture on the early whorls of teleoconch formed only by fine axial threads instead of a coarse reticulate pattern.

It also resembles *P. marcosi* spec. nov., from which it is distinguished mainly by having strong spinose tubercles on the first three spiral cords, which become lighter nodules on the other cords; by having the outer lip crenulated in the part close to the columella, and lacking denticles inside.

*Parviturbo comptus* (Woodring, 1928) (Figure 25A-F, 26A-D)

'*Fossarus* (*Gottoina*)' *comptus* Woodring, 1928. *Carnegie Inst. Washington Pub.*, 385: 353, pl. 27, figs. 3-4. [Type Locality: Bowden beds (Miocene), Jamaica].

*Parviturbo* *comptus* (Woodring, 1928) - WARMKE & ABBOTT, 1961. *Caribbean Seashells*: 63, pl. 11, fig. C.

**Type material:** Holotype in USNM (369501). Miocene fossil, Jamaica.

**Material examined:** (7 spm, 17 s): Dominican Republic: 1 s, Parque La Caleta, beached (MHNS). Guadeloupe, Karubenthos: 1 s, Grand Cul-de-Sac Marin, Face à Fajou, Stn. GB04, 16°21.75'N-61°36.7'W, 23 m, fonds coraliens (MNHN IM-2012-5732); 1 s, Basse-Terre, Tête a l'Anglais, Stn. GB06, 16°22.9'N-

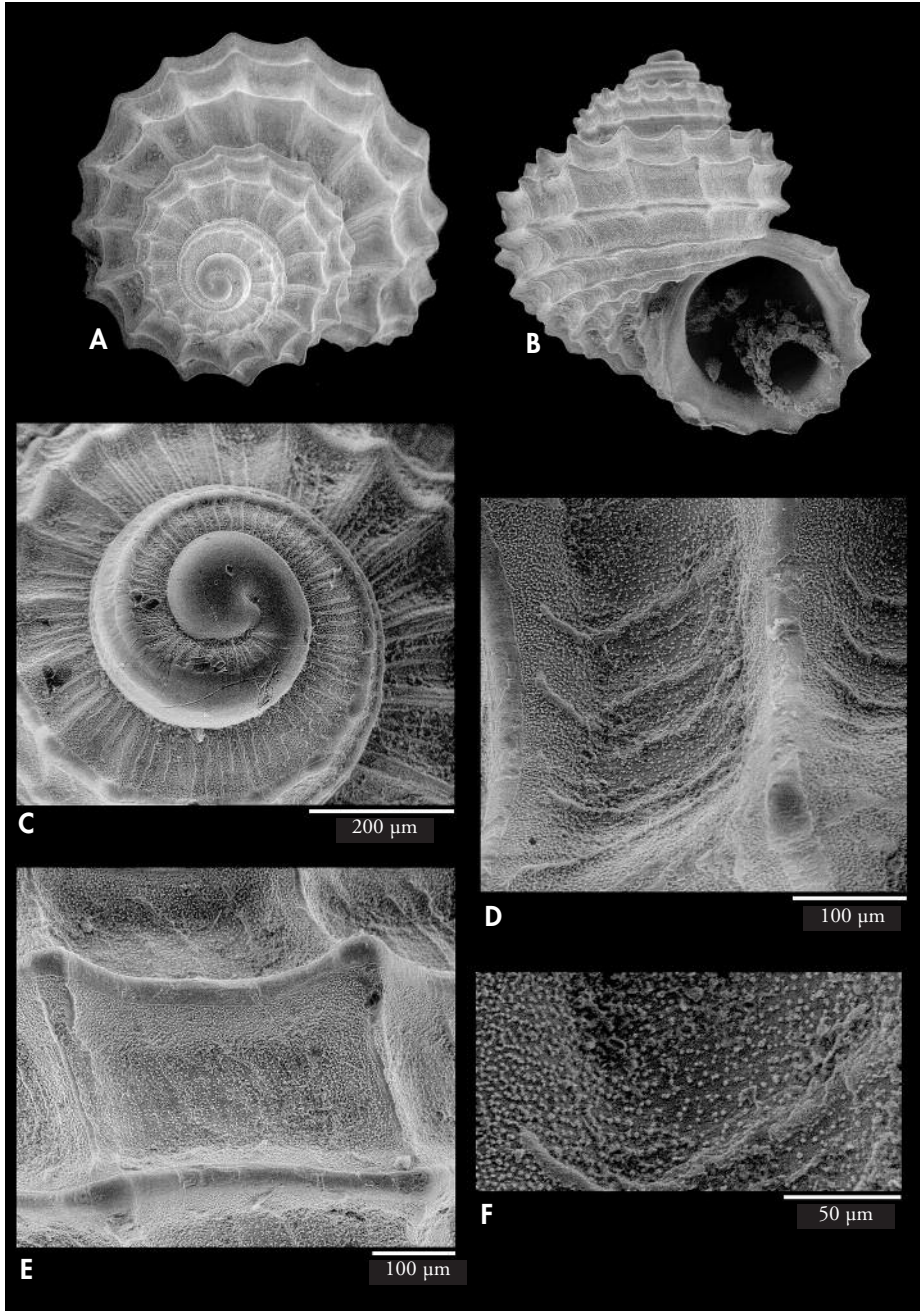


Figure 24. *Parviturbo rectangularis* spec. nov. A, B: holotype, 2.23 mm in diameter, Grand Cul-de-Sac Marin, Port-Louis, Guadeloupe, 160 m (MNHN); C: protoconch; D-F: microsculpture and detail.

*Figura 24. Parviturbo rectangularis spec. nov. A, B: holotipo, 2.23 mm de diámetro, Grand Cul-de-Sac Marin, Port-Louis, Guadalupe, 160 m (MNHN); C: protoconcha; D-F: microescultura y detalle.*

61°45.94'W, 23 m, rocky bottom (IM-2012-5733); 1 s, Grandf Cul-de-Sac Marin, Sud Port-Louis (bouée PCA), Stn. GB15, 16°22.57'N-61°31.74'W, 8 m, rocky bottom (MNHN IM-2012-5734); 1 s, Grand Cul-de-Sac Marin, Port Louis (grotte aux Barracudas); Stn. GB16, 16°27.34'N-61°32.07'W, 19 m, rocky bottom (MNHN IM-2012-5735); 7 spm, Grand Cul-de-Sac Marin, derrière Ilet Fajou, Stn. GD57, 16°19.21'N-61°35.32'W, 6 m (MNHN IM-2012-5736); 1 s, Basse-Terre, Pointe à Lèzard, Stn. GR10, 16°08.43'N-61°46.92'W, 29 m, blocs etroches (MNHN IM-2012-5737); 4 s, Grand Cul-de-Sac Marin, Chenal Ilet à Colas, Stn. GS02, 16°20.94'N-61°34.39'W, 15 m (MNHN IM-2012-5738); 1 s, Grand Cul-de-Sac Marin, external slope, Stn. GS04, 16°21.97'N-61°37.98'W, 11 m, coralline bottom (MNHN IM-2012-5739); 3 s, Basse-Terre, Pointe de Malendure, Stn. GS14, 16°05.95'N-61°47.5'W, 8 m, rocky bottom (MNHN IM-2012-12545); 3 s, Basse-Terre, Sec Ferry, Stn. GS15, 16°17.51'N-61°48.96'W, 27 m (MNHN IM-2012-12546).

*Description (from the original description and new data):* Shell small, robust, turbiniform, wider than high (H/D: 0.80), formed by 4 whorls, widely umbilicate.

Protoconch of  $\frac{3}{4}$  whorls, 200  $\mu$ m in diameter and with marked spiral cords on its surface. Teleoconch of 3  $\frac{1}{4}$  whorls, not carinate, with a moderately impressed suture; periphery rounded.

Ornamentation formed by spiral cords, axial ribs and microgranules in the interspaces. The cords are wider than their interspaces; in apertural view, 4 cords can be seen on the first whorl, 3 on the second and 8 on the last one between the suture and the umbilicus; from these, the first cord, which is closer to the suture is undulating, without protruding nodules, the 2nd to 5th cords are totally smooth and the 6th to 8th cords have thick nodules. In the 2  $\frac{1}{2}$  first whorls of the teleoconch, fine axial threads can be observed in the space between the suture and the first subsutural cord; in the interspaces between the 1st and the 7th cords, the center of the spaces appear covered by spiral rows of raised axial lamellae; these lamellae are not observed between the 6th to 8th cords. Only in the last  $\frac{3}{4}$  of the last whorl the cords become progressively more nodulose; nodules are thick and wide, not sharp.

Umbilicus narrow and deep, delimited by a moderately thick cord, inside only with marked growth lines. Aperture rounded, prosocline; columella almost straight, thickened, not reflected; parietal area without any callus. Outer lip very thick, scalloped by the termination of the spiral cords, inside with up to 8 thick denticles.

*Dimensions:* The shells examined measure 2.0 – 2.57 mm in diameter and 1.55-1.73 mm in height.

*Habitat:* Infralittoral species which in Guadeloupe lives in rocky and coralline bottoms between 6 and 29 m. Reasonably common from shallow dredgings (WARMKE & ABBOTT, 1961).

*Distribution:* Puerto Rico (WARMKE & ABBOTT, 1961); Curaçao, ABC Islands (DE JONG & COOMANS, 1988). [Range: 18°N to 12.4°N; 69°W to 67°W]. Dominican Republic and Guadeloupe in the present work. Fossil from the Miocene of Jamaica (WOODRING, 1928).

*Remarks:* Species described as a fossil from the Miocene of Bowden in Jamaica, previously placed in the genus *Fossarus* (WOODRING, 1928) and *Parviturbooides* (WARMKE & ABBOTT, 1961).

WOODRING (1928: 353) comments: "The holotype is one of 26 in the Aldrich collection. The denticles on the basal and outer lips are like the smaller denticles on the basal lip of *mundulus*, and probably are correlated with the thicker lips of *comptus*. On young shells the outer and basal lips are thin and strongly frilled. No species similar to *comptus* is now living in West Indian waters".

WARMKE & ABBOTT (1961: 63) mention: "This species was described as a fossil (*Fossarus comptus*) from Jamaica; there is no question that it is still living in Puerto Rico". In Guadeloupe Island it is also relatively common, being found in 10 sampling localities.

*Parviturbo comptus* differs from *P. weberi* in having the nodules rounded rather than pointed, and in the space between the suture and the first cord the axial threads are much finer. The shell is also wider than high (H/D: 0.80) contrary to *P. weberi*.

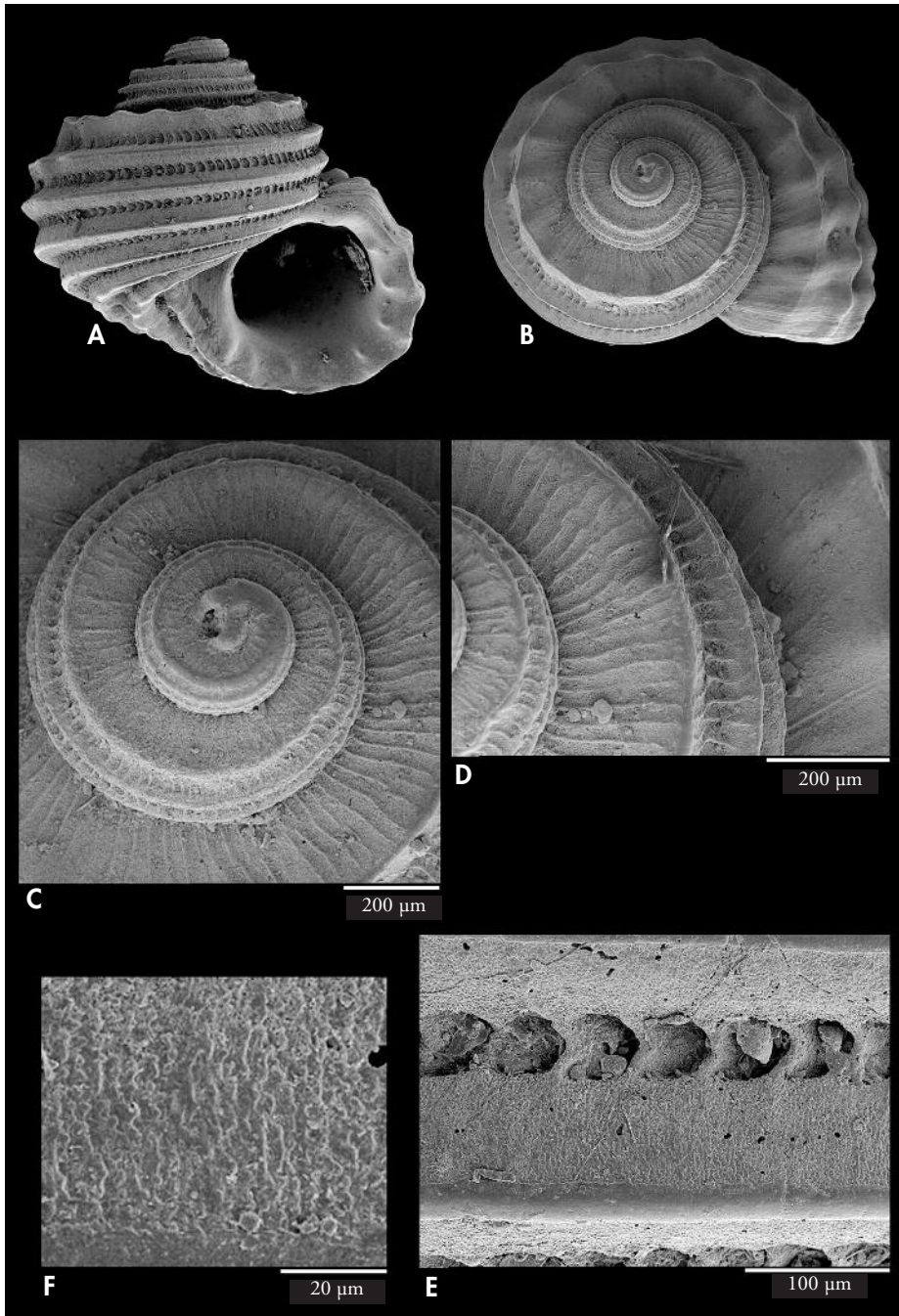


Figure 25. *Parviturbo comptus* (Woodring, 1928). A, B: shells, 2.12, 2.5 mm in diameter, Dominican Republic (MHNS); C: protoconch; D: axial ornamentation; E, F: microsculpture and detail. *Figura 25. Parviturbo comptus* (Woodring, 1928). A, B: conchas, 2.12, 2.5 mm de diámetro, República Dominicana (MHNS); C: protoconcha; D: ornamentación axial; E, F: microescultura y detalle.

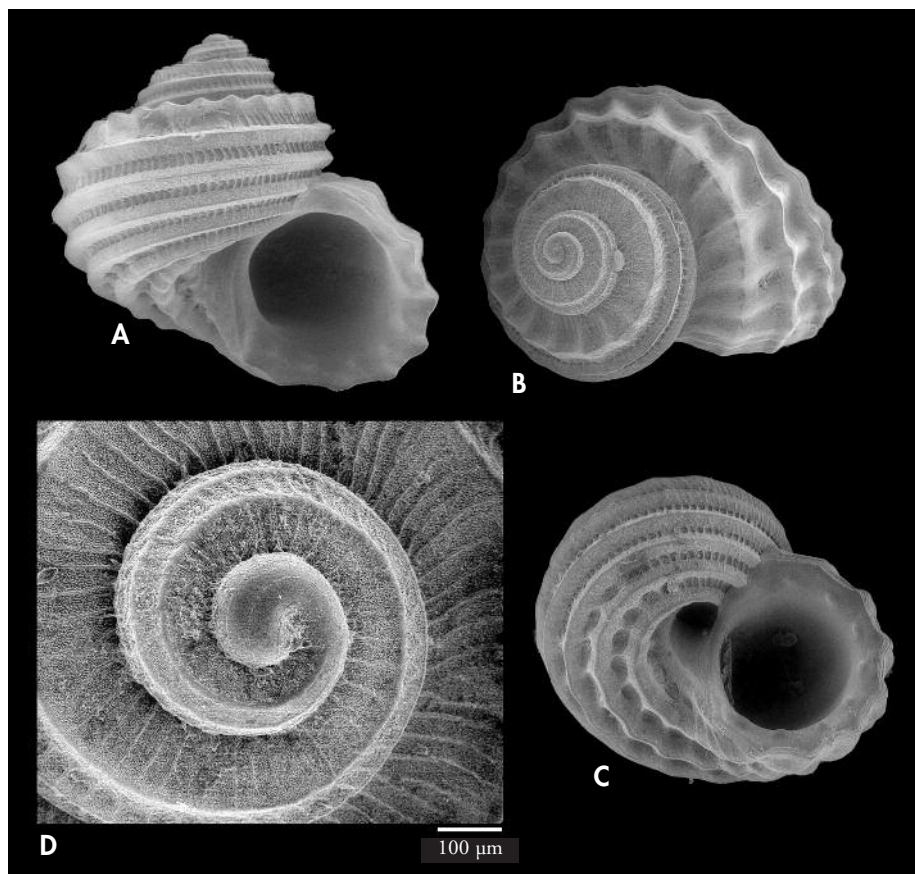


Figure 26. *Parviturbo comptus* (Woodring, 1928). A-C: shells, 2.4, 2.5, 2.57 mm in diameter, Guadeloupe, Grand Cul-de-Sac Marin, behind Ilet Fajou, Stn. GD57 (MNHN); D: protoconch.  
*Figura 26. Parviturbo comptus* (Woodring, 1928). A-C: conchas, 2,4, 2,5, 2,57 mm de diámetro, Guadalupe, Grand Cul-de-Sac Marin, detrás de Ilet Fajou, Stn. GD57 (MNHN); D: protoconcha.

### *Parviturbo gofasi* spec. nov. (Figure 27A-F)

**Type material:** Holotype in MNHN IM-2000-30347 (Figs. 27A-B) and 3 paratypes in MNHN IM-2000-30348.

**Type locality:** Adícora, peninsula of Paraganá, Estado Falcón, Venezuela, in beach deposits.

**Etiymology:** The species is named after Serge Gofas, who collected it during a stay in Venezuela.

**Description:** Shell small, whitish, very robust, as high as wide (H/D: 1.02), formed by  $3\frac{3}{4}$  whorls, narrowly umbilicate.

Protoconch of almost one whorl, about 260  $\mu$ m in diameter, completely smooth. Teleoconch with 3 whorls. Ornamentation of spiral cords, axial ribs

and lamellae, and microgranules. In apertural view, 3 spiral cords can be seen on the first and the second whorls, and 7 wide spiral cords on the last whorl, prominent and angled so as to form carinae; the first cord close to the suture is nodulose, and the remaining are smooth. The interspaces between the



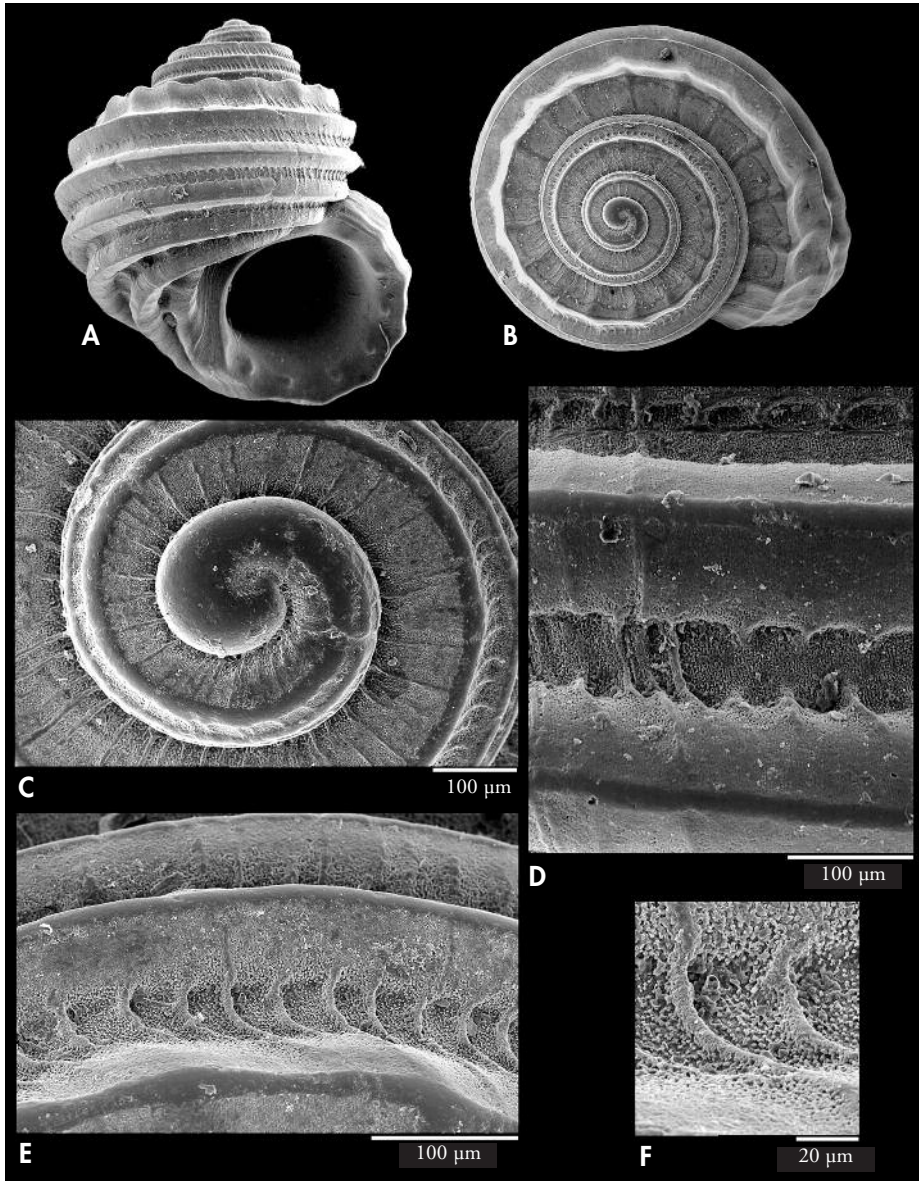


Figure 27. *Parviturbo gofasi* spec. nov. A, B: holotype, 1.9 mm in diameter, Adicora, Paraguaná, Venezuela (MNHN); C: protoconch; D-F: microsculpture and detail.

