

# The Pyramidellidae (Mollusca: Gastropoda) from the Miocene Cantaure Formation of Venezuela

Bernard M. Landau<sup>1,3</sup> & Patrick I. LaFollette<sup>2</sup>

<sup>1</sup> *Naturalis Biodiversity Center, P.O. Box 9517, NL-2300 RA Leiden, The Netherlands; Instituto Dom Luiz da Universidade de Lisboa, Portugal and International Health Centres, Av. Infante de Henrique 7, Areias São João, P-8200-261 Albufeira, Portugal; bernielandau@sapo.pt*

<sup>2</sup> *Research Associate, Malacology Department, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California, U.S.A.; pat@lafollette.com*

<sup>3</sup> *corresponding author*

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The Pyramidellidae Gray, 1840 present in the upper Burdigalian-lower Langhian, Lower-Middle Miocene, Cantaure Formation assemblage of Venezuela is described and discussed. Twenty-one species are recognised: 13 are described as new: *Brachystomia cantaurana* nov. sp., *Goniodostomia bicarinata* nov. sp., *Iolaea miocenica* nov. sp., *Chrysallida cantaurana* nov. sp., *Kleinella pumila* nov. sp., *Parthenina martae* nov. sp., *Ividella guppyi* nov. sp., *Chemnitzia macsotayi* nov. sp., *Turbonilla paraguayensis* nov. sp., *Pyrgiscus caribbaeus* nov. sp., *Pyrgiscus silvai* nov. sp., *Eulimella dianeae* nov. sp. and *Iselica belliata* nov. sp., three are left in open nomenclature. The state of knowledge of tropical American Neogene pyramidellids is rudimentary, but the assemblage is fairly typical at generic level to that of the tropical American Neogene today, with some species suggesting closer affinities with tropical American Pacific taxa.

KEY WORDS: Pyramidellidae, Miocene, Cantaure, Venezuela, new species.

## Introduction

Despite the enormous amount of research done by the Panama Paleontology Project and others in the tropical American Neogene, the micromolluscan faunas are hardly known. Even within these poorly known groups of small shells, the pyramidellids are one of the least studied. Guppy or Dall (in Guppy & Dall, 1896) described and figured nine pyramidellid species from the middle Oligocene of Trinidad and Miocene of Jamaica. Maury (1917) in her monograph on the Neogene of the northern Dominican Republic described and figured 19 pyramidellid species. Pilsbry & Johnson (1917) and Pilsbry (1922) described and figured 29 fossil pyramidellids also from the Dominican Neogene. This is the largest number of pyramidellids in any monograph on the tropical American Neogene so far. Nevertheless, many species remain undescribed (NHMW and NMB collections). Woodring (1928) noted that 35 pyramidellid species occurred in the Pliocene Bowden Formation of Jamaica. Only seven were listed to species level, but not discussed or figured, 'as it is expected that they will be included in a report by Doctor Bartsch on fossil species from localities in the West Indian region' (p. 407). Gardner (1947, p. 571) in her monograph on the Lower Miocene Chipola Formation of Florida noted that Paul Bartsch was monographing the

Pyramidellidae. Of these projects, only Bartsch's 1955 'The pyramidellid mollusks of the Pliocene deposits of North St. Petersburg, Florida' was published. Weisbord (1962) described and figured 16 fossil species from the Plio-Pleistocene of northern Venezuela. However, many of these species are based on fragmentary and eroded material and poorly illustrated, making interpretation of these species difficult. Woodring (1970), in his landmark monograph on the Neogene of the Canal Zone of Panama, whilst acknowledging the presence of pyramidellids in these assemblages, commented that two *Turbonilla* species described by Brown & Pilsbry (1913) from the Gatun Formation probably were extreme forms of a single species, and omitted the rest of the family. Jung (1969) described and figured three *Pyramidella* (*s.l.*) species, but no other pyramidellids from the Lower Miocene Springvale Formation of Trinidad. Most of the other monographic works dealing with tropical American Neogene assemblages exclude any mention of pyramidellids (*i.e.* Maury, 1925; Anderson, 1929; Olsson, 1922, 1964; Jung, 1965, 1971).

In this work we hope to begin to redress this omission, and describe and illustrate the pyramidellid assemblage found in the upper Lower to lower Middle Miocene Cantaure Formation of Venezuela.

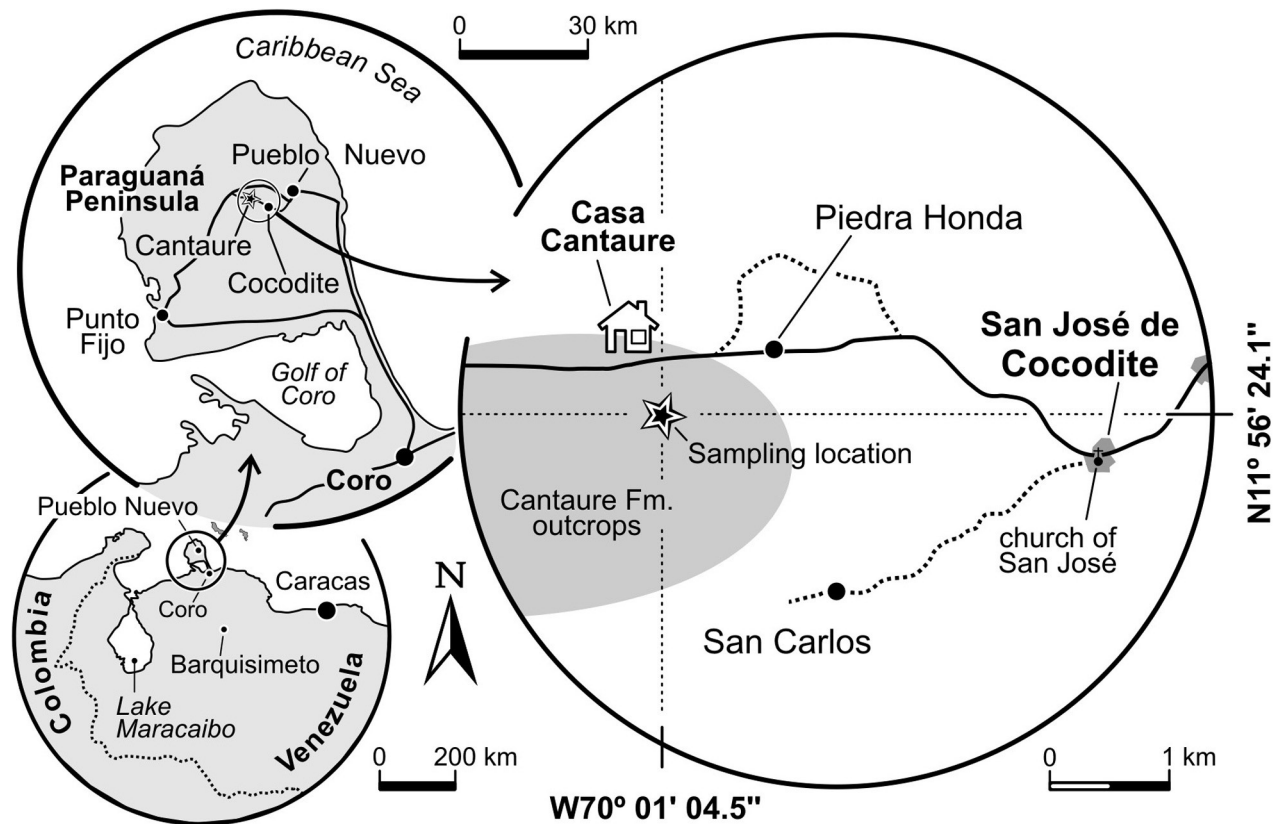


Figure 1. Geographic location of the study site South of Casa Cantaure, Paraganá Peninsula, Falcón State, Venezuela.

### Geologic and stratigraphic setting

The pyramidellid material herein described and discussed comes from the San José de Cocodite region in the Paraganá Peninsula of northern Venezuela (Falcon State). The collection site where it originates from is located in the Cantaure area, 3.4 km West of the church of the village of San José de Cocodite (as the crow flies), at an altitude of approximately 140 m above sea-level on an acacia and cactus covered area approximately 400 m South of Casa Cantaure with the approximate geographic coordinates: N11° 56' 24.1' W70° 01' 04.5'' (1; location of Casa Cantaure after Griffiths *et al.*, 2013: N11° 56' 35.9'' W70° 01' 10.8'').