Figura 27. *Parviturbo gofasi* spec. nov. A, B: holotipo, 1,9 mm de diámetro, Adicora, Paraguaná, Venezuela (MNHN); C: protoconcha; D-F: microescultura y detalle.

cords are covered by microgranules, also in the first whorl they have thin axial threads, and in the remaining whorls fine lamellae.

Umbilicus very narrow and deep, delimited by a thick cord, inside with only fine growth lines. Aperture rounded, slightly prosocline. Parietal

callus thin, continued into an arched columella, not very thick and barely reflected; outer lip very thick, its edge indented by the termination of the spiral cords, and with 7 equidistant, rounded and prominent denticles on its internal part.

Dimensions of the holotype: 2.07 mm in height and 1.9 mm in diameter.

*Habitat*: Infralittoral species, found in coastal sediments.

*Distribution*: Only known with certainty from Paraguaná, Venezuela, its type locality. The material from Vitória Seamount figured as *Parviturbo weberi* Pilsbry & McGinty, 1945 by Leal (1991: 302, pl. 4, figs. A, B) could be the present species.

*Remarks*: *Parviturbo gofasi* spec. nov. differs from *P. weberi*, the most similar

species, in lacking spiral cordlets on the protoconch; in having one cord less and lacking of nodules on the cords 2, 6th, 7th and 8th; also the lamellae that occupy the spaces between cords are much finer. From *P. comptus*, it is distinguished also by having one cord less, by lacking nodules on the abapical cords and for being as high as wide.

LEAL (1991) recorded *Parviturbo weberi* from Oceanic Islands (Vitória Seamount), off northeastern Brazil. However, after examining closely the photographed specimen, we consider that it is not *P. weberi* but more similar to *P. gofasi*, having a completely smooth protoconch, without spiral cordlets, and having the lamellae of the interspaces much more numerous and thinner.

### *Parviturbo tuberculosus* (d'Orbigny, 1842) (Figure 28A-E)

*Trochus* (*Delphinula*) *tuberculosa* d'Orbigny, 1842. *Hist. Phys. Polit. Nat. Cuba*, 2: 69-70, pl. 19, figs. 28, 30. [Type locality: Jamaica].

**Type material**: Six syntypes, registration number NHMUK 1854.10.4.270. Locality: Jamaica. D'Orbigny collection, examined by photograph. The specimens are very damaged. A lectotype is designated from Jamaica (Fig. 28E).

**Material examined**: Only the type material.

*Description (from the original description and the lectotype)*: Shell small, robust, as high as wide ( $H/D=0.96$ ), white, turbiniform, formed by  $3\frac{3}{4}$  whorls, narrowly umbilicate. Protoconch of  $\frac{3}{4}$  whorls, apex sharp. Teleoconch of 3 whorls, the last one very wide, separated by a impressed suture; periphery rounded. Ornamentation formed by spiral cords and axial ribs. The cords are as wide as their interspaces; in apertural view, 3 cords can be seen on the first whorl and 8 on the last one between the suture and the umbilicus. The 2 subsutural cords and the 2 basal ones are nodulose; on the last quarter of whorl, strong nodules appear on all the cords until the edge of the outer lip. Axial ribs finer than the spiral cords, wider and more separate in the last quarter of whorl.

Umbilicus narrow, deep, delimited by a thick cord, inside with only

marked growth lines. Aperture rounded, prosocline; parietal callus thick, continued into the columella which is very thick, not curved nor reflected. Outer lip strong, with a bevelled edge, scalloped by the termination of the spiral cords.

The lectotype designed from Jamaica is 2.45 mm in diameter and 2.35 mm in height.

Maximum Reported Size: 2.5 mm

*Habitat*: Infralittoral species reported as very abundant in shallow water. ARANGO (1878) indicates that it is an abundant species in the sands of the El Chivo beach, Havana, Cuba, but the absence of the species in recent collecting may indicate that the species was confused with another one.

*Depth*: 6 m.

*Distribution*: Probably endemic of Jamaica.



Figure 28. *Parviturbo tuberculosus* (d'Orbigny, 1842). A: figures of the original description; B-D: material from the NHMUK (d'Orbigny collection); E: shell selected and designated as lectotype (NHMUK); F, G: shells from the lot and probably a different species.

*Figura 28. Parviturbo tuberculosus* (d'Orbigny, 1842). A: figuras de la descripción original; B-D: material en el NHMUK (colección d'Orbigny); E: concha seleccionada y designada como lectotipo (NHMUK); F, G: conchas de este lote pero probablemente siendo una especie diferente.

*Remarks:* The name *Delphinula tuberculata* appears in the plate caption, a misspelling unless the plate can be shown to have been published before the text.

*Parviturbo venezuelensis* Weisbord, 1962 has been considered a synonym; this is a Cenozoic fossil and the only known shell is in too poor condition to allow a comparison.

*Parviturbo fortius* spec. nov. (Figure 29A-F)

**Type material:** Holotype in MNHN IM-2012-5726 (Fig. 29A) and 7 paratypes in MNHN IM-2012-37354 (Figs. 29B-C).

**Material studied:** (5 spm, 111 s): Guadeloupe, KARUBENTHOS (all in MNHN): 8 s, Grand Cul-de-Sac Marin, Passe à Caret, Stn. GS29 (16°22.283'N-61°38.14'W), 29 m, *Thalassia* meadows (type material)(holotype MNHN IM-2012-5726; paratypes MNHN IM-2012-37354); 1 spm, Grand-Terre, Pointe de la Vigie (Pointe Montagnier), Stn. GB22, (16°30.57'N-61°28.45'W), 12 m (IM-2012-5704); 9 s, Grand Cul-de-Sac Marin, external slope, Stn. GB02 (16°21.970'N- 61°37.988.0'W), 11 m, coralline bottom (IM-2012-5697); 2 s, Grand Cul-de-Sac Marin, face à Fajou (Arches), Stn. GBB03 (16°21.72'N-61°36.354'W), 22 m, coralline bottom (IM-2012-5698); 7 s, Basse- Terre, Rocroy sud, Stn. GB08 (16°02.384'N-61°45.71'W), 17 m (IM-2012-5699); 6 s, Basse-Terre, Cote Ferry, Stn. GB11 (16°17.697'N-61°48.23'W), 10 m, rocky bottom (IM-2012-5700); 5 s, Grand Cul-de-Sac Marin, Port-Louis (èpave avion), Stn. GB12 (16°25.61'N- 61°32.576'W), 14 m (IM-2012-5701); 5 s, Basse-Terre, Pointe du Quesy, Stn. GB07 (16°06.071'N-61°46.374'W), 6 m, rocky bottom (IM- 2012-5702); 3 s, Grand Cul-de-Sac Marin, Sud Port-Louis (PCA buoy), Stn. GB15 (16°22.576'N-61°31.74'W), 8 m, rocky bottom (IM-2012-5703); 1 s, Grand-Terre, Pointe de la Vigie (grotte Amédier), Stn. GB23 (16°30.04'N-61°28.798'W), 16 m (IM-2012-5705); 3 s, Basse-Terre, Sec Paté, Stn. GB24 (15°54.0'N-61°39.3'W), 25 m (IM- 2012-5706); 2 s, Grand Cul-de-Sac Marin, Passe á Caret, Stn. GB26 (16°22.283'N-61°38.14'W), 29 m, rocky bottom (IM-2012-5707); 2 s, Grand Cul-de-Sac Marin, Ouest Ilet Fajou, Stn. GB29 (16°21.354'N-61°35.798'W), 2 m, terrasse fonds blancs (IM-2012-5708); 4 spm, Petite-Terre, Stn. GB31 (16°09.71'N-61°07.73'W), 15 m (IM-2012- 5709); 1 s, Petite-Terre, lagon, Stn. GB32 (16°10.54'N-61°06.51'W), 4 m (IM-2012-5710); 4 s, Petite-Terre, western shoal, Stn. GB36 (16°09.45'N-61°10.5'W), 16 m (IM-2012-5711); 1 s, Basse-Terre, pointe Nord Baie de Bouillante, Stn. GD10 (16°08.485'N-61°47.03'W), 54 m (IM-2012-5712); 4 s, Basse-Terre, Tête à l'Anglais, Stn. GR12 (16°22.9'N-61°45.94'W), 21 m, rocky bottom and meadows (IM-2012- 5713); 2 s, Basse-Terre, Sec Ferry, Stn. GR21 (16°17.51'N- 61°49.960'W), 27 m (IM-2012-5714); 1 s, Grand Cul-de-Sac Marin, Port-Louis (airplane wreck), Stn. GR23 (16°25.61'N-61°32.576'W), 20 m (IM-2012-5715); 4 s, Grand Cul-de-Sac Marin, external slope, Stn. GS04 (16°21.972.0'N-61°378.980'W), 11 m, coralline bottom (IM-2012- 5716); 2 s, Grand Cul-de-Sac Marin, facing Fajou (Arches), Stn. GS05 (16°21.72'N-61°36.354'W), 22 m, coralline bottom (IM-2012- 5717); 7 s, Grand Cul-de-Sac Marin, facing Fajou, Stn. GS06 (16°21.8'N75'N-61°36.071'W), 23 m, coralline bottom (IM-2012-5718); 1 s, Basse Terre, Pointe de l'Ermitage, Stn. GS09 (16°07.61'N- 61°46.53'W), 11 m, rocky bottom (IM-2012-5719); 1 s, Basse Terre, Baie de Bouillante, Stn. GS12 (16°08.071'N-61°46.71'W), 6 m, rocky bottom and meadows (IM-2012-5720); 1 s, Grand Cul-de-Sac Marin, Port-Louis (ouest Petit Canal), Stn. GS19 (16°22.576'N-61°31.74'W), 8 m, rocky bottom (IM-2012-5721); 5 s, Grand Cul-de-Sac Marin, Pointe Gris-Gris, Stn. GS21 (16°23.263'N-61°31.798'W), 14 m, rocky bottom (IM-2012-5722); 1 s, Basse-Terre, Stn. GS24 (16°26.78' /30.576'N-61°28.45/32.41'W), 12-16 m (IM-2012-5723); 1 s, Grand-Terre, Pointe de la Vigie (grotte Amedier), Stn. GS25 (16°30.04'N-61°28.798'W), 16 m, rocky bottom (IM-2012-5724); 1 s, Grand Cul-de-Sac Marin, Stn. GS27 (16°21.879'N-61°31.78'W), 5 m, *Thalassia* meadows (IM-2012-5725); 1 s, Petit Cul-de-Sac Marin, Ilet Caret, Stn. GS30 (16°21.263'N-61°37.798'W), 2 m, *Thalassia* meadows (IM-2012-5727); 5 s, Petite-Terre, Stn. GS34 (16°09.71'N- 61°07.73'W), 15 m (IM-2012-5728); 4 s, Petite-Terre, Stn. GS36 (16°07.879'N-61°12.52'W), 50 m (IM-2012-5729); 8 s, Petite-Terre, haut-fond ouest, Stn. GS39 (16°09.45'N-61°10.5'W), 16 m (IM-2012- 5730); 3 s, Grand-Terre, Anse Tarare, Stn. GD69 (16°156.970'N- 61°10.182'W), 60 m (IM-2012-5731).

**Type locality:** Guadeloupe, Grand Cul-de-Sac Marin, Passe à Caret (16°22.283'N-61°38.1'W), 29 m, *Thalassia* meadows [KARUBENTHOS: Stn. GS29].

**Etymology:** The specific name alludes the strong aspect of the shell.

*Description:* Shell small, white, very strong and robust, turbiniform, formed by 4 ¼ whorls separated by a deep suture, narrowly umbilicate. Protoconch of ¾ whorl, 220 µm in diameter and with 3 spiral cordlets. Teleoconch with 3 ½ very convex whorls.

Ornamentation of wide spiral cords, very wide ribs and microgranules. In apertural view, 4 spiral cords can be seen on the first whorl, 3 on the second and 7 on the last one between the suture and the umbilicus; those 3 cords closest to the suture have pointed nodules and

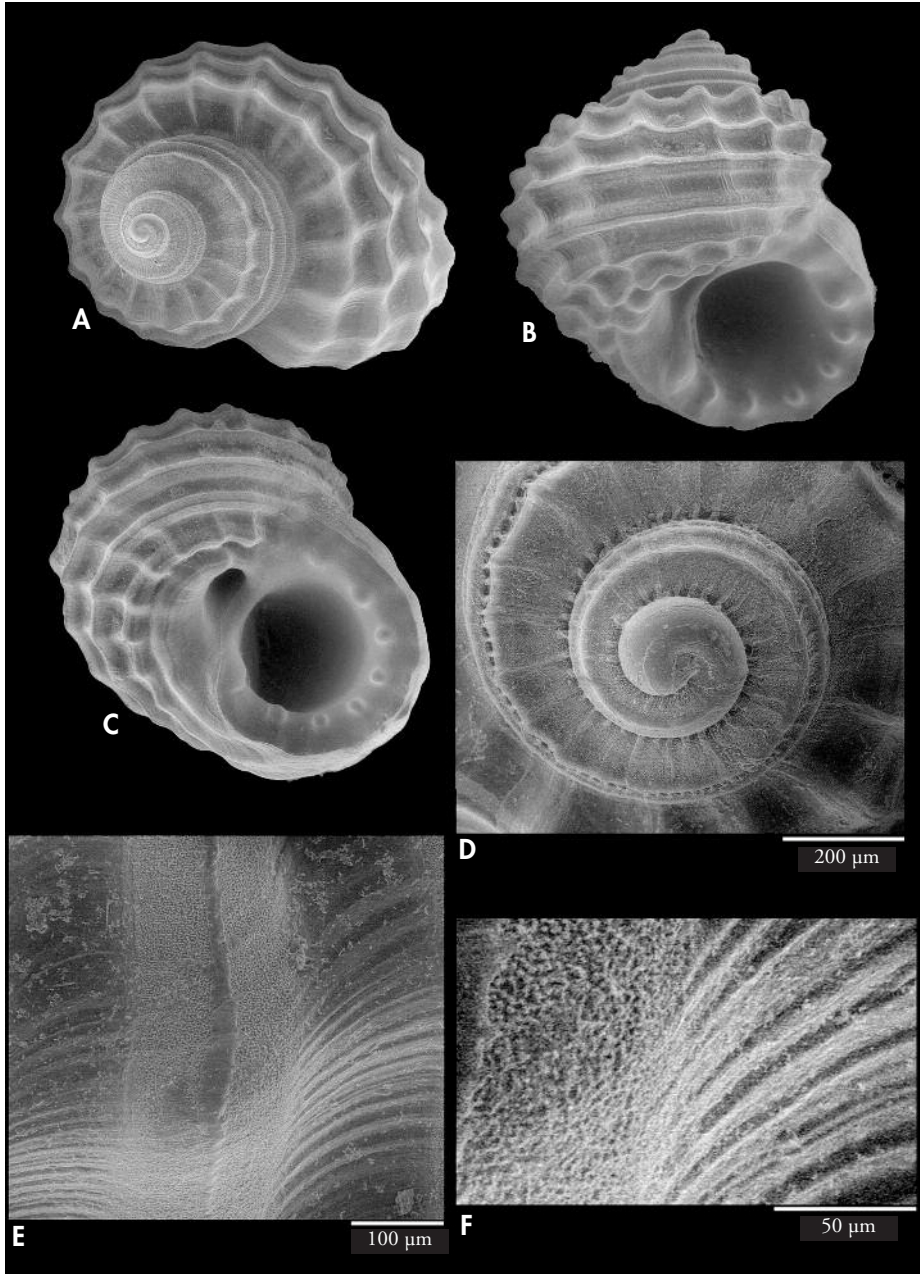


Figure 29. *Parviturbo fortius* spec. nov. A: holotype, 2.60 mm in diameter (MNHN); B, C: paratypes, 2.55, 2.8 mm in diameter, all from Guadeloupe, Grand Cul-de-Sac Marin, Stn. GS29, 29 m, *Thalassia* meadows (MNHN); D: protoconch of the holotype; E, F: microsculpture and detail.

*Figura 29. Parviturbo fortius spec. nov. A: holotipo, 2,60 mm de diámetro (MNHN); B, C: paratipos, 2,55, 2,8 mm de diámetro, todas de Guadeloupe, Grand Cul-de-Sac Marin, Stn. GS29, 29 m, praderas de Thalassia (MNHN); D: protoconcha del holotipo; E, F: microescultura y detalle.*

the 2 periumbilical cords, blunt nodules. The spaces between the cords in the first whorl of the teleoconch are occupied by thin axial ribs, forming a fine reticulate pattern as they cross the spiral cords; in the second whorl these spaces are occupied by fine lamellae, which disappear in the later whorls; the entire surface of the teleoconch is covered by microgranules.

Umbilicus rounded, narrow and very deep delimited by a cord with thick nodules, inside only with fine axial striae can be observed.

Aperture rounded, strongly prosocline; parietal callus thick, continued into the columella which is thick and arched, wider at the base on which there is a very thick denticle; outer lip very thick, with 8 coarse denticles on its inner side and with the outer margin slightly crenulated by the termination of the spiral cords.

Dimensions of the holotype: 2.73 mm in height and 2.60 mm in diameter.

*Habitat*: Infralittoral species living in hard bottom and in seagrasses such as *Thalassia* between 0 and 30 m.

*Distribution*: Only known from Guadeloupe its type locality.

*Remarks*: *Parviturbo fortius* spec. nov. resembles the lectotype of *Delphinula tuberculosa* d'Orbigny, 1842 but differs by its greater robustness, by having 7 instead of 8 cords on the last whorl, the periumbilical cords with large rounded nodules, coarser and less numerous than in *P. tuberculosus*. The number of spiral cords in first whorl of the teleoconch is also different (2 in *P. tuberculosus* and 4 in *P. fortius*).

*Parviturbo fortius* spec. nov. is the most common species of the genus in the island, attending the material collected, presenting all them a common morphology which distinguish it from other studied species.

## 2.C. SPECIES NOT INCLUDED IN PREVIOUS GROUPS

### *Parviturbo brasiliensis* spec. nov. Rubio, Rolán & Lee (Figure 30A-F)

**Type material**: Holotype in FLMNH (478951) (Figs 30A-B) and 1 paratype from Praia Itararé, São Vicente, São Paulo, Brasil; ex-CHL.

**Other material studied**: None.

**Type locality**: Praia Itararé, São Vicente, São Paulo, Brazil.

**Etymology**: The specific name is of the country from which the species was collected.

*Description*: Shell solid, robust, wider than high, spire formed by 3  $\frac{3}{4}$  whorls separated by a marked suture. Protoconch  $\frac{3}{4}$  whorl, about 200  $\mu$ m in diameter, smooth. Teleoconch with 3 whorls.

Ornamentation of thick spiral cords, axial threads and microgranules. Spiral cords triangular in section, as wide as their interspaces, not very sharp. There are 4 cords on the first whorl, 3 in the second and 8 on the last one; only the periumbilical cord looks slightly nodulous. Undulating axial threads form curved lamellae in the peripheral and basal interspaces. Contrary to other species of the genus, in apical view the axial threads maintain the same distance in all the whorls.

Umbilicus broad, with only thick growth lines inside. Aperture ovoid,

prosocline, with a continuous peristome. Outer lip thick, without nodules on its external margin, denticulate inside; columella straight, widened at its base forming a broad triangular area where it meets the periumbilical cord.

Dimensions of the holotype: 1.55 mm in height and 1.85 in diameter.

*Habitat*: The studied specimens come from beached sediments, and so we assume that it is a sublittoral species living in shallow waters.

*Distribution*: Only known from Praia Itararé, São Vicente, São Paulo, Brazil, its type locality.

*Remarks*: *Parviturbo brasiliensis* spec. nov. differs from most of the congeneric species in having axial threads regularly spaced in all the whorls. It differs from

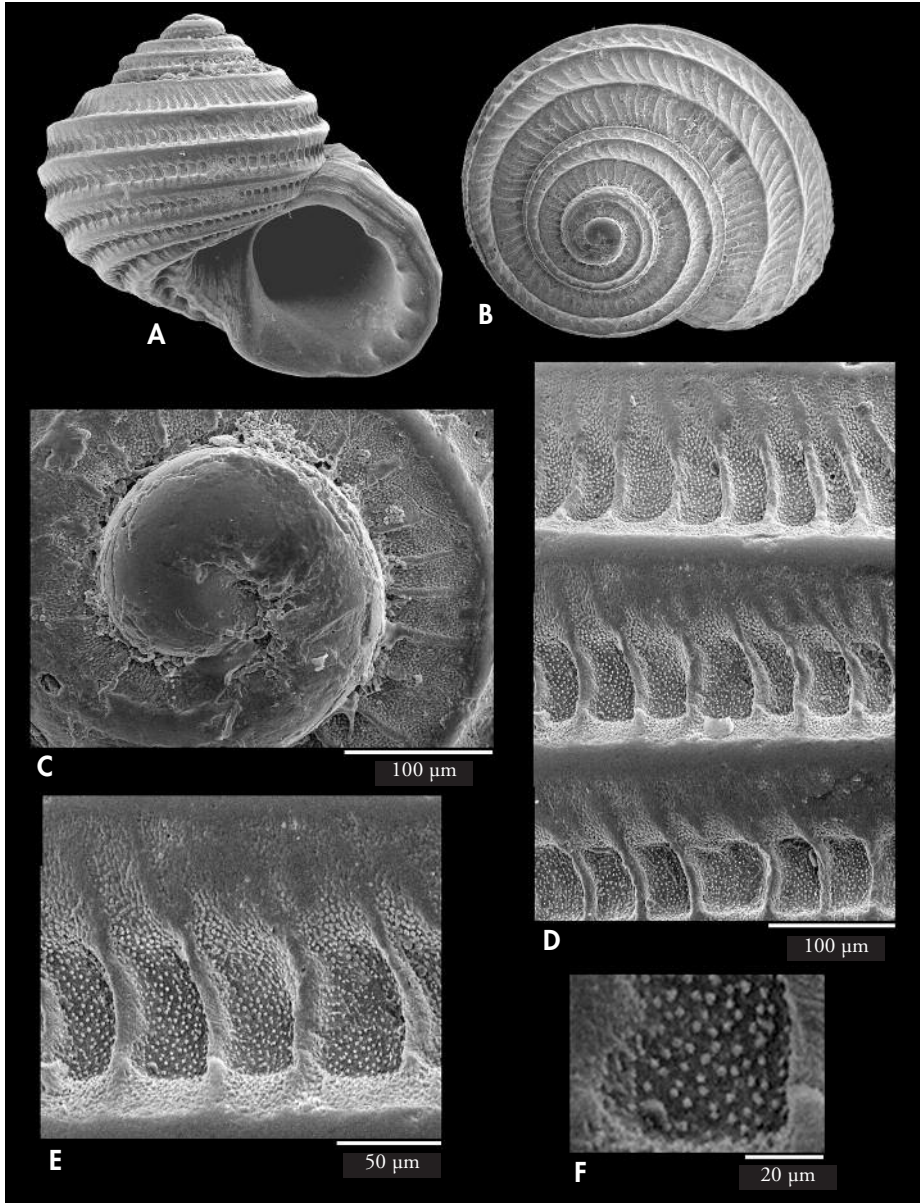


Figure 30. *Parviturbo brasiliensis* spec. nov. A, B: holotype, 1.85 mm in diameter, Itararé Beach, São Vicente, São Paulo, Brazil (FLMNH); C: protoconch; D-F: microsculpture and detail.

Figura 30. *Parviturbo brasiliensis* spec. nov. A, B: holotipo, 1,85 mm de diámetro, Playa Itararé, San Vicente, San Paulo, Brasil (FLMNH); C: protoconcha; D-F: microescultura y detalle.

*Parviturbo weberi* and *P. marcosi* spec. nov. in lacking nodulous cords both sub-sutural and basal. *Parviturbo granulum*

differs by its general form, thickness of the spiral cords and the form of the columella.

*Parviturbo zylmanae* spec. nov. Rubio, Rolán & Lee (Figure 31A-F)

**Type material:** Holotype (Figs. 31A-B) deposited in FLMNH (478953, ex-CHL) and one paratype (lost).

**Other material studied:** No.

**Type locality:** Deadman Chest, British Virgin Islands, sediment sample 18 m.

**Etymology:** The specific name is to honour Linda Zylman of Palm City, Fla., USA, who has brought several new species of marine micromollusks to light through her diligent collecting in various parts of the Caribbean Faunal Province.

*Description:* Shell very small, very solid, turbiniform, formed by  $3\frac{1}{4}$  whorls. Protoconch of  $\frac{3}{4}$  whorl, about 220  $\mu\text{m}$  in diameter and having three fine spiral cordlets. Teleoconch with  $2\frac{1}{2}$  whorls, completely covered by spiral cords, wavy axial threads and microgranules.

The cords are thick, not nodulous and almost as wide as the interspaces. In apertural view, 3 cords are seen in the first whorl and 8 in the last one; they fade out as fine cordlets when they reach the outer lip. Axial threads cross the spiral cords so as to indent their crest; in the first whorl, the axial threads are more separated forming first pentagonal and later quadrangular cells with the spiral cords; in the later whorls, the threads are more closely set giving to the surface of the shell a characteristic appearance.

Umbilicus very narrow, inside with scarcely visible growth lines. Aperture

rounded, prosocline; outer lip sharp, slightly crenulated on its outer edge and not denticulate inside; columella thin, almost straight, broadening to form a triangular space where it meets the umbilical cord.

Dimensions of the holotype: 1.1 mm in height and 1.1 mm in diameter.

*Habitat:* Infralittoral species living in coralline sand bottom to 18 m depth.

*Distribution:* Only known from Deadman Bay, British Virgin Islands its type locality.

*Remarks:* *Parviturbo zylmanae* spec. nov. is the only known species of *Parviturbo* whose axial threads override the spiral cords, causing that the outer edge of the cords are ragged. Another characteristic not observed in the remaining species is as the way the thick spiral cords fade out into fine cordlets in the proximity of the labial margin.

*Parviturbo robustior* spec. nov. Rubio, Rolán & Lee (Figure 32A-D)

**Type material:** Holotype (Figs. 32A-B) in FLMNH (478948), ex CHL.

**Type locality:** Amphitheater, Grand Turk, Turks & Caicos, 18 m.

**Etymology:** The specific name alludes the strong appearance of the shell.

*Description:* Shell very small but robust, formed by 4 whorls of rapid growth, separated by a marked suture. Protoconch (in poor condition on the holotype) with a diameter of about 360  $\mu\text{m}$ . Teleoconch with  $3\frac{1}{4}$  whorls.

Ornamentation of coarse, rounded spiral cords, as wide as their interspaces, not nodulose, and of weak axial ribs between the suture and the first cord. In apertural view, 3 cords can be seen in the 1st and 2nd whorls and 8 on last one; the first cord is at the same height as the suture and gives a shouldered appearance to the periphery. The spaces between the cords

are concave and filled with regularly spaced, curved lamellae.

Umbilicus narrow and deep, delimited by a thick umbilical cord, with growth lines and without spiral cordlets inside. Aperture rounded, peristome continuous; outer lip thickened, not modified by the spiral cords, without denticles inside; columella arched, thick, not reflected.

Dimensions of the holotype: 1.7 mm in height and 1.46 mm in diameter (H/D: 1.16). The height of the aperture is the 56% of the total height of the shell.

*Habitat:* Unknown.



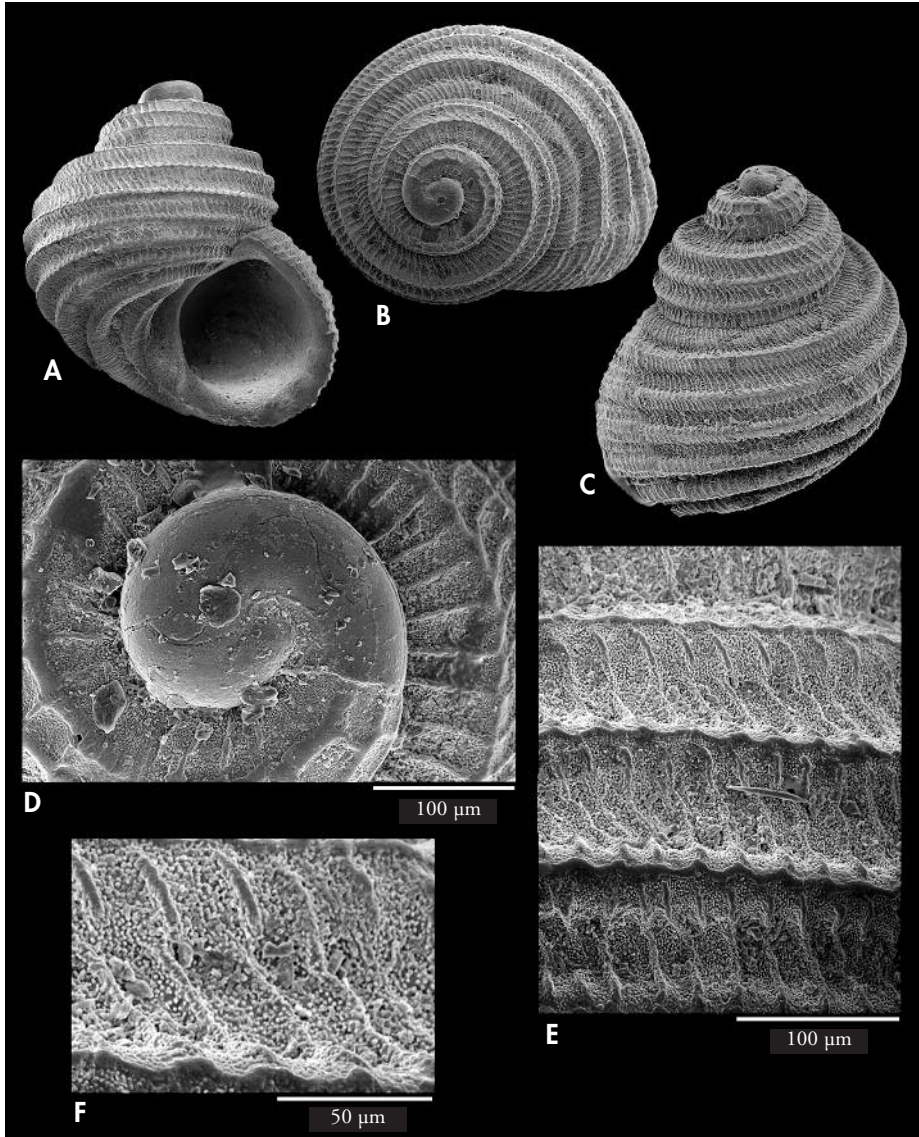


Figure 31. *Parviturbo zylmanae* spec. nov. Rubio, Rolán & Lee. A, B: holotype 1.1 mm in diameter (FLMNH); C: paratype, 1.1 mm, Deadman Bay, British Virgin Islands (CHL); D: protoconch; E, F: microsculpture.

*Figura 31. Parviturbo zylmanae spec. nov. Rubio, Rolán & Lee. A, B: holotipo, 1,1 mm de diámetro (FLMNH); C: paratipo, 1,1 mm, Deadman Bay, Islas Vírgenes Británicas (CHL); D: protoconcha; E, F: microescultura.*

*Distribution:* Only known from the holotype.

*Remarks:* *Parviturbo robustior* spec. nov. is distinguished from its congeners by its

thick, rounded spiral cords, which are not nodulose; by their concave interspaces with regularly spaced lamellae in them, and by its definitely shouldered profile.

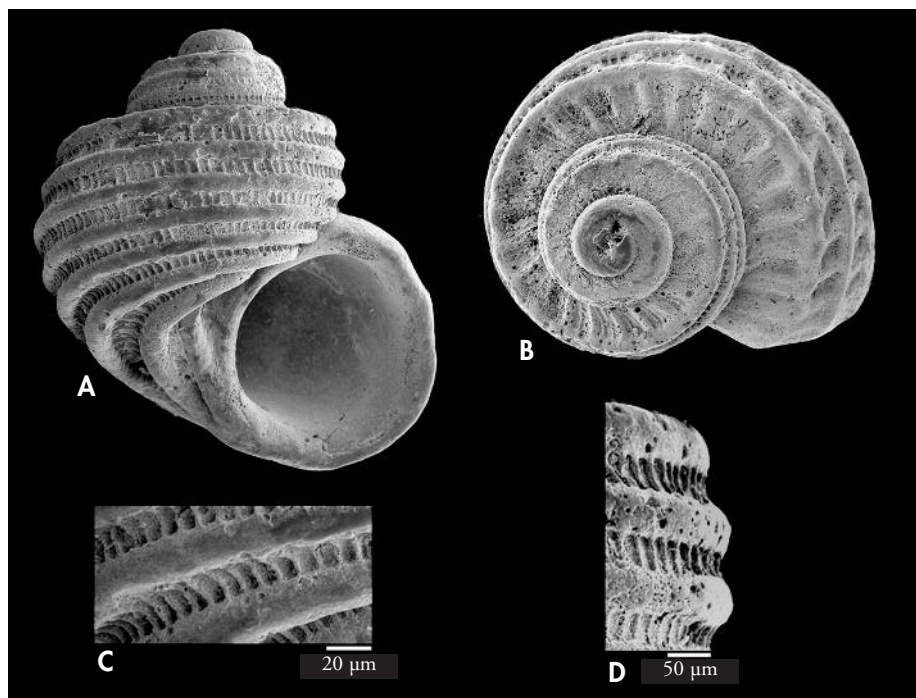


Figure 32: *Parviturbo robustior* spec. nov. Rubio, Rolán & Lee. A, B: holotype, 1.46 mm in diameter, Amphitheatre, Turks & Caicos, (FLMNH); C, D: sculpture.

Figura 32: *Parviturbo robustior* spec. nov. Rubio, Rolán & Lee. A, B: holotipo, 1,46 mm de diámetro, Amphitheatre, Turks & Caicos, (FLMNH); C, D: escultura.

### 3. THE PANAMIC PROVINCE

The Panamic zoogeographic Province extends from Lower California to Peru. There are four described species: *Parviturbo acuticostatus* (Carpenter, 1864), *P. conceptionensis* (Lowe, 1935), *P. erici* (Strong & Hertlein, 1939) and *P. stearnsii* (Dall, 1918). In the original descriptions, the different authors employed the genera *Liotia*, *Homalopoma*

and *Fossarus*. After the creation of the genus *Parviturbo* Pilsbry & McGinty, 1945, they were transferred by KEEN (1971) to this genus. RUBIO ET AL. (2013) transferred *Parviturbo erici* and *P. conceptionensis* to the genus *Haplocochlias*, thereby reducing the known species from this area to *P. acuticostatus* and *P. stearnsii*.

#### *Parviturbo acuticostatus* (Carpenter, 1864) (Figure 33A-G)

*Liotia acuticostata* Carpenter, 1864. *Proc. Calif. Acad. Sc.*, 3 (3): 157-158. Lectotype designated by PALMER (1958: 146). [Type locality: Catalina Island 10-20 fms].

*Fossarus angiolus* Dall, 1919. *Publ. U. S. Nat. Mus.*, 56 (2295): 350. [Type locality: Todos los Santos Bay, Lower California, near San Diego] - OLDROYD, 1927. *Mar. Sh. W. Coast N. America*, 2 (3): 70.

*Parviturbo acuticostatus* (Carpenter, 1864) - McLEAN, 1969. *Los Angeles County Mus. Nat. Hist., Sci. Ser.* 24: 23, fig. 9.6. - WARÉN, 1992. *Boll. Malac.* 27 (10-12): 193, 202, fig. 1A.

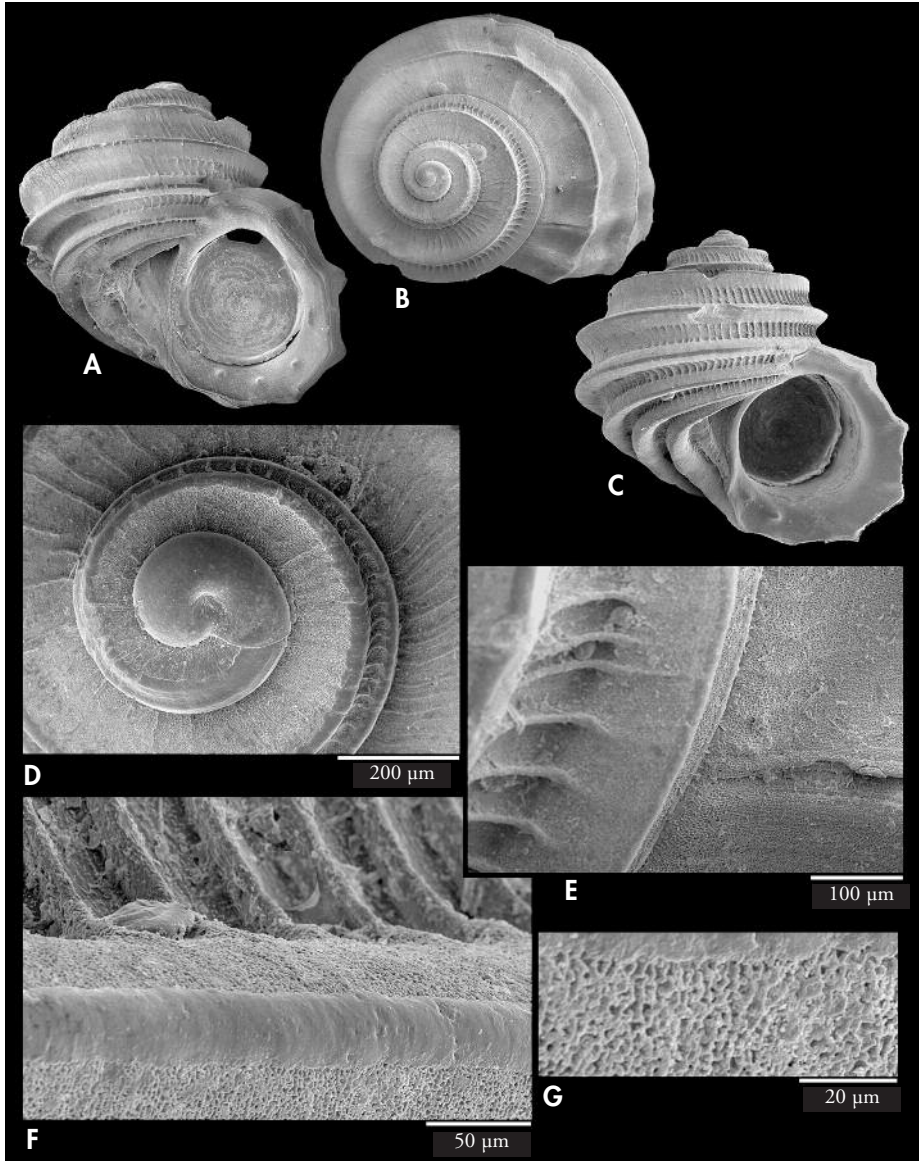


Figure 33. *Parviturbo acuticostatus* (Carpenter, 1864). A, B: shell, 2.8 mm in diameter, Baja California (LACM); C: shell, 2.7 mm, Wilson Rock, California (LACM); D: protoconch; E-G: microsculpture and detail.

Figura 33. *Parviturbo acuticostatus* (Carpenter, 1864). A, B: concha, 2,8 mm de diámetro, Baja California (LACM); C: concha, 2,7 mm, Wilson Rock, California (LACM); D: protoconcha; E-G: microescultura y detalle.

**Type material:** Lectotype of *Liotia acuticostata* deposited in USNM (16282). Type specimen of *Fossarus angiolus* deposited in USNM (271503), not examined.

**Material examined:** (55 s): Mexico: 10 s, about 10 miles south of Puerto Cortez, east side of Santa Margarita Is., Baja California, intertidal (LACM 66-8); 9 s, approx. 1 mile south of Puerto Santo

Tomas, Baja California, 12 m, on rock and gravel bottom (LACM 67-49). California, USA: 4 s, Little Rock Slide Cove, Pt. Vicente, Palos Verdes Peninsula, Los Angeles Co., 3-10 m (LACM 74-79); 20 s, Crescent Bay, Laguna Beach, Orange Co., 9 m (LACM 74-80); 12 s, Wilson Rock, off San Miguel Is., 23-27 m, granite pinnacles (LACM 82-59).

*Description (from the original description and new data in LAFOLLETE, 1976):* Shell small, globose, uniformly white, turbiniform, formed by 4 whorls, narrowly umbilicate. Protoconch smooth, of  $\frac{3}{4}$  whorls, about 270  $\mu$ m in diameter. Teleoconch of 3  $\frac{1}{4}$  whorls, carinate, separated by an impressed suture; periphery rounded.

Ornamentation formed by spiral cords, axial ribs and microgranules in the interspaces. The cords are wider than their interspaces, elevate like carinae; in apertural view, 2 cords can be seen on the first and second whorls and 7 on the last one between the suture and the umbilicus (6 evenly spaced spiral cords on the body whorl plus one surrounding the umbilicus). Axial sculpture of fine, sharp, closely spaced lamellae between the spiral cords on the spire, becoming more or less obsolete on the body whorl of the adult, where they are replaced in many specimens from north of 29°N (central Baja California) by more widely spaced, broad, rounded axial ribs on the upper part of the whorl, forming squarish pits. The entire surface of the teleoconch is covered by microgranules.

Umbilicus narrow, deep, delimited by a moderately thick cord, with only marked growth lines inside. Aperture

rounded, prosocline; parietal callus thin, continued with the columella which is not very thick, is curved and slightly reflected at its base and slightly widening where it meets the periumbilical cord. Outer lip strong, reflected outwards, with a bevelled edge, on which the termination of the spiral cords are projected; with 4-5 tubercles on its inner side.

The shells examined measure between 2.1 – 2.9 mm in diameter and 2.1-2.8 mm in height.

Operculum chitinous, multispiral, with 5 to 6 whorls, light brown in colour.

*Habitat*: Infralittoral species, living on gravel bottoms, in 3 to 30 m (KEEN, 1971).

*Distribution*: Monterrey, Santa Catalina Island (CARPENTER, 1864); Isthmus Cove, Santa Catalina Island, California; Guadalupe Island; Magdalena Bay; Cape San Lucas; Tres Marias Islands, Mexico (STRONG & HERTLEIN, 1939); Monterey, California, to Cape San Lucas and Cerralvo Island, Gulf of California (KEEN, 1971); Monterey, California to the Gulf of California (ABBOTT, 1974).

*Remarks*: ABBOTT (1974) wrote: "6 spiral ribs on the body whorl, with the interspaces smooth. A variable species with several varietal names.

### *Parviturbo stearnsii* (Dall, 1918) (Figure 34A-F)

*Liotia acuticostata stearnsii* Dall, 1918. *Proc. Biol. Soc. Washington*, 31: 8. [Type locality: Gulf of California]. *Liotia heimi* Strong & Hertlein, 1939. *Allan Hancock Pacif. Exped.*, 2: 238, pl. 21 figs. 4, 7. [off Taboga Island, Panama] – ABBOTT, 1974. *American seashells*, 2nd ed.: 57.

*Parviturbo stearnsii* (Dall, 1918) - KEEN, 1971. *Sea Shells of Tropical West America*: 345, fig. 124.

**Type material**: Type material of *Liotia acuticostata stearnsii* in USNM (47062). Holotype of *Liotia heimi*, stated as deposited in California Academy of Science, Paleontology type collection (n° 730), not examined. Paratype of *Liotia heimi* in LACM (1736), from Bahia Honda, Panama, in 3-9 fathoms, examined.

**Material examined**: (173 s): Mexico: 54 s, South anchorage, Guadalupe Is., Baja California, 15-30 m (LACM 65-42); 27 s, Saladita cove and first cove north, near Guaymas, Sonora, 9-18 m (LACM 68-27); 47 s, NW end Cedros Island, Baja California, 14 m (LACM 72-114); 62 s, off Isla Blanca, Concepción Bay, 11-18 m (LACM 73-122). Costa Rica: 45 s, small islets off Quepos, Puntarenas Province, 23 m, gravel and cobble (LACM 72-59).

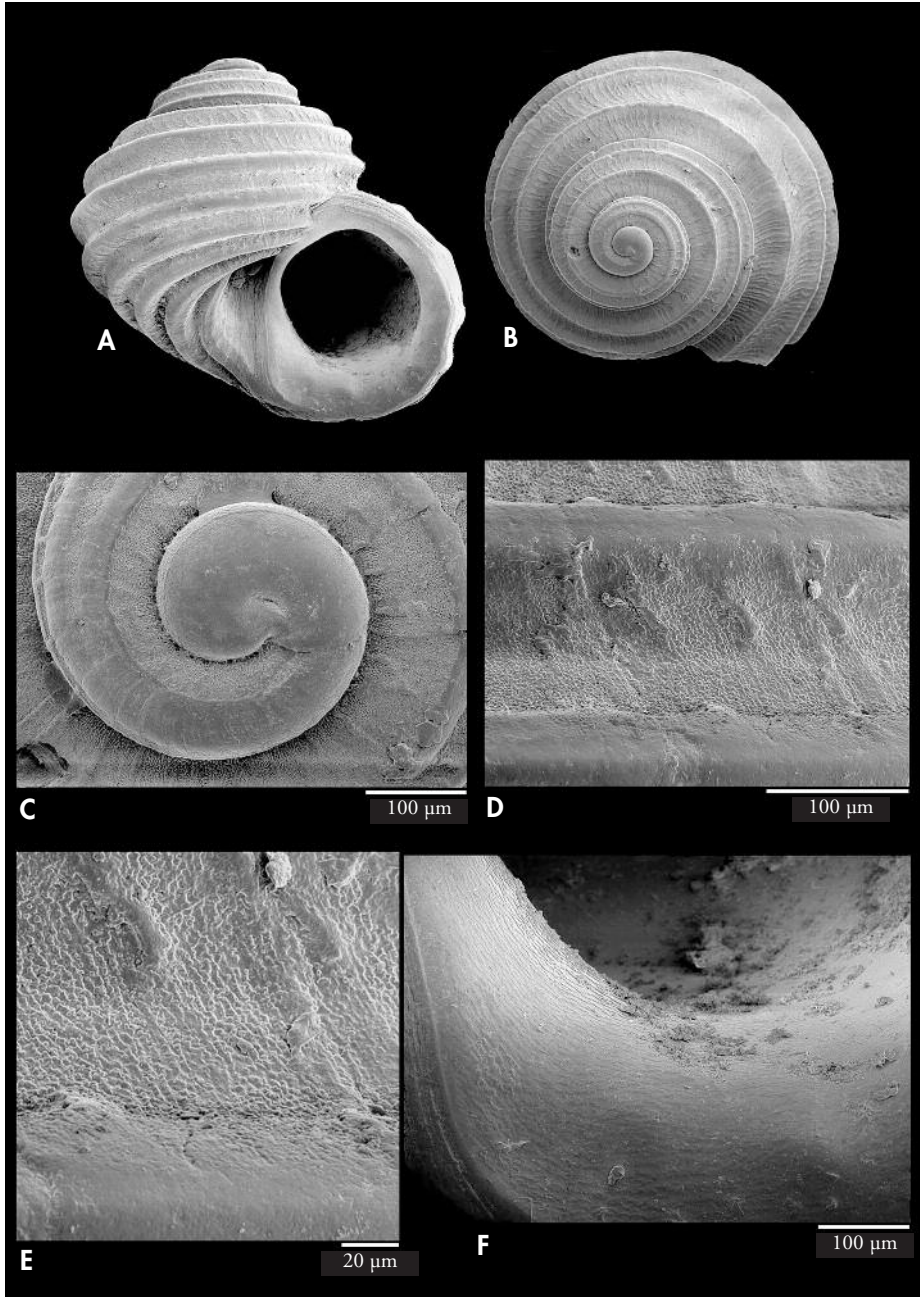


Figure 34. *Parviturbo stearnsii* (Dall, 1918). A, B: shells, 1.85, 1.75 mm in diameter, NW end Cedros Island, Baja California, Mexico, 14 m (LACM 72-114); C: protoconch; D, E: sculpture and detail; F: detail of the aperture.

*Figura 34. Parviturbo stearnsii* (Dall, 1918). A, B: conchas, 1,85, 1,75 mm de diámetro, extremo NO de La Isla de Cedros, Baja California, México, 14 m (LACM 72-114); C: protoconcha; D, E: escultura y detalle; F: detalle de la abertura.

*Description (from the original description and new data):* Shell small, globose, white, turbiniform, formed by 3  $\frac{3}{4}$  whorls, narrowly umbilicate. Protoconch of  $\frac{3}{4}$  whorls, about 210  $\mu\text{m}$  in diameter, its surface is rough with a spiral cordelet. Teleoconch of about 3 whorls, carinate, separated by an impressed suture; periphery rounded.

Ornamentation formed by spiral cords, axial ribs and microgranules in the interspaces. The cords are as wide as their interspaces; in apertural view, 3 elevated cords, like carinae, can be seen on the first and second whorls and 8 on the last one between the suture and the umbilicus. Axial ribs finer than the spiral cords.

Umbilicus narrow, deep, delimited by a thick cord, inside with only marked growth lines. Aperture rounded, prosocline; parietal callus thick, continued into the columella which is very thick, not curved and becoming wider towards its base where it meets the periumbilical cord. Outer lip strong, reflected outwards, without tubercles on its inner side.

The holotype is 2.3 mm in diameter and 2.3 mm in height.

*Habitat:* Dredged from 3 to 9 fms (STRONG & HERTLEIN, 1939). On gravel bottoms, in 3 to 30 m (KEEN, 1971).

*Distribution:* From off Taboga Island and Honda Bay, Panama (STRONG & HERTLEIN, 1939); Asunción Island, outer coast of Baja California, north in the Gulf of California to Guaymas; south to Port Utria, Colombia (KEEN, 1971); Baja California to Colombia (ABBOTT, 1974).

*Remarks:* As regards to *Liotia heimi* STRONG & HERTLEIN (1939: 238) wrote: "In common with many species in the genus there is some variation in the character and strength of the axial sculpture while the spiral sculpture remains very constant. The present species belongs in the group with *Liotia acuticostata* Carpenter, 1864 and its varieties from southern and Lower California. It differs in the greater number of spiral cords and stronger axial riblets".

*Parviturbo stearnsii* in its general form is very similar to *P. annejoffeae* spec. nov. from the Caribbean, but differs in having the spiral cords more rounded, the umbilical cord much more developed and lacking nodules, the columella much wider basally, and a hint of nodules inside the outer lip.

#### 4. TROPICAL PACIFIC

The only known record of *Parviturbo* for the Tropical Pacific was provided by MAES (1967), who placed *Liotia parvissima* Hedley, 1899 in this genus. However *Liotia parvissima* is transferred to the genus *Lophocochlias* Pilsbry, 1921 by KAY (1979) and in the

last revision by RUBIO & ROLAN (in press).

So, the four species considered here for the Pacific area were hitherto undescribed: *P. vanuatuensis* spec. nov., *P. javiercondei* spec. nov., *P. pombali* spec. nov. and *P. dispar* spec. nov.

#### *Parviturbo vanuatuensis* spec. nov. (Figure 35A-F)

**Type material:** Holotype in MNHN IM-2000-30349 (Figs. 35A-B).

**Material examined:** (1 s): Vanuatu, SANTO 2006: 1 s, Palikulo Bay, Stn. DB46, 15°28.8'S-167°15.2'E, 2-3 m, sandy flat.

**Type locality:** Vanuatu, Palikulo Bay, 15°28.8'S-167°15.2'E, 2-3 m, sandy flat [SANTO 2006: Stn. DB46].

**Etymology:** The specific name is dedicate to the island where the species was collected.

*Description:* Shell small, white, robust, wider than high (H/D: 0.88), formed by 3 whorls of rapid growth,

separated by a deep suture; carinate and narrowly umbilicate. Protoconch of one whorl, about 270  $\mu\text{m}$  in diameter, orna-

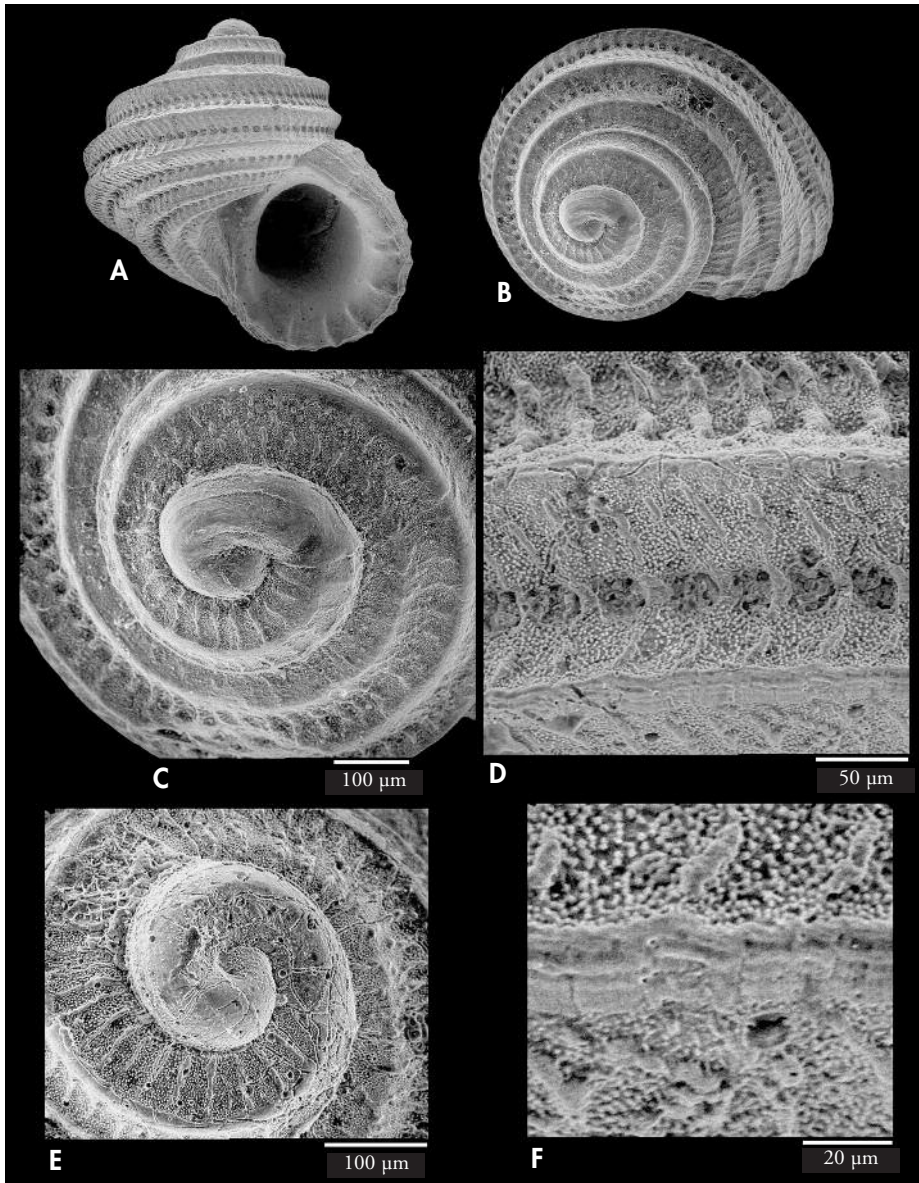


Figure 35. *Parviturbo vanuatuensis* spec. nov. A, B: holotype, 0.84 mm in diameter, Vanuatu (MNHN); C: protoconch; D-F: microsculpture and detail.

*Figura 35. Parviturbo vanuatuensis spec. nov.*; A, B: *holotipo*, 0,84 mm de diámetro, Vanuatu (MNHN); C: *protoconcha*; D-F: *microescultura y detalle*.

mented with 3 spiral cords. Teleoconch with two whorls, carinate.

Ornamentation formed by thick spiral cords, and thin axial threads and

lamellae in the spaces between the carinae. In apertural position, two cords can be seen on the first whorl and 7 on the last whorl, in addition to a

cord delimiting the umbilicus. The space between the cords is occupied by fine axial threads on the first whorl, which are raised into small lamellae in the central part of the interspaces of the last whorl; between the first and second cords two rows of lamellae are visible.

Except on the crest of the cords and on the axial threads, the teleoconch is entirely covered by microgranules.

Umbilicus narrow and deep, delimited by a moderate spiral cord; inside only with marked growth lines. Aperture rounded; parietal callus rather thick, continued into a nearly straight columella, widened at the base and slightly reflected towards the umbilicus,

but without occluding it; outer lip very thick, margin scalloped by the termination of the cords, inside with 5 thick elongated tubercles.

Dimensions of the holotype: 0.74 mm in height and 0.84 mm in diameter.

*Habitat*: Infralittoral species collected on a sandy bottom in 2-3 m depth.

*Distribution*: Only known from type locality.

*Remarks*: *Parviturbo vanuatuensis* spec. nov. somewhat resembles *Parviturbo javiercondei* spec. nov. (see below), but differs in being wider than high (H/D: 0.88), in having very prominent and spiral cords angled like carinae and in having elongated tubercles inside the outer lip.

### *Parviturbo javiercondei* spec. nov. (Figure 36A-D)

**Type material**: Holotype in MNHN IM-2000-30350 (Figs. 36A-B).

**Material examined**: (1 s): Fiji, MUSORSTOM 10: only the holotype.

**Type locality**: Fiji, South of Viti Levu, 18°12'S - 178°33'E, 149-168 m [MUSORSTOM 10: Stn. CP1366].

**Etymology**: The specific name is after Javier Conde, Spanish malacologist who cooperates frequently with language editing of "Iberus".

*Description*: Shell very small, white, turbiniform, slightly higher than wide, with 3 whorls, narrowly umbilicate. Protoconch of a little more than one whorl, about 240  $\mu$ m in diameter; although it is eroded, a spiral cord close to the suture can be seen.

Teleoconch with 2  $\frac{1}{4}$  whorls, completely covered by thick cords.

Ornamentation formed by thick spiral cords, axial threads and microgranules. In apertural position, 3 cords can be seen on the first whorl and 8 on the last; the subsutural cord, present in the first whorl is gradually fading, disappearing on the last one. The spaces between the cords are covered by rather thick axial threads and microgranules.

Umbilicus narrow and deep, delimited by a fine spiral cord, inside with only marked axial growth lines.

Aperture rounded, slightly prosocline; parietal callus thick, continued into a columella which is slightly arched, very strong and reflected

towards the umbilicus. Outer lip very wide, with the edge slightly scalloped by the termination of the spiral cords, while on its inner part can be seen several poorly defined tubercles.

Dimensions of the holotype: 0.93 mm in height and 0.90 mm in diameter (H/D: 1.03).

*Habitat*: Circalittoral species dredged at 149-168 m deep.

*Distribution*: Only known from its type locality.

*Remarks*: *Parviturbo javiercondei* spec. nov. is very similar in shape to *Parviturbo vanuatuensis* spec. nov. from which it can be differentiated by being slightly higher than wide (H/D: 1.03), by having the spiral cords less prominent, not carinate and by having the tubercles on the inner part of the outer lip poorly defined.

From *P. pombali* spec. nov., it may be differentiated by having fine lamellae in the spaces between the cords instead of axial ribs; and by having the external lip wider and not so reflected externally.



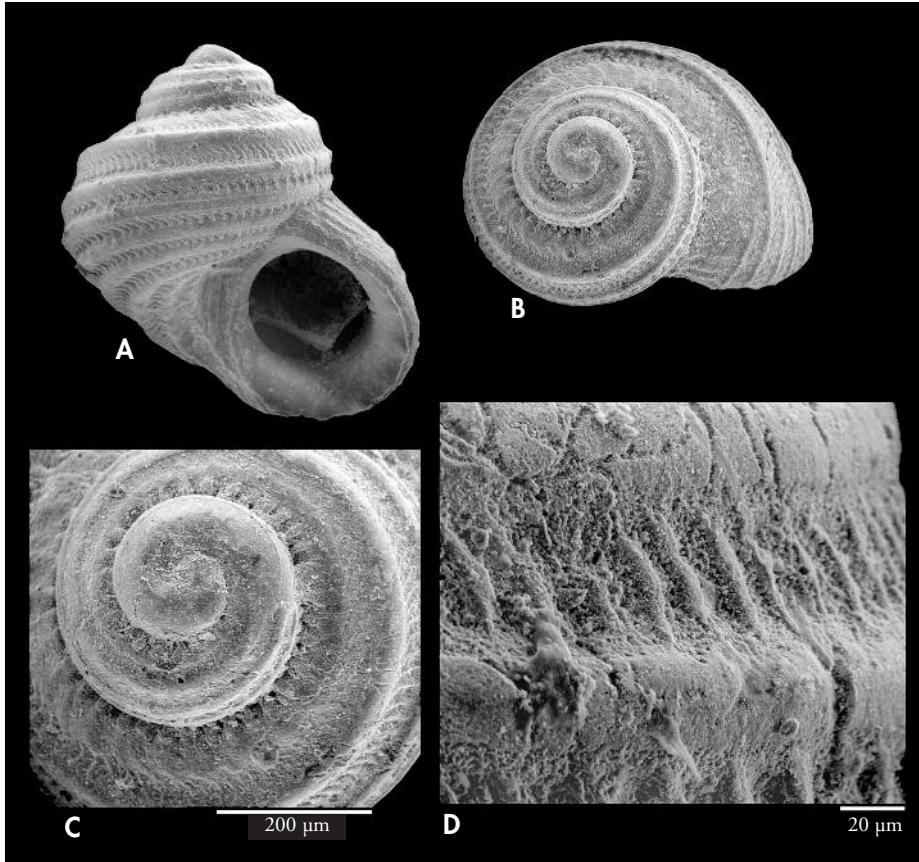


Figure 36. *Parviturbo javiercondei* spec. nov. A, B: holotype, 0.90 mm in diameter, Fiji (MNHN); C: protoconch; D: microsculpture.

*Figura 36. Parviturbo javiercondei spec. nov. A, B: holotipo, 0,90 mm de diámetro, Fiji, (MNHN); C: protoconcha; D: microescultura.*

***Parviturbo pombali* spec. nov. (Figure 37A-F)**

**Type material:** Holotype in MNHN IM-2000-30351 (Fig. 37A) and one paratype in MNHN IM-2000-30352 (Fig. 37B).

**Material examined:** (3 s): Vanuatu, SANTO 2006: 2 s, E Palikulo Peninsula, Stn. VM54, 15°28.9'S - 167°15.5'E, 0 m, intertidal; 1 s, Reef near Oyster Island, Stn. FB40, 15°22.9'S - 167°11.7'E, 9 m, sand slope with dead corals.

**Type locality:** Vanuatu, E Palikulo Peninsula, 15°28.9'S - 167°15.5'E, intertidal [SANTO 2006: Stn. VM54].

**Etymology:** The specific name is after Prof. Manuel Angel Pombal of the Vigo University, for his contribution to biology.

*Description:* Shell small, as wide as high (H/D: 1.02), solid, formed by 3 whorls separated by a deep suture, with a reticulate sculpture and narrowly

umbilicate. Protoconch 193 µm in diameter, of one whorl, totally covered by microgranules and with 2 spiral cordlets. Teleoconch with 2 whorls.

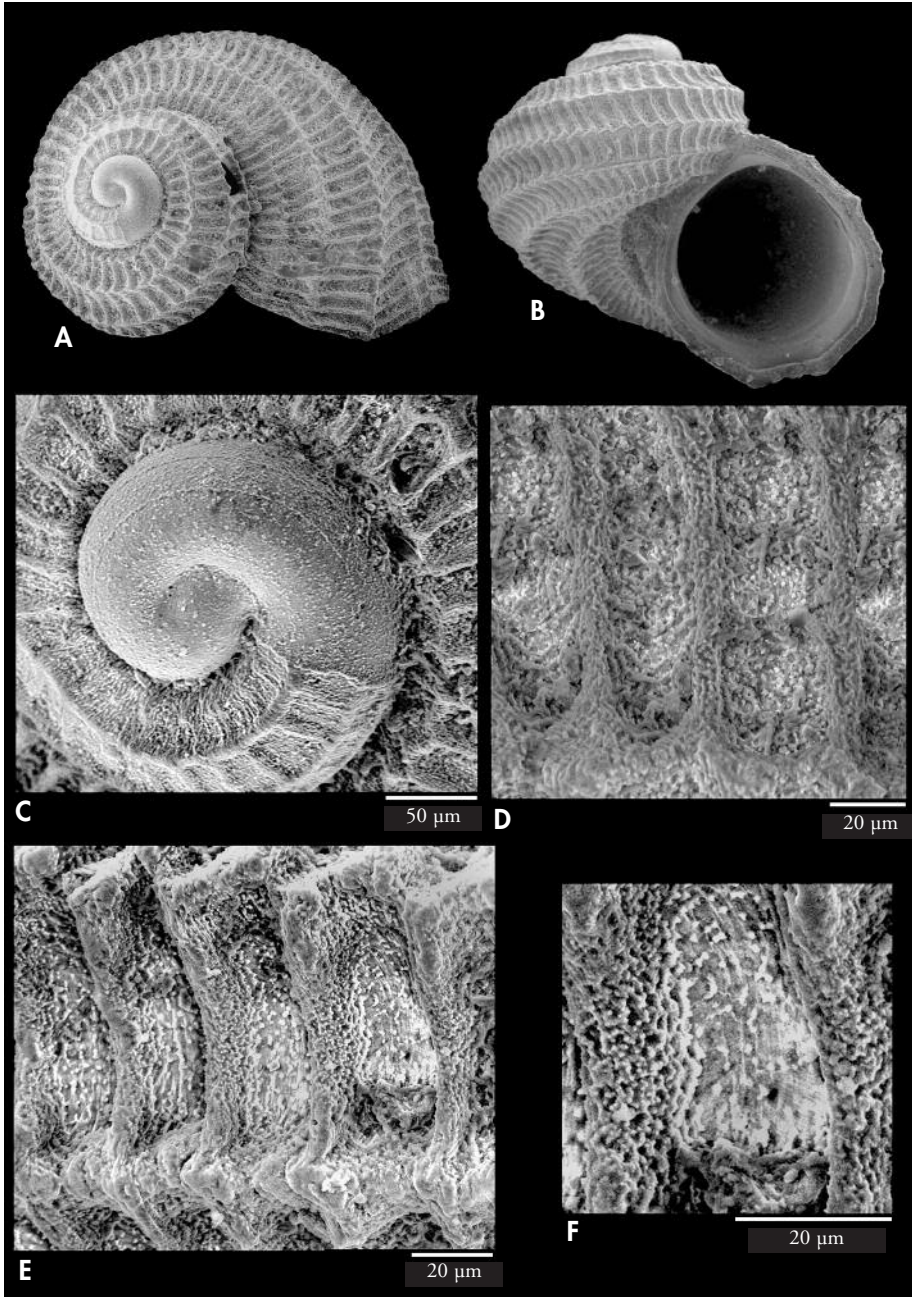


Figure 37. *Parviturbo pombali* spec. nov.; A: holotype, 1.08 mm in diameter, Vanuatu, Stn. VM54 (MNHN); B: paratype, 1.12 mm in diameter (MNHN); C: protoconch of the holotype; D-F: microsculpture and detail.

Figura 37. *Parviturbo pombali* spec. nov.; A: holotipo, 1,08 mm de diámetro, Vanuatu, Stn. VM54 (MNHN); B: paratipo, 1,12 mm de diámetro (MNHN); C: protoconcha del holotipo; D-F: microscultura y detalle.

Ornamentation of spiral cords which develop in zigzag, axial riblets and microgranules. In apertural position, 7 wide spiral cords can be seen on the last whorl; the spaces between cords are clearly concave and bear strong, prosocline axial riblets, forming with the spiral cords rectangular cells, characteristic of the species.

Umbilicus narrow and deep, inside with a spiral cordlet and marked growth lines. Aperture rounded, prosocline; parietal callus rather thin, continued into an arched columella, not too strong neither reflected towards the umbilicus; external lip with the edge scalloped by the termination of the spiral cords,

without any tubercles on its internal side.

Dimensions of the holotype: 1.1 mm high and 1.08 mm in diameter.

*Habitat*: Infralittoral species collected between 0 and 9 m on a sand slope with dead corals.

*Distribution*: Only known from Vanuatu, its type locality.

*Remarks*: *Parviturbo pombali* spec. nov. differs from *P. vanuatuensis* spec. nov. and *P. javiercondei* spec. nov. in having narrower spiral cords, in having distinct axial riblets forming rectangular cells in the space between cords, and by having the external lip not very thickened and distinctly reflected outwards.

*Parviturbo dispar* spec. nov. Rubio, Rolán & Letourneux (Figures 38A-G, 39A-D)

**Type material**: Holotype in MNHN IM-2000-30353 (Figs. 38A-B) and 30 paratypes in MNHN IM-2000-30354; 10 in the CJL.

**Material examined**: (+ 225 s): Société Islands: +200 s, from Tuamotu, Atolls of Rangiroa, Makemo, Katiu, Pinaki, Ame, Tatakoto, Nukutavake, Fangatau and Kauhei, 1-100 m (type locality) (CJL); 7 s + 9 juv, from Australes, Atolls of Rurutu, Rimatara, Raivavae and Maria, 1-20 m (CJL); 8 s, from Marquises, Atolls of Nukuhna and Lia Pou, 1-68 m (CJL); 1 s, from Gambier, Atoll of Totegegi, 0 m, intertidal sand (CJL).

**Type locality**: Société Islands, Tuamotu, encompassing the atolls of Rangiroa, Makemo, Katiu, Pinaki, Ame, Tatakoto, Nukutavake, Fangatau and Kauhei, 1-100 m.

**Etymology**: The specific name is derived of the Latin name *dispar, aris*, which means "different" alluding its differences with the type species of the genus.

*Description*: Shell very small, higher than wide (H/D: 1.10), turbiniform, formed by up to 3 ½ whorls separated by a marked suture, umbilicate. Protoconch of one whorl, with a maximum diameter between 230-250 µm; it has a strong spiral cord which begins in the nucleus and continues as a keel until near the end of the protoconch; its surface is rough and bears 3 cordlets and a spiral depression from which depart small oblique incisions in a spiked pattern. Teleoconch with 2 ¾ whorls.

Ornamentation formed by thick spiral cords, fine axial ribs and microgranules. In apertural view there are 2 thick cords on the first whorl of the teleoconch and 8 on the last, of which the peripheral ones are thicker and form

angulate carinae on the periphery; interspaces with fine axial riblets, which, starting from the sides of the crest, are directed obliquely toward the centre of the interspace, but without joining; small tubercles of different forms can be observed in the area where the riblets come close together. In the area immediately preceding the outer lip, a thickening occurs, the carinae disappear and are replaced by numerous fine cords which overrun the margin of the outer lip.

Umbilicus not very wide but deep, partially occluded by the reflection of the columella; inside with fine cordlets and coarse axial folds. Aperture rounded-oval, somewhat prosocline; parietal area callose covered by a thick layer; columella almost straight, thick,

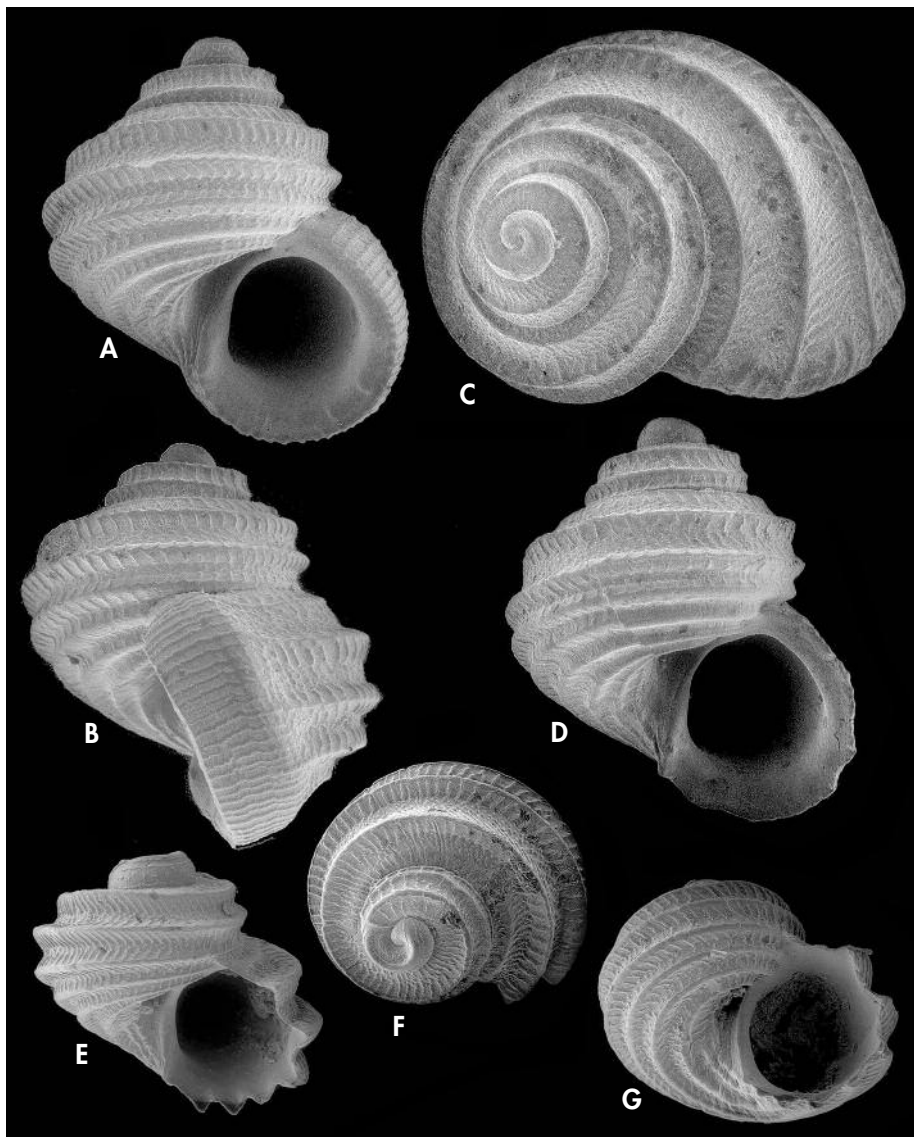


Figure 38. *Parviturbo dispar* spec. nov. A, B: holotype, 1.21 mm in diameter (MNHN); C, D: paratypes, 1.61, 1.13 mm in diameter (CFL); E, G: juvenile, 0.85 mm; F: juvenile, 0.77 mm. All from Tuamotu, French Polynesia.

*Figura 38. Parviturbo dispar spec. nov. A, B: holotipo, 1,21 mm de diámetro (MNHN); C, D: paratipos, 1,61, 1,13 mm de diámetro (CFL); E, G: juvenil, 0,85 mm; F: juvenil, 0,77 mm. Todos de Tuamotu, Polinesia Francesa.*

widened at the base and reflected towards the umbilicus, with a small denticle on its base; outer lip very thick, its outer edge crenulated by the numer-

ous spiral cordlets, inside with several denticles, elongated, of different size and thickness, matching the peripheral carinae.

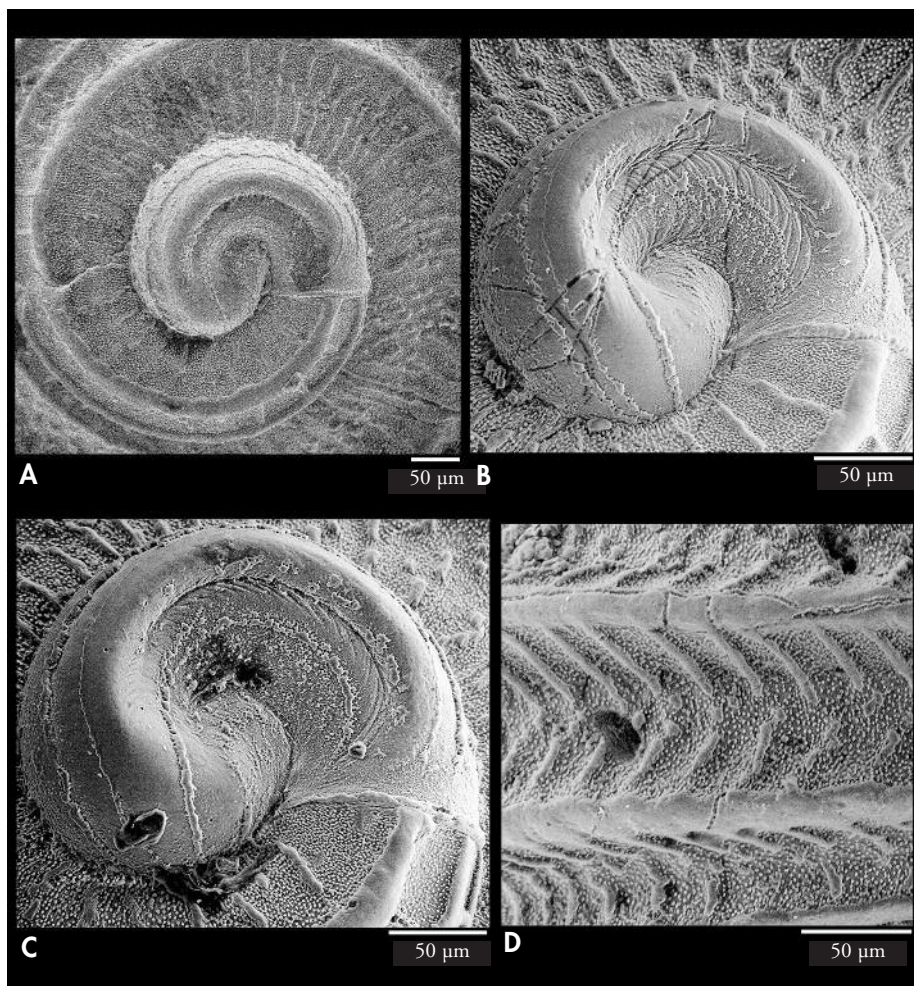


Figure 39. *Parviturbo dispar* spec. nov. A: protoconch of the holotype; B, C: details of protoconchs from juveniles of Figure 38F and G, Tuamotu, French Polynesia; D: detail of the microsculpture.  
 Figura 39. *Parviturbo dispar* spec. nov. A: protoconcha del holotipo; B, C: detalles de las protoconchas de juveniles de las Figuras 38F y G, Tuamotu, Polinesia Francesa; D: detalle de la microescultura.

Holotype size 1.33 in height x 1.21 mm in diameter. The largest paratype is 1.61 mm in diameter.

*Habitat*: Dredged at 0-100 m in sandy bottoms.

*Distribution*: Only known from type locality.

*Remarks*: *Parviturbo dispar* spec. nov. differs from the other known species of the Indo-Pacific (*P. vanuatuensis*, *P. javiercondei* and *P. pombali*), primarily by

having a keeled protoconch, which presents, in addition to 3 spiral cords, a spiral groove bearing many oblique striae in a spiked pattern.

The most similar species is *P. vanuatuensis*, which differs, in addition to the form of the protoconch, by being smaller, with more spiral cords in the last whorl and outer lip thickening, and in having fewer denticles inside the outer lip.

5. FOSSIL SPECIES

*Parviturbo maturensis* Jung, 1969 (Figure 40A)

*Parviturbo maturensis* Jung, 1969. *Bull. Am. Paleont.* 55: 424, pl. 42, figs. 14-17. [Type locality: Matura, Trinidad, Miocene-Pliocene].

**Type material:** Holotype deposited in the Natural History Museum Basel (H 14625).

*Remarks:* JUNG (1969) mentions that this species is based on the holotype and one immature paratype. Also he comments that *P. maturensis* may be distinguished from *P. milium* (Dall,

1892) from the Pliocene of Florida and from the living species *P. rehderi*, *P. francesae* and *P. calidimaris* by having the lowest spire and a prominent peripheral spiral.

*Parviturbo milium* (Dall, 1892) (Figure 40B)

*Liotia* (*Arene?*) *milium* Dall, 1892. *Trans. Wagner Free Inst. Sci.*, 3: 409, pl. 18, fig. 4. [Type locality: Pliocene of the Caloosahatchie River, Florida].

**Type material:** Holotype in USNM (113085).

*Description:* Original description in DALL (1892): "Shell minute, spirally sculptured, with one smooth nuclear and two and a half subsequent whorls; spiral sculpture, between the sutures three and on the last whorl between suture and umbilicus eight even, rounded, well-elevated, simple threads separated by equal, channelled interspaces, in which toward the aperture may be a single extremely fine intercalary thread; interstices crossed by rather elevated fine lines of growth not apparent on the ribs; whorls rounded; suture distinct; umbilicus narrow, deep,

bordered by a wellmarked isolated rib; aperture nearly circular, a little thickened, its outline crenulated by the ribs". Alt. of shell 1.5; max. diam. 1.8 mm.

*Remarks:* WEISBORD (1962) describing *P. venezuelensis* mentions: "Another *Parviturbo* in Florida, this one from the Pliocene, is *P. milium* (DALL, 1892, p. 409, pi. 18, fig. 4) which has "eight even, rounded, well elevated simple threads separated by equal, interspaces" on the last whorl between the suture and the umbilicus. *P. venezuelensis* has six such spiral ridges and they are subequal".

*Parviturbo venezuelensis* Weisbord, 1962 (Figure 40C)

*Parviturbo venezuelensis* Weisbord, 1962. *Bulletins of American Paleontology*, 42 (193): 99-101, pl. 7, figs. 5-7. [Type locality: Mare formation at W-25, south flank of Punta Gorda anticline, Distrito Federal, Venezuela. Range: 11°N; 64°W].

**Type material:** Holotype (26047) from Mare Formation, in Paleontological Research Institution, Ithaca, New York.

*Remarks:* JUNG (1969: 424) after the description of *Parviturbo maturensis* mentions: "*P. venezuelensis* Weisbord, 1962, pp. 99, pl. 7, figs. 5-7) from the Pliocene Mare Formation of northern Venezuela,

is based on a single, incomplete specimen which lacks the protoconch".

In the Malacolog database ([www.malacolog.org/search.php?nameid=1064](http://www.malacolog.org/search.php?nameid=1064)) *P. venezuelensis* is considered

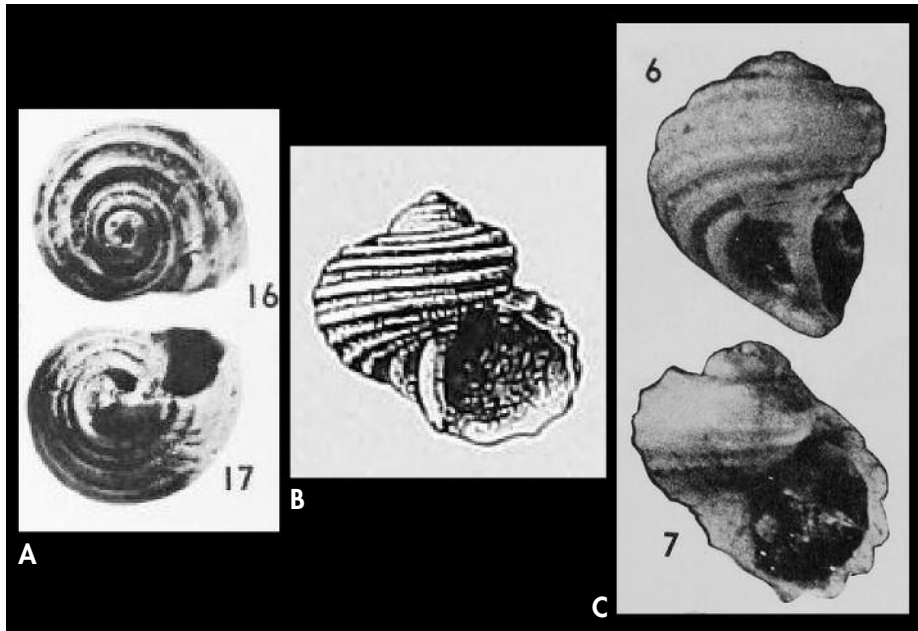


Figure 40. Original figures of fossil species placed in *Parviturbo*: A: *Parviturbo maturensis* Jung, 1969; holotype in Natural History Museum Basel (H 14625). B: *Parviturbo milium* (Dall, 1892); holotype in USNM (113085). C: *Parviturbo venezuelensis* Weisbord, 1962; holotype.

Figura 40. Figuras originales de especies asignadas a *Parviturbo*: A: *Parviturbo maturensis* Jung, 1969; holotipo en Natural History Museum Basel (H 14625). B: *Parviturbo milium* (Dall, 1892); holotipo en USNM (113085). C: *Parviturbo venezuelensis* Weisbord, 1962; holotipo.

synonym of *P. tuberculosus* without any explanation. After comparison with the original figuration, we do not support

this view, being a fossil species, based on an incomplete specimen with a broken protoconch.

## 6. DOUBTFUL TAXA POSSIBLY BELONGING TO *PARVITURBO*

### *Leptothyra alfredensis* Bartsch, 1915 (Figure 41A)

*Leptothyra alfredensis* Bartsch, 1915. *U.S. Nat. Mus. Bull.*, 91: 149-150, pl. 32, figs. 1-3. [Type locality: Port Alfred, South Africa].

*Parviturbo alfredensis* (Bartsch, 1915) - HERBERT, 2012. *Afr. Invert.* 53 (2): 398.

**Type material:** Type specimen in USNM (n° 250500).

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

**Remarks:** BARTSCH (1915): "It has four whorls and measures: Altitude 4.7 mm, greater diameter 4.8 mm". HERBERT (2012: 398) in his revision of the Chilodontidae of southern Africa briefly mentions this

species and wrote "*Leptothyra alfredensis* Bartsch, 1915, and *Cyclostremella alfredensis* Bartsch, 1915, both from Port Alfred, Eastern Cape, superficially resemble *Vaceuchelus*, but show much greater similarity to the skeneid genus *Parviturbo* Pilsbry & McGinty, 1945 (HICKMAN &

MCLEAN, 1990; WARÉN, 1991). Unfortunately, this cannot be confirmed by examination of the radula, as neither species has ever been found alive. Both names may quite possibly apply to the same species. Likewise *Vitrinella agulhasensis* Thiele, 1925,

from the Agulhas Bank, resembles *Vaceuchelus*, but is also probably a species of *Parviturbo*. Although HERBERT (2012: 398) mentions *Cyclostremella alfredensis* Bartsch, 1905, the actual original name is *Cyclostrema alfredensis* Bartsch, 1905.

### *Cyclostrema alfredensis* Bartsch, 1915 (Fig. 41B)

*Cyclostrema alfredensis* Bartsch, 1915. *U.S. Nat. Mus. Bull.*, 91: 169, pl. 36, figs. 6-8. [Type locality: Port Alfred, South Africa].

**Type material:** Type in USNM (n° 250501a).

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

**Remarks:** BARTSCH (1915): "It has one

and one-fifth postnuclear whorls; and measures: Altitude 1.2 mm, greater diameter 1.7 mm".

### *Vitrinella agulhasensis* Thiele, 1925

*Vitrinella agulhasensis* Thiele, 1925. *Wiss. Ergebn. Deutsch. Tiefsee-Exped. "Valdivia"*, 17 (2): 37 [71], pl. 3 [15], fig. 17 [Type Locality: Valdivia sta. 95, off Cap Agulhas, 34°51'S, 19°37.8'E, 80 m and Sta. 106, Agulhas Bank, 35°26.8'S, 20°56.2'E].

*Parviturbo agulhasensis* (Thiele, 1925) - HERBERT (2012). *African Invertebrates*, 53 (2): 398.

**Type material:** Museum für Naturkunde, Berlin - syntype (Malakologie-109203b), syntype (Malakologie-109203a): Deutsche Tiefsee-Expedition.

**Distribution:** Cap Agulhas, South Africa (THIELE, 1925).

**Remarks:** HERBERT (2012) notes "Likewi-

se *Vitrinella agulhasensis* Thiele, 1925, from the Agulhas Bank, resembles *Vaceuchelus*, but is also probably a species of *Parviturbo*."

## 7. SPECIES THAT WERE DESCRIBED AS *PARVITURBO* AND NOW BELONG TO OTHER GENERA/FAMILY

### *Fossarus eutorniscus* Melvill, 1918 (Figure 42A-E, 43A-D)

*Fossarus eutorniscus* Melvill, 1918. *Ann. Mag. Nat. Hist.* (9) 1: 148, pl. 5, fig. 21 [Type locality: Karachi, Pakistan].

*Parviturbo dibellai* Buzzurro & Cecalupo, 2007 "2006". *Boll. Malac.*, 42 (1-4): 27-32. [Type locality: Taçucu, SE Turkey]. New synonym.

**Type material:** *Fossarus eutorniscus*: Syntype deposited in NMW (1b-051) from Karachi, Pakistan (Melvill-Tomlin Collection: NMW 1955.158, 2510), examined by photograph. *Parviturbo dibellai*: Holotype deposited in MNHM (29773) and 1 paratype in HUI (HUI 50847), examined by photograph; 1 paratype from Taçucu, Turkey (CAC).

**Material examined:** (2 s): Turkey: the paratype from Taçucu mentioned (CAC). South of Madagascar: Atimo Vatae: 1 s, Baie des Galions, Stn. TB11 (25°09.2'S - 46°45.4'E), 5-6 m, rock ledge and silt (MNHN).

**Distribution:** Known from Karachi, Pakistan (Melvill, 1918); and South of

Madagascar; introduced into the Mediterranean Sea at Taçucu (southeast



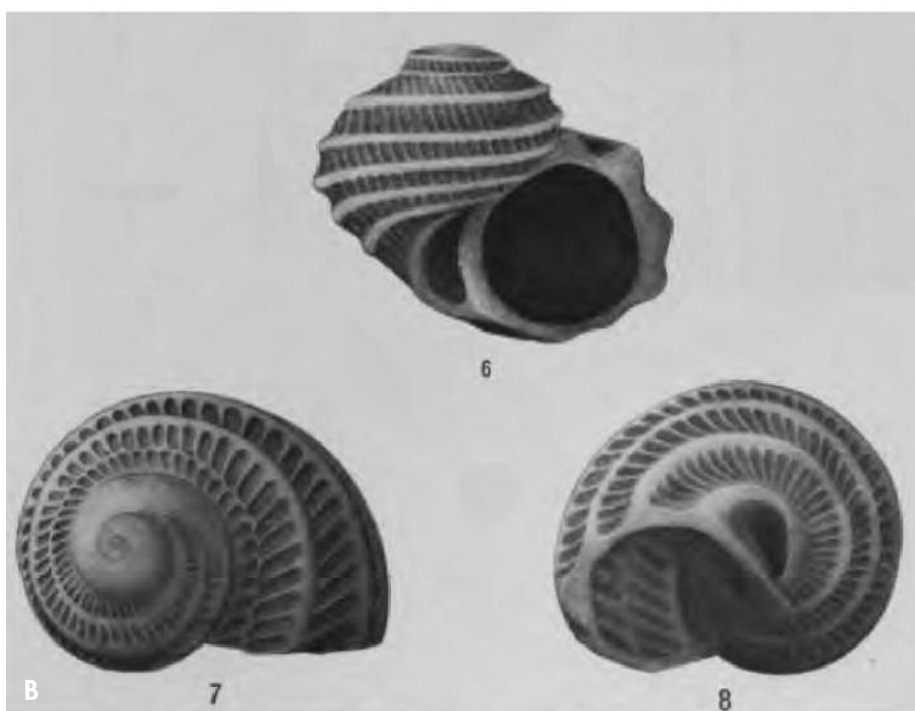
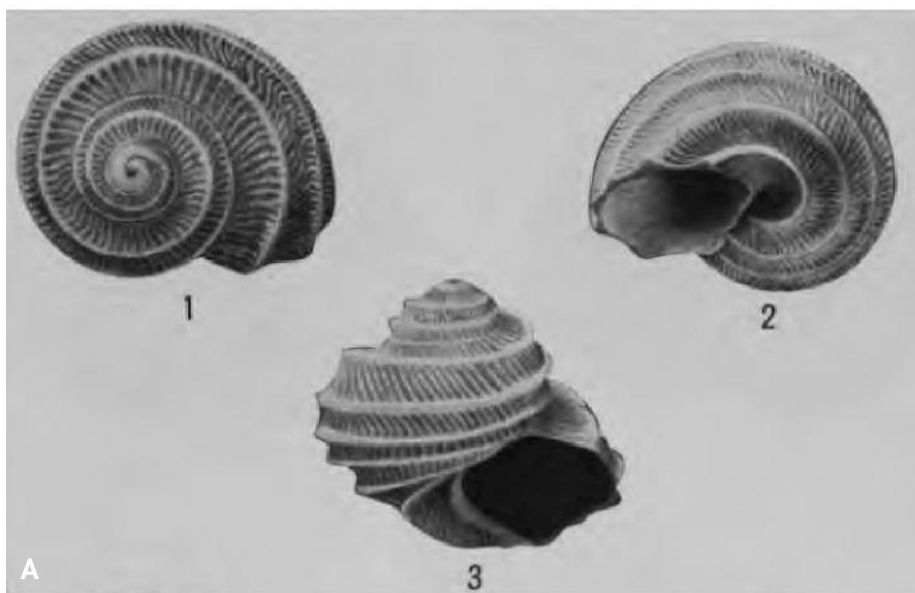


Figure 41. Original figures from Bartsch, 1915. A. *Leptothyra alfredensis*, USNM 250500. B. *Cyclostrema alfredensis*, USNM 250501a.

Figura 41. Figuras originales en Bartsch, 1915. A. *Leptothyra alfredensis*, USNM 250500. B. *Cyclostrema alfredensis*, USNM 250501a.

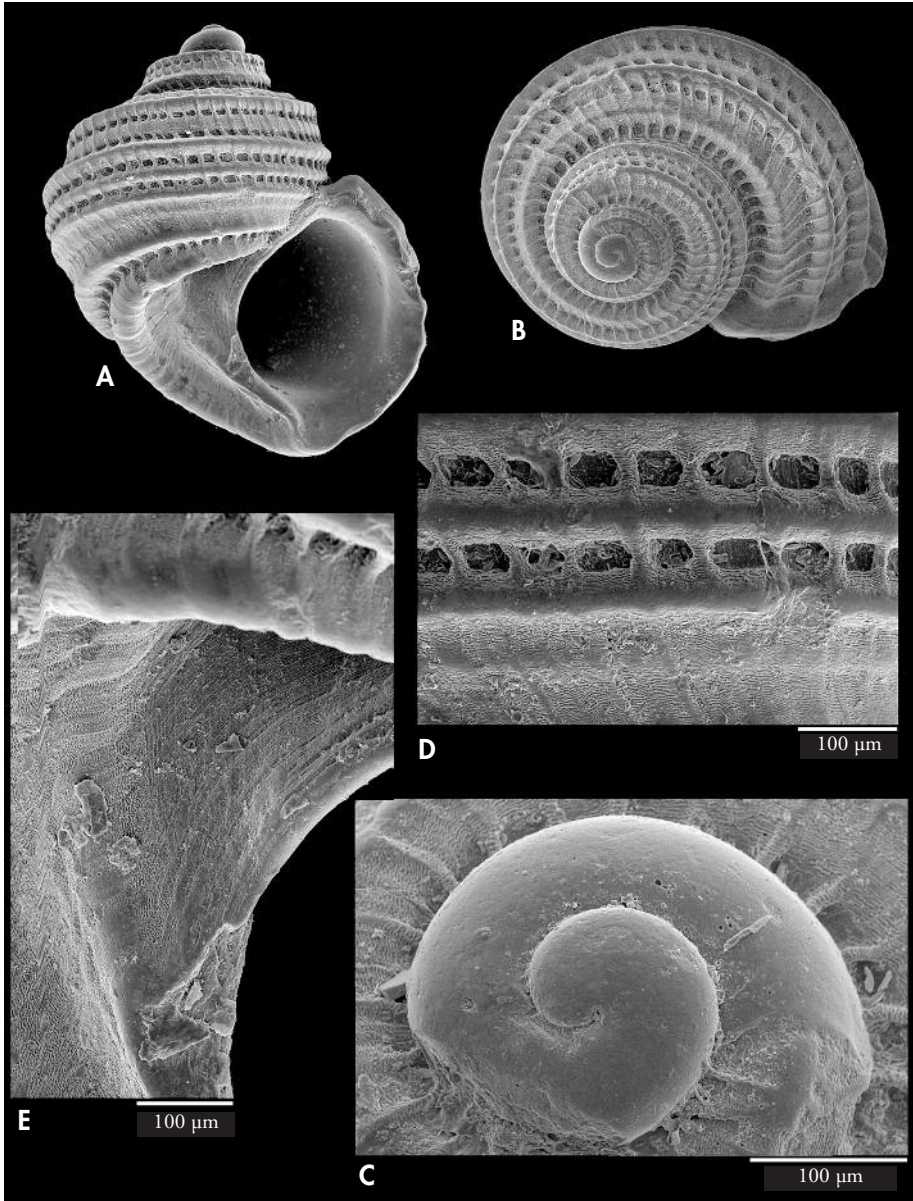


Figure 42. *Fossarus eutorniscus* Melvill, 1918 (paratype of *Parviturbo dibellai* Buzzurro & Cecalupo, 2007). A, B: shell, 1.75 mm, Taçucu, SE Turkey (CAC); C: protoconch; D, E sculpture.

Figura 42. *Fossarus eutorniscus* Melvill, 1918 (paratipo de *Parviturbo dibellai* Buzzurro & Cecalupo, 2007). A, B: concha, 1,75 mm, Taçucu, sureste de Turquía (CAC); C: protoconcha; D, E: escultura.

coast of Turkey) and Akko, Haifa e Rosh Hanikra, Israel coast (BUZZURRO & CECALUPO, 2007)

Remarks: MELVILL (1918: 148) described, *Fossarus eutorniscus* from Karachi, Pakistan (NMW n° 1b-051)



Figure 43. *Fossarus eutorniscus* Melvill, 1918. A, B: shell, 1.48 mm, South Madagascar (MNHN); C: protoconch. D: *Fossarus eutorniscus* Melvill, 1918, syntype, 1.55 mm, Karachi, Pakistan (NMW 1955.158).

Figura 43. *Fossarus eutorniscus* Melvill, 1918. A, B: concha, 1,48 mm, Sur de Madagascar (MNHN); C: protoconcha. D: *Fossarus eutorniscus* Melvill, 1918, sintipo, 1,55 mm, Karachi, Pakistan (NMW 1955.158).

which is similar in profile to *Parviturbo dibellai*. After the comparison of the type material of *Parviturbo dibellai* and *Fossarus eutorniscus* we conclude that both are the same species, being *P. dibellai* to be a junior synonym of *F. eutorniscus*.

The protoconch of *P. dibellai* with almost  $1\frac{1}{2}$  whorls and two distinct phases, differs essentially from the protoconch of

the other species of *Parviturbo*. In our opinion this species is a vitrinellid although the general shape of the teleoconch, the ornamentation and the microsculpture resemble those of the genus *Parviturbo*.

Provisionally we maintain the original combination in *Fossarus* until it can be confirmed in which genus of Vitrinellinae this species belongs.

*Parviturboides copiosus* (Pilsbry & Olsson, 1945) (Figure 44A)

*Parviturbo copiosus* Pilsbry & Olsson, 1945. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 97: 275, pl. 30, figs. 1, 1a, 1b. [Type locality: Punta Callo, Province of Manabi, Ecuador].

*Parviturboides copiosus* (Pilsbry & Olsson, 1945) - KEEN, 1971. *Sea Shells of Tropical West America*: 382.

**Type material:** Holotype in ANSP (181270).

*Distribution:* Guaymas, Mexico to Ecuador. places it in *Parviturboides* Pilsbry & McGinty, 1949 on the basis of the protoconch and radula.  
*Remarks:* Species originally described in the genus *Parviturbo*, KEEN (1971)

*Parviturboides clausus* (Pilsbry & Olsson, 1945) (Figure 44B)

*Parviturbo decussatus clausus* Pilsbry & Olsson, 1945. *Proc. Acad. Nat. Sci. Philadelphia*, 97: 275, pl. 30 fig. 2, 2a, 2b.

*Parviturboides clausus* (Pilsbry & Olsson, 1945): KEEN, 1971. *Sea Shells of Tropical West America*: 382.

**Type material:** Holotype in ANSP (181281).

*Distribution:* Ecuador. places it in *Parviturboides* Pilsbry & McGinty, 1949 on the basis of the protoconch and radula.  
*Remarks:* Species originally described in the genus *Parviturbo*, KEEN (1971)

*Parviturboides germanus* (Pilsbry & Olsson, 1945) (Figure 44C)

*Parviturbo germanus* Pilsbry & Olsson, 1945. *Proc. Acad. Nat. Sci. Philadelphia*, 97: pl. 30 fig. 4, 4a.

*Parviturboides germanus* (Pilsbry & Olsson, 1945) - KEEN, 1971. *Sea Shells of Tropical West America*: 382.

**Type material:** Holotype in ANSP (181282).

*Distribution:* Colombia to Ecuador. placed it in *Parviturboides* Pilsbry & McGinty, 1949 on the basis of the protoconch and radula.  
*Remarks:* Species originally described in the genus *Parviturbo*, KEEN (1971)

*Haplocochlias calidimaris* (Pilsbry & McGinty, 1945)

*Parviturbo calidimaris* Pilsbry & McGinty, 1945. *Nautilus* 59: 56-57, pl. 6, fig. 4. [Type locality: 1 ½ miles off Cape Florida].

*Haplocochlias calidimaris* (Pilsbry & McGinty, 1945) - RUBIO, FERNÁNDEZ-GARCÉS & ROLAN, 2013. *Iberus*, 31 (2): 89-91, fig. 28.

**Type material:** Holotype in ANSP (181319), paratypes in Weber and McGinty collections. Examined a photograph of the holotype sent by ANSP.

*Remarks:* RUBIO ET AL. (2013) placed *P. calidimaris* in the genus *Haplocochlias*.

*Haplocochlias francesae* (Pilsbry & McGinty, 1945)

*Parviturbo francesae* Pilsbry & McGinty, 1945. *The Nautilus*, 59: 56, pl. 6, fig. 6. [Type locality: Off Palm Beach, Florida, USA].

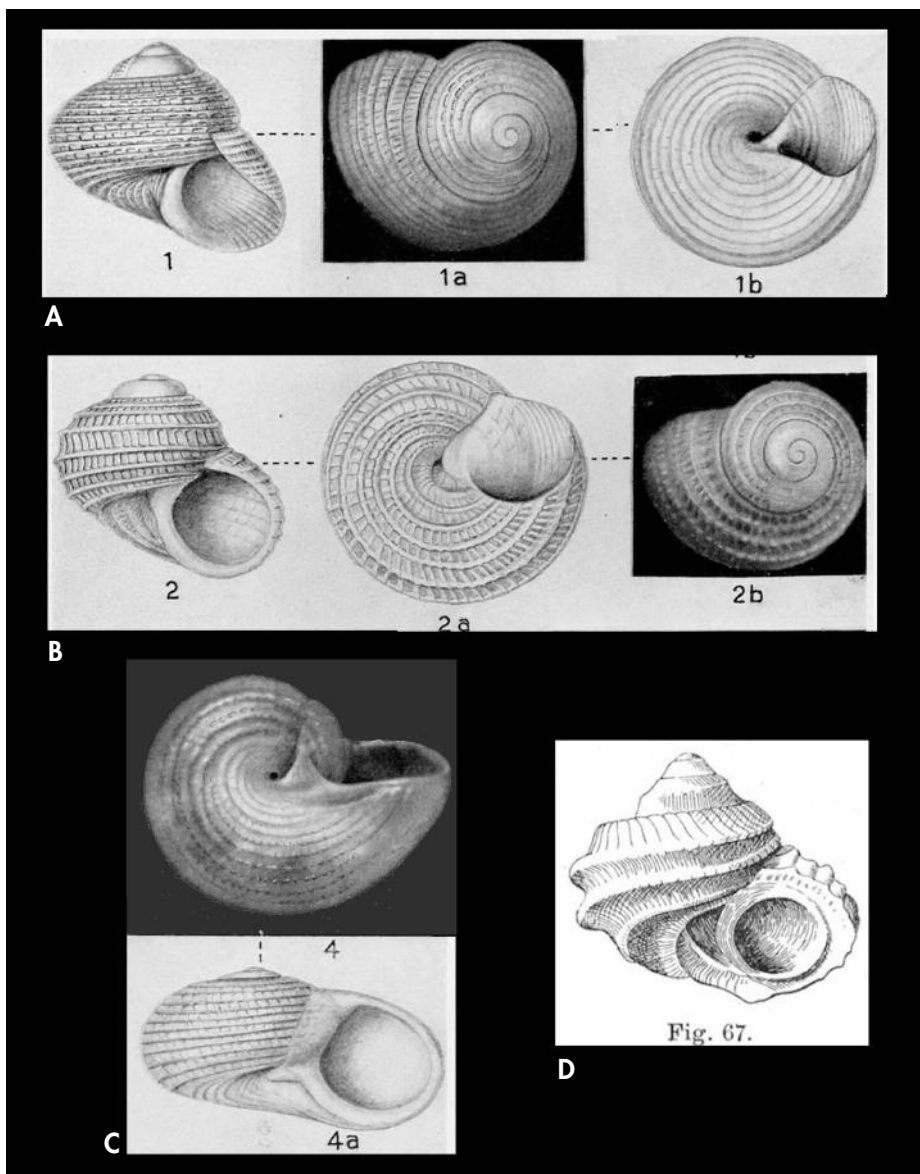


Figure 44. Original figures of species here excluded from *Parviturbo*. A: *Parviturbo copiosus* Pilsbry & Olsson, 1945; holotype; B: *Parviturbo decussatus clausus* Pilsbry & Olsson, 1945; holotype; C: *Parviturbo germanus* Pilsbry & Olsson, 1945; D: *Liotia parvissima* Hedley, 1899.  
 Figura 44. Figuras originales de especies que aquí se excluyen de *Parviturbo*. A: *Parviturbo copiosus* Pilsbry & Olsson, 1945; holotipo; B: *Parviturbo decussatus clausus* Pilsbry & Olsson, 1945; holotipo; C: *Parviturbo germanus* Pilsbry & Olsson, 1945; D: *Liotia parvissima* Hedley, 1899.

*Haplocochlias francesae* (Pilsbry & McGinty, 1945) - RUBIO, FERNANDEZ-GARCÉS & ROLAN, 2013. *Iberus*, 31 (2): 98-100, fig. 33.

**Type material:** Holotype in ANSP (181316) examined on photograph; paratypes in McGinty collection at MCZ (226843 and 207086).

*Remarks:* RUBIO ET AL. (2013) placed *P. francesae* in the genus *Haplocochlias*.

*Lophocochlias parvissimus* (Hedley, 1899) (Figure 44D)

*Liotia parvissima* Hedley, 1899. *Mem. Austr. Museum*, 3 (17): 554-555, fig. 67. [Type locality: off Tutanga Islet, Funafuti, dredged at 200 fathoms].

*Parviturbo parvissima* (Hedley, 1899) – MAES, 1967. *Proc. Acad. Nat. Sci. Philadelphia*, 119: 106, pl. 3 fig. D.

**Type material:** Holotype (C.5650) and one paratype (C.5651) deposited in AM.

**Description:** See RUBIO & ROLAN (in press).

**Habitat:** Bathyal species dredged at 150-200 fathoms (HEDLEY, 1899).

**Distribution:** Off Tutanga Islet, Funafuti Atoll, Tuvalu and off Funamanu, Beacon (HEDLEY, 1899).

**Remarks:** Species initially described in the genus *Liotia* (HEDLEY, 1899) and later transferred to *Parviturbo* by MAES (1967).

From the shape of the shell, form and size of the protoconch we consider that it does not belong to *Parviturbo*. A similar, recently studied species is *Lophocochlias minutissima*. This is so far a monotypic genus, created as a subgenus of *Haplocochlias* to accommodate this species. WENZ (1938) considers it a valid genus and places it in Skeneidae. The species is mentioned in RUBIO & ROLAN (in press).

Genus *Pseudorbis* Monterosato, 1884

*Pseudorbis* Monterosato, 1884. *Nomenclatura generica e specifica di alcune conchiglie mediterranee*, p. 109.

[Type species: *Fossarus granulum* Brugnone, 1873, by monotypy]. Mediterranean and Canary islands.

**Remarks:** We add the references to the genus *Pseudorbis* because it is close to the genus *Parviturbo* and comprises few known species, also because PILSBRY & MCGINTY (1945: 54) describing the genus *Parviturbo* mention: “*Parviturbo* needs comparison with the Mediterranean genus *Pseudorbis* Monterosato, 1884, founded on *Fossarus granulum* Brugnone, 1873, of which the animal and operculum are unknown, and the shell lacks interstitial cross-threads”.

There are two known living species so far: *Pseudorbis granulum* (Brugnone, 1873) and *Pseudorbis jameoensis* Rubio & Ro-

dríguez Babío, 1991). RUBIO & RODRÍGUEZ BABÍO (1991) described and illustrate for the first time the radula of *Pseudorbis granulum*, and based on the radula, operculum and the shell morphology, placed the genus in the family Skeneidae. WARÉN (1992), in agreement with the radular data published and with anatomical data provided by Serge Gofas (per. com.) indicating the presence of a propodial penis, confirmed its systematic position.

LOZOUET (1999) described two additional fossil species from the Middle Miocene and Upper Oligocene of Aquitaine (South West of France).

1. EAST ATLANTIC SPECIES

*Pseudorbis granulum* (Brugnone, 1873) (Figures 45, 46A-G, 47A-E, 48A-H, 49A-F)

*Fossarus granulum* Brugnone, 1873. *Miscellanea Malacologica*: 13. [Type locality: Sicilia].

*Pseudorbis granum* (Brugnone, 1873) – GIANNUZZI-SAVELLI, PUSATERI, PALMERI & EBREO, 1994. *Atl. Conch. Mar. Medit.*, vol. 1: 110-111.

**Type material:** Probably in Monterosato coll. (MCZR).

**Material examined:** (31 s): Spain: Alboran Island: 2 s, 30-40 n (CFR); Canary Islands: 10 s, La Caleta de Adeje, Tenerife, 1.5 m (CFR); 3 s, Gran Canaria, Arinaga (CHO); 2 s, Las Canteras (MHNS). Italia: 7 s, Trapani, Sicilia (CPM). West Africa: Morocco: 4 s, Essaouira, intertidal (MNHN). Senegal: 3 s (CFS).

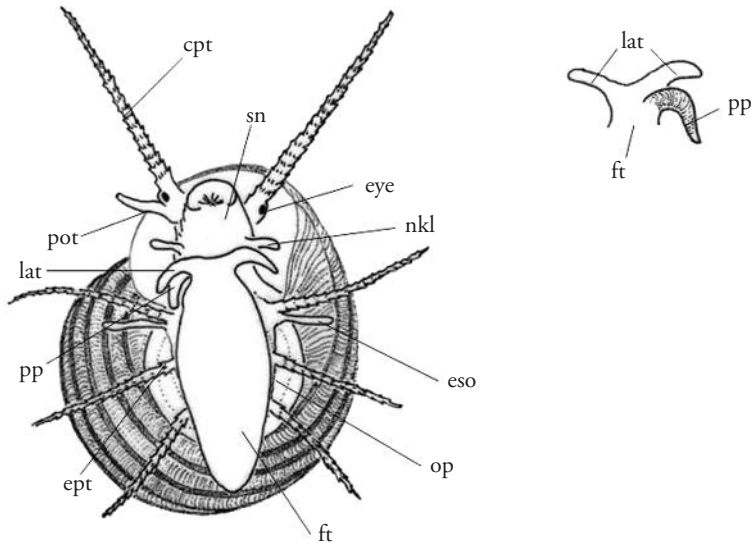


Figure 45. *Pseudorbis granulum* (Brugnone, 1873), living animal from Essaouira, Morocco (Abbreviations: cpt, cephalic tentacle; ept, epipodial tentacle; eso, epipodial sense organ; eye, eye; ft, foot; lat, lateral extensions of foot; nkl, neck lobe; op, operculum; pp, propodial penis; pot, postoptic tentacle; sn, snout). Redrawn from a field sketch by Serge Gofas.

Figura 45. *Pseudorbis granulum* (Brugnone, 1873), animal vivo de Essaouira, Marruecos. (Abreviaturas: cpt, tentáculos cefálicos; ept, tentáculo epipodial; eso, órgano sensorial epipodial; eye, ojo; ft, pie; lat, extensiones laterales del pie; nkl, lóbulo del cuello; op, opérculo; pp, pene propodial; pot, tentáculo postóptico; sn, morro). Redibujado de un apunte de campo de Serge Gofas.

**Description:** Shell (see BRUGNONE, 1873).

Animal (Fig. 45) with long, ciliated cephalic tentacles, small black eyes, not pedunculated, and with a postocular tentacle on the right side. Cervical lobes reduced to small projections with a smooth margin. There is a thick propodial penis located on the right side of the foot. Epipodium with three pairs of slender, ciliated tentacles, similar to the cephalic ones but smaller; at the base of the first pair there is a long and digitiform sensory organ. Snout elongate, rounded, not bilobed. Foot elongate, with lateral projections on each side of the anterior border.

Operculum multispiral, with a central nucleus.

Radula rhipidoglossate, with formula n.4.1.4.n. Central tooth very wide, expanded laterally, with rounded sides; cutting edge without apparent denticula-

tion. Lateral teeth similar among them, distributed stepwise towards outside and leaning outwards from their bases; cutting edges with 6-7 small, sharp denticles. Narrow and long marginal teeth that widen into their cutting edge as a spatula, presenting 7-8 sharp and uneven denticles and a serrated appearance.

**Habitat:** In Alboran Island it lives on rocky bottoms with *Laminaria* in 34-44 m, with dominance of *Laminaria ochroleuca* de la Pylaie, 1824 and *Sacchoriza polyschides* (Lighfoot) Batters, 1902 and abundance of fragments of the coralline parts of *Lithophyllum* and *Lithothamnium*. In Essaouira, Atlantic coast of Morocco, it was found in a deep crevice of the infralittoral rock with layers of oxides and hardly any visible sessile organisms, together *Alvania cancellata* (da Costa, 1778) and *Alvania imperspicua* (Pallary, 1920) (Serge Gofas, pers. com.).

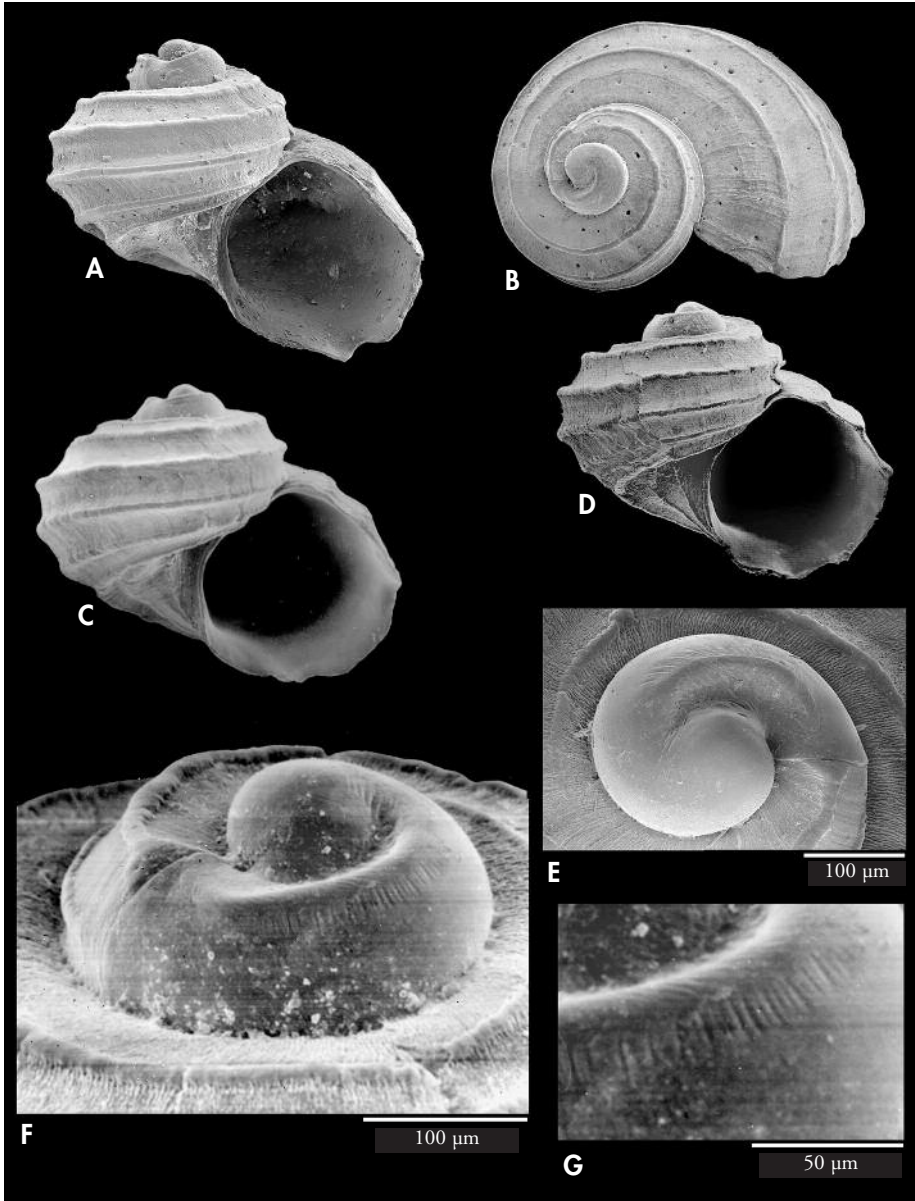


Figure 46. *Pseudorbis granulum* (Brugnone, 1873). A-D: shells, 1.27, 1.27, 1.1, 0.9 mm, Alboran Island (CFR); E: protoconch; F: detail of the microsculpture; G: detail.

Figura 46. *Pseudorbis granulum* (Brugnone, 1873). A-D: conchas, 1,27, 1,27, 1,1, 0,9 mm, Isla de Alborán (CFR); E: protoconcha; F: detalle de la microescultura; G: detalle.

*Distribution:* Known from deep water in the Mediterranean, in the Sicily Channel and in Alboran Island, at 30-40

m (RUBIO & RODRÍGUEZ BABÍO, 1991). ROLÁN (2011) enlarged its distribution to the Canary Islands and figure shells



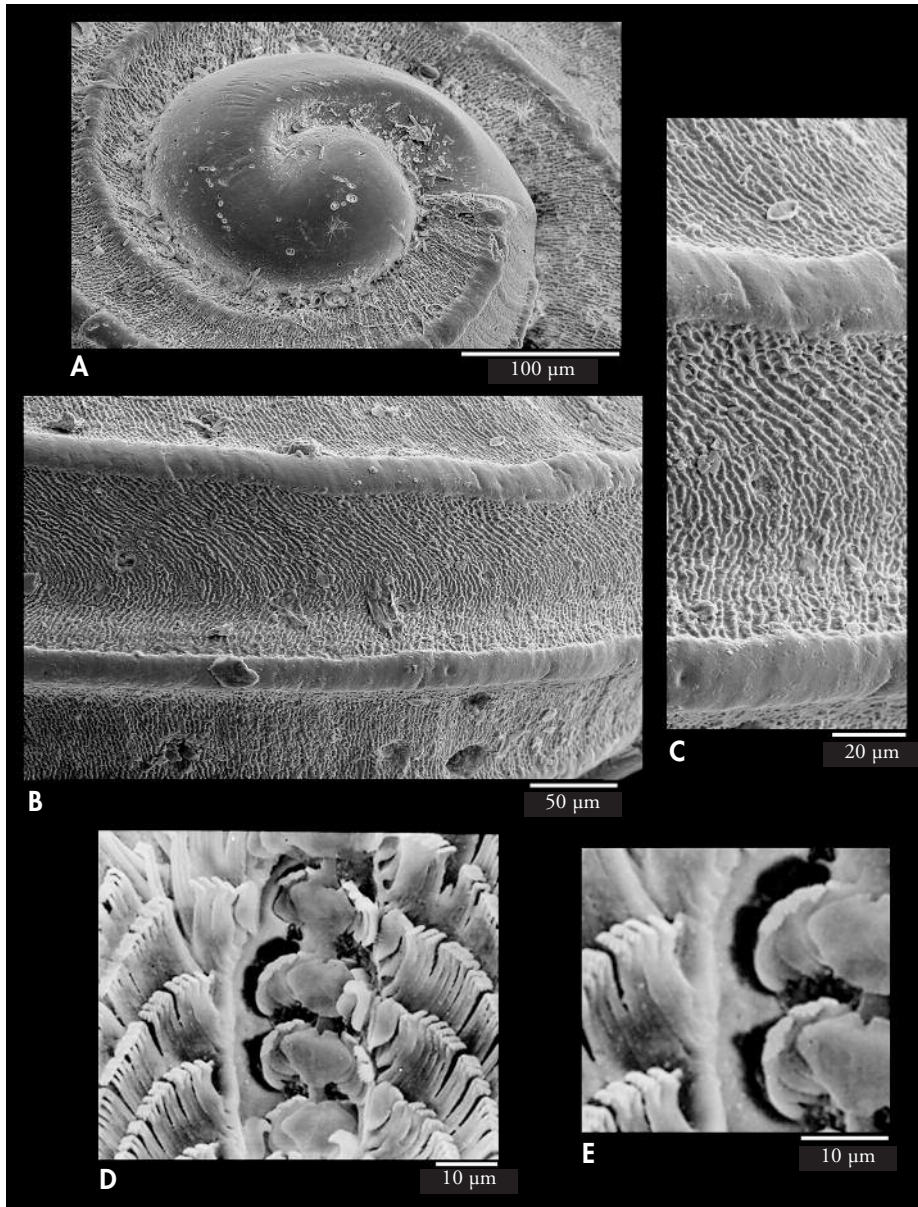


Figure 47. *Pseudorbis granulum* (Brugnone, 1873). A: protoconch; B, C: microsculpture; D, E: radula of a specimen from Alboran Is.

Figura 47. *Pseudorbis granulum* (Brugnone, 1873). A: protoconcha; B, C: microescultura; D, E: rádula de un ejemplar de la Isla Alborán (CFR).

from Arinaga and Las Canteras, on the island of Gran Canaria. In the present work its distribution is further extended

to the island of Tenerife and to Senegal (Figs. 48C-D) towards the southern range of the distribution of this species.

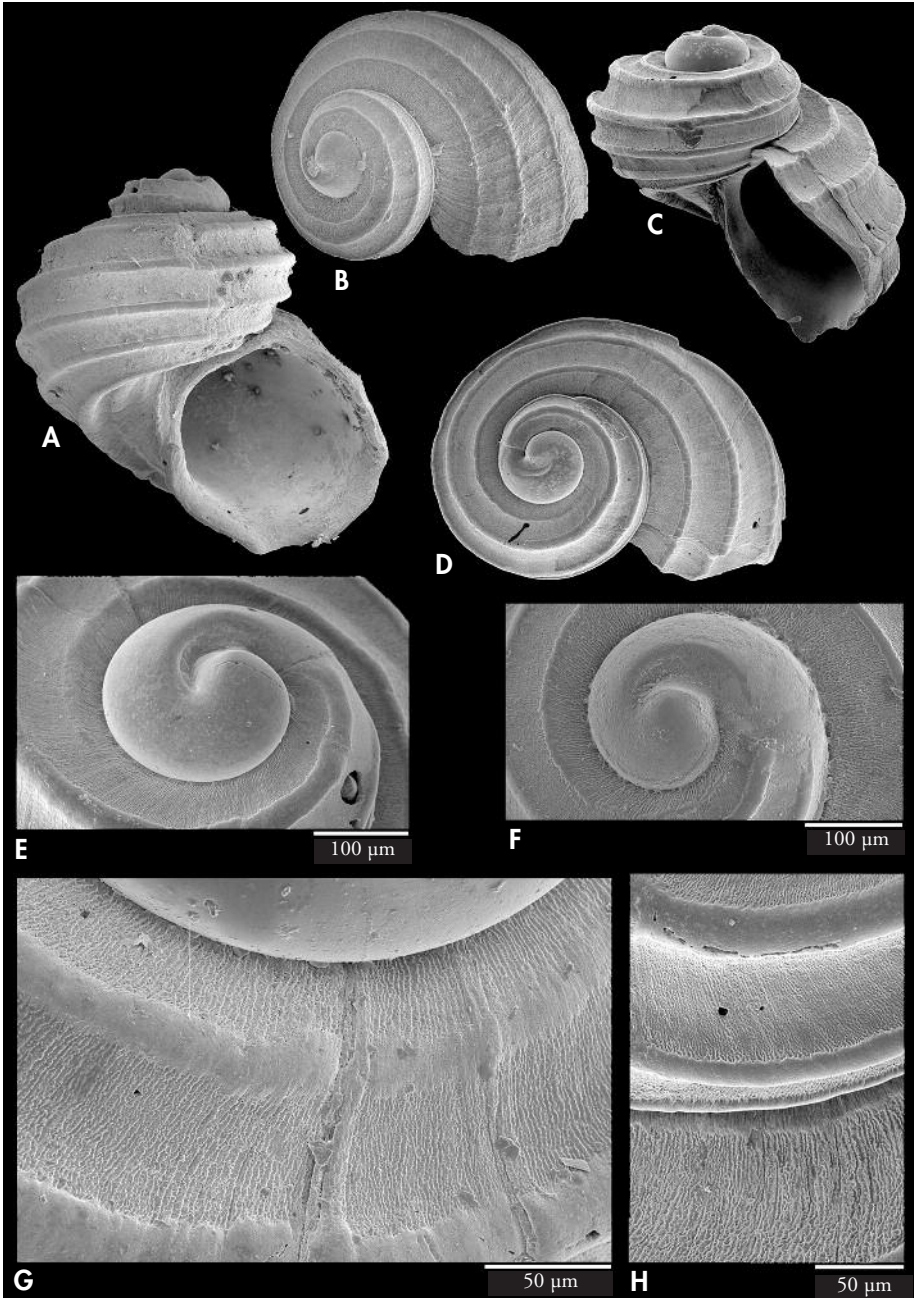


Figure 48. *Pseudorbis granulum* (Brugnone, 1873). A, B: shells, 1.1, 0.9 in diameter, from Canary Islands (CHO); C, D: shells, 1.0, 1.1 mm, from Dakar, Senegal (CFS); E, F: protoconchs from Dakar; G, H: microsculpture from Canary and Senegal respectively.

*Figura 48. Pseudorbis granulum* (Brugnone, 1873). A, B: conchas, 1,1, 0,9 de diámetro, de las Islas Canarias (CHO); C, D: conchas, 1,0, 1,1 mm, de Dakar, Senegal (CFS); E, F: protoconchas de Dakar; G, H: microescultura de Canarias y Senegal respectivamente.

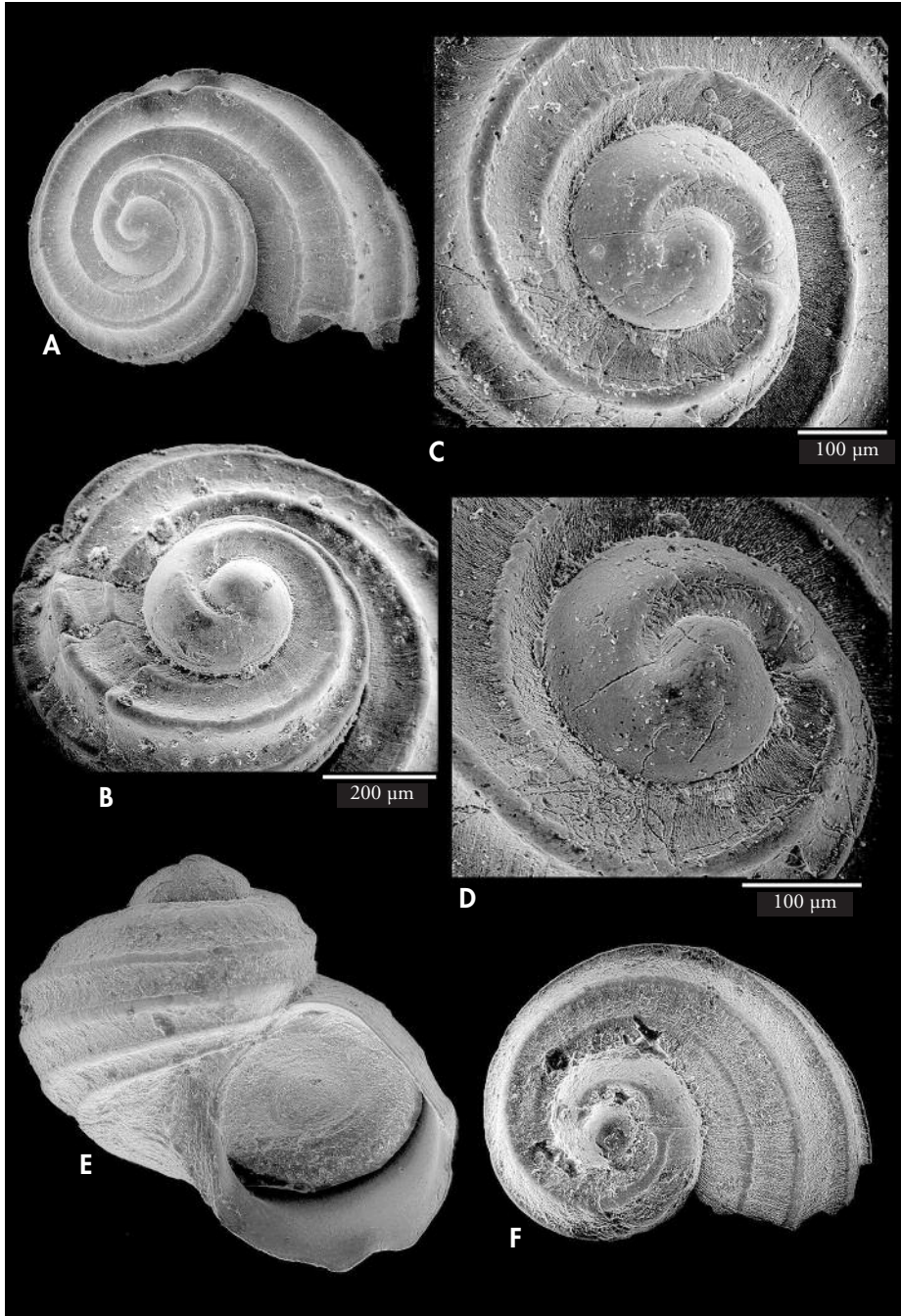


Figure 49. *Pseudorbis granulum* (Brugnone, 1873). A: shell, 1.1 mm, Trapani, Italy (CPM); B-D: protoconch and detail; E, F: shells from Essaouira, Morocco, intertidal (MNHN).

Figura 49. *Pseudorbis granulum* (Brugnone, 1873). A: shell, 1,1 mm, Trapani, Italia (CPM); B-D: protoconcha y detalle; E, F: conchas de Essaouira, Marruecos, intermareal (MNHN).

*Remarks:* Morphologically *Pseudorbis granulum* can be distinguished from *Pseudorbis jameoensis* (1) by having on the last whorl only 7 thick spiral cords, the subsutural one finer than the others, (2) by having a finer cord inside the umbilicus and (3) by having a keeled protoconch with axial striae. The latter character is not present in the shells from Canaries and Senegal.

Among the shells from Trapani (type locality) (Fig. 49A), Alboran Island (Figs. 46A-D), Canary Islands (Figs. 48A-B) and Senegal (Figs. 48C-D) there are some morphological differences, mainly in the ornamentation of the protoconch as well as in the devel-

opment of the spire and in the distribution of the spiral cords, that suggested us initially that there could be different species.

However, taking into account the morphology of the shell as a whole, we consider that it is the same species which, across its geographical range, shows some morphological differentiation between the studied populations. We would therefore consider geographical morphotypes and not different species. Only a more complete study of living individuals of the different populations, taking into account DNA data, would make possible a correct species delimitation.

*Pseudorbis jameoensis* Rubio & Rodríguez Babío, 1991 (Figure 50A-F)

*Pseudorbis jameoensis* Rubio & Rodríguez Babío, 1991. *Iberus* 9 (1-2): 204-205, lam. 2, figs. 6-8. [Type locality: Los Jameos del Agua, Lanzarote, Canary Islands].

**Type material:** Holotype (Fig. 50A) and one paratype deposited in MNCN (15.05/3306) (Fig. 50B). One paratype in MNHN. Other paratypes in the MNHST and in CFR.

**Other material examined:** No.

*Habitat:* There are no known living specimens; the collected shells come from coralline shell grit collected between 34 and 44 metres depth (ROLÁN, 2011). In los Jameos del Agua, Lanzarote, it has been localized in sediment deposits from debris of lava, which provide a macroporous interstitial habitat (MARTÍNEZ, PALMERO, BRITO, NÚÑEZ & WORSAAE, 2009).

*Distribution:* Limited to the island of Lanzarote, Canary Islands. ROLÁN

(2011) figured a shell from Arinaga, Gran Canaria Island; after careful observation of this shell, we doubt that is really *P. jameoensis*, therefore we consider its distribution as confirmed only for Lanzarote.

*Remarks:* *Pseudorbis jameoensis* differs from *P. granulum*: (1) in having a more elevated spire, (2) in having the spiral cords stronger and more numerous and (3) by lacking axial striae on the protoconch.

## 2. FOSSIL SPECIES

*Pseudorbis carinifera* Lozouet, 1999 (Figura 51A)

*Pseudorbis carinifera* Lozouet, 1999. *Cossmanniana* 6 (1-2): 12, pl. 7, fig. 10. [Type locality: Landes, Saint-Paul-lès-Dax (Estoti). Upper Oligocene, falun à *Miogypsinoides*].

**Type material:** Holotype and 30 paratypes in MNHN.

*Remarks:* The number of the spiral cords of *Pseudorbis carinifera* is intermediate between *P. granulum* and *P.*

*jameoensis*.

*Dimensions of the holotype:* 1 mm high and 1.1 mm in maximum diameter.



Figure 50. *Pseudorbis jameoensis* Rubio & Rodríguez Babío, 1991. A: holotype, 0.84 mm (MNCN 15.05/3306); B: paratype, 0.75 mm (MNCN 15.05/3306); C, D: paratypes, 0.75, 0.67 mm (CFR); E: protoconch of a paratype; F: protoconch of the holotype.

*Figura 50.* *Pseudorbis jameoensis* Rubio & Rodríguez Babío, 1991. A: holotipo, 0,84 mm (MNCN 15.05/3306); B: paratipo, 0,75 mm (MNCN 15.05/3306); C, D: paratipos, 0,75, 0,67 mm (CFR); E: protoconcha de un paratipo; F: protoconcha del holotipo.



Figure 51. A. *Pseudorbis carinifera* Lozouet, 1999, holotype, Saint-Paul-lès-Dax (Upper Oligocene). B. *Pseudorbis falunica* Lozouet, 1999, holotype, Le Louroux (Middle Miocene).

Figura 51. A. *Pseudorbis carinifera* Lozouet, 1999, holotipo, Saint-Paul-lès-Dax (Oligoceno superior). B. *Pseudorbis falunica* Lozouet, 1999, holotipo, Le Louroux (Mioceno medio).

### *Pseudorbis falunica* Lozouet, 1999 (Figure 51B)

*Pseudorbis falunica* Lozouet, 1999. *Cossmanniana* 6 (1-2): 12-13, pl. 7, fig. 11. [Type locality: Indret-et-Loire, Le Louroux. Middle Miocene of the Loire Basin, falun du Pontilévien].

**Type material:** Holotype and 20 paratypes in MNHN.

**Remarks:** LOZOUET (1999): “Il n’y a pas identité parfaite entre le populations miocènes et oligocènes. En particulier, les individus oligocènes présentent des rubans plus nombreux et plus fins. L’espèce falu-

nica se distingue de *P. carinifera* par ses nombreux rubans spiraux ne formant jamais de carène”.

**Dimensions of the holotype:** 0.8 mm in height and 0.95 mm in diameter.

## CONCLUSIONS AND COMMENTS

*Parviturbo*, *Pseudorbis* and *Haplocochlias* are similar genera by anatomical, radular and morphological affinity.

After the work of RUBIO ET AL. (2013) in which 5 species, included hitherto in *Parviturbo*, were transferred to the genus *Haplocochlias*, the species comprised in the genus *Parviturbo* are much more homogeneous regarding the morphology of the shell.

In the present worldwide revision, a total of 33 species of *Parviturbo* have been studied; this genus has been shown to be more species-rich in the Atlantic where there are 27 species, 10 in the eastern part and 17 in the Western; in contrast there are only 2 species on

the American Pacific west coast, and 4 more in the tropical South Pacific, where this genus is recorded for the first time.

*Parviturbo* was a genus in need of revision. Up to now most of the species were known only from the older authors, and only three species were described since the year 2000. So far no studies had been made using scanning electronic microscopy (SEM), which is essential for details of the protoconch, microsculpture and for a correct comparison between species. An outcome is the number of new species revealed in the present study: 5 out of 10 species in the Eastern Atlantic, 12 out of 17 in the Western Atlantic, and all 4 species from the Tropical South Pacific.

Their small size is one of the problems for the collecting and study of the species of this group. Of the 33 species studied, only one exceeds 3 mm of maximum diameter (*P. multispiralis*); five exceed 2 mm of maximum dimension, and most are between 1 and 2 mm. Two species of the tropical South Pacific hardly reach 1 mm.

The number of specimens and shells examined for this study has been relatively short. In total we have seen about 1560 shells, but only for 5 species did we have more than 100 shells available (in one case more than 500 and in one other more than 250). Four species were represented by 25 to 100 shells, in 5 cases more than 10 shells for species, but in 15 cases, the number of shells was between 1 and 5.

In relation with the morphology of *Parviturbo*, usually the spiral sculpture is predominant over the axial. In the East Atlantic species this prevalence is moderate in some species (*Parviturbo elegantulus*, *P. sp.*, *P. ergasticus*, *P. alboranensis* and *P. multispiralis*) since the spiral cords are not very different in thickness from the ribs. In *P. seamountensis* the spirals and axials are of equal strength and in *P. fenestratus*, *P. rolani* and *P. azoricus* the axial component is only slightly finer. *P. insularis* is an intermediate case because it has cords of different width.

Most species of the Western Atlantic have elevated or very elevated spiral cords, which contrast with the axial sculpture, formed by threads or fine riblets, the exceptions being *Parviturbo rectangularis* and *P. fortius*, which have axial ribs separate and stronger.

The two known species of the American Pacific and two of the three species of the Tropical South Pacific, have a predominance of the spiral sculpture, except for *P. pombali* in which both cords and ribs are developed.

Regarding the protoconch, it is usually short (3/4 of whorl). The species of the Eastern Atlantic usually have a smooth protoconch, with the exception of: *Parviturbo insularis* and *P. multispiralis* (which have spiral sculpture). In contrast, almost all the West Atlantic species

present but have 3-4 spiral cordlets, with the exception of: *Parviturbo dengyanzhangii* (probably smooth), *P. marcosi*, *P. rectangularis*, *P. guadeloupensis* and *P. gofasi* (smooth). *P. brasiliensis* and *P. robustior* have the protoconch eroded and it is not easy to define if they have or not spiral cordlets. The two species of the American Pacific seems a protoconch with spiral cordlets. The three species of the tropical Pacific have one protoconch whorl and have spiral cordlets.

The number of spiral cords of the teleoconch is very variable from species to species; most of the studied species have 7-8 cords; *Parviturbo fenestratus*, *P. azoricus* and *P. rolani* have 6; *P. granulum* has 10-11 spiral cordlets as well *P. ergasticus*; *P. insularis* has a variable number of cords with a group of subsubtural fine cordlets and other larger below (in total between 10-14) and *P. multispiralis* with much more cords (about 24) than the others.

#### Comparison between *Parviturbo* and *Pseudorbis*

The genera *Parviturbo* and *Pseudorbis* are actually similar to each other but different. The radula is different: *Pseudorbis granulum*, type species of the genus, has 4 lateral teeth at each side, while *Parviturbo* (observed on *P. insularis*) has 5. On the shell of *Parviturbo*, the spaces between the spiral cords have distinct axial threads, whereas only very fine and irregular axial lines can be observed in *Pseudorbis*.

*Habitat*: The information on the habitat is incomplete in some cases, because most of the specimens are empty shells collected in sediments usually in shallow depth. In some cases there is more definite information like for *P. elegantulus*, in 200 m in soft coral of cold waters (*Lophelia pertusa* and *Madrepora oculata*); *Parviturbo guadeloupensis*, 0-30 m, on rocky bottom; *P. fortius*, in 29 m, on rocky bottom with *Thalassia*. However, most records are referred to sand or gravel.

Usually they are infra- or circalittoral species which bathymetric range is

comprised between 0 and 60 m depth. A few species have been collected at greater depths: *Parviturbo javiercondei* was collected between 149 and 168 m; *P. rectangularis* between 60 and 160 m; *P. seamountensis* between 275 and 730 m; and *P. elegantulus* at 200 m.

*Distribution:* Generally the distribution area of the studied species was small but in many cases there is not more than one or two samples available. The presence of species with a short protoconch in islands allow us to suppose that speciation there originated many of the species. So, in the eastern Atlantic there is one species from Azores, another one in the Canaries, two in Cape Verde Islands, one in Alboran, five in the Mediterranean and one on the Atlantic Seamounts.

In the Western Atlantic, Antigua, Tobago, Turk & Caicos, Venezuela and Brasil hold one species each, whereas there are two from the Virgin Islands, four from Guadeloupe, and some others shared by several areas, three for Cuba (one also in Bahamas), etc. In the American Pacific, one is in California and another one in Costa Rica. In the Tropical south Pacific, there are two species in Vanuatu and one in Fiji.

*Taxonomic information reported:* By first time the type of *Delphinula tuberculosa* d'Orbigny, 1842 is photographed and one of the 6 syntypes from Jamaica, d'Orbigny collection, depositados en NHMUK (1854.10.4.270) is designate lectotype.

By first time 2 syntypes of *Cyclostrema granulum* Dall, 1889a in USNM (54751) are shown with photography.

In relation with the genus *Pseudorbis*, its type species *Pseudorbis granulum* has a wide distribution, having been found in Trapani, Sicilia (type locality), Alboran Island, Canary Islands, Essaouira, Morocco, and Senegal. Each of these populations present small morphological differences between them in the ornamentation of the protoconch, development of the spire and distribution of the spiral cords, which are in evidence and at same time we consider that

these morphological differences are not in a spetiation process, but are the consequence of at the geographic dispersión.

*Pseudorbis* are infralittoral species which live in different kind de substrates; they have been found in narrow spaces between rocks in the infralittoral area and in *Laminaria* bottom on rocks at 34-44 m in depth. Fossil records: from Miocene Moyen and Upper Oligocene of Aquitaine (Soutwest of France).

## ACKNOWLEDGEMENTS

The authors thanks to the museums which allowed material for study, being the first of this aspect the MNHN, from which Philippe Bouchet, Virginie Heros, Philippe Maestrati and Pierre Louzouet made their help making possible this work. To Andreia Salvador and Kathie Way from the NHMUK from which some images were courtesy of Harry Taylor (NHMUK Photographic Unit). Jerry Harasewich and Yolanda Villacampa allowed us to get photographs of *Cyclostrema sphaeroideum* in the USNM. Anders Warén, authorized the use of some Photographs from his works.

An important part of the studied material was from private collections and here we must acknowledge the outstanding contribution of Harry G. Lee, who cooperated with the donation of numerous type material for the museums. Alberto Cecalupo loaned a paratype of *Parviturbo dibellai* for photographing. Pasquale Micali also loaned material from his collection.

Serge Gofas loaned the material collected by himself of *Pseudorbis granulum* and made the drawing of the soft parts of this species.

Jesús Méndez and Inés Pazos of the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo made most of the photographs necessary for this work. To the Museo de Historia Natural of the University of Santiago de Compostela and to its Director Prof. Mabel Fraga for the support of the present work.



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