The specimens were collected from a thick friable yellow fine sandstone bed containing an abundant and diversified molluscan assemblage (mostly gastropods and bivalves with rare fossils of *Nautilus* cephalopods), as well as other elements such as barnacles and corals. This bed is part of the Cantaure Formation (Jung, 1965; Hunter & Bartok, 1974) which as a whole, after Díaz de Gamero (1974), is correlated with the planktonic foraminiferal biozones *Globigerinatella insueta* and *Praeorbulina glomerosa* of Bolli (1966), biozones N7 and N8 of Blow (1969), which in turn, according to the latest geologic time scale of Gradstein *et al.* (2012), correspond to the Lower to Middle Miocene transition, upper Burdigalian to lower Langhian. Rey (1996) corroborates this bio-

stratigraphic correlation stating that the Cantaure calcareous nannofossil assemblage contains the *Helicosphaera ampliaperta* and *Sphenolithus heteromorphus* markers corresponding to the biozones NN4 and NN5 of Martini (1971), which broadly correlate with the above mentioned foraminiferal zones. For further discussion see Landau *et al.* (in prep.).

The Cantaure Formation consists of an approximately 75 m thick sedimentary sequence mainly composed of fossiliferous silts, silty sandstones and fine to medium grained sandstones interbedded with thin algal limestones (Hunter & Bartok 1974; L $\acute{e}$ xico Estratigr $\acute{a}$ fico de Venezuela, 1997; Aguilera *et al.*, 2013). A diverse fossil assemblage, particularly rich in molluscs, but also featuring corals, decapods and cirripedian crustaceans, and fish remains, has been identified in the sediments of the Cantaure section, especially in its lower part (*e.g.* Jung 1965; Nolf & Aguilera 1998; Aguilera & Rodrigues de Aguilera, 1999; Griffiths *et al.*, 2013). Locally, decimetric boulders of limestone with *in situ* attached valves of the shallow marine bivalve *Spondylus* sp. may be observed within the friable fine sandstone beds. This fossil assemblage is indicative of a shallow to coastal tropical marine environment, with clear waters and marine euhaline salinity (Jung, 1965; Díaz de Gamero, 1974; Nolf & Aguilera, 1998; Aguilera *et al.*, 2013; Griffiths *et al.*, 2013).

## Material and methods

The material described here is from the Gibson-Smith collection housed in the Naturhistorisches Museum Basel (NMB coll.), Switzerland and the Bernard Landau collection (BL coll.), now deposited in the Naturhistorisches Museum Wien (NHMW coll.), Vienna, Austria. As in our previous works on the Cantaure assemblage and other recent monographic works (Beu, 2010; Landau *et al.*, 2013), we have avoided the use of subgenera. By elevating the rank of these subgeneric taxa to full generic status it is more likely that we are dealing with monophyletic groups.

In characterizing the shapes of pyramidellid protoconchs, we follow the more self-explanatory descriptive style of Robba (2013), preferring this to the letter-number type designations employed by Aartsen *et al.* (1998) and others. Following Robba, the term ‘intorted’ is used for those protoconchs that are little tilted and nearly engulfed by the first teleoconch whorl. When the shape of the protoconch shell can be discerned, the term “umboniiform” is used for those that are flat-spined and lenticular, “helicoid” for those that are globose and low spired, or “bulimoid” for those that are higher spired.

The higher classification is that of Bouchet & Rocroi (2005); placement of genera follows Schander, *et al.* (1999).

### Abbreviations:

ANSP	Academy of Natural Sciences of Philadelphia, Philadelphia, USA.
LACM	Natural History Museum Los Angeles County, California, USA.
NHMW	Naturhistorisches Museum Wien, Austria.
NMB	Naturhistorisches Museum Basel, Switzerland.
PRI	Paleontological Research Institute, Ithaca, New York, USA.
RAMME	Royal Albert Memorial Museum, Exeter, England.
USNM	United States National Museum of Natural History, Washington DC, USA.

## Systematic palaeontology

Family Pyramidellidae Gray, 1840

Subfamily Pyramidellinae Gray, 1840

Tribe Pyramidellini Gray, 1840

Genus *Longchaeus* Mörch, 1875

1875 *Longchaeus* Mörch, p. 158. Type species *Pyramidella punctata* Férussac, 1821 (by subsequent designation, Dall & Bartsch, 1904, p. 4, as *Pyramidella punctata* Chemnitz; invalid, ICZN, 1944, 1954), Holocene, Polynesia and Indian Ocean. *Pyramidella acus* (Gmelin, 1791) is a senior synonym.

1889 *Pharcidella* Dall, p. 333. Type species (by origi-

nal designation): *Pyramidella (Pharcidella) folinii* Dall, 1889, Recent, Caribbean.

1903 *Callolongchaeus*, Dall, p. 1584. Type species (by original designation): *Pyramidella (Longchaeus) jamaicensis* Dall, in Guppy & Dall, 1896, Pliocene, Jamaica.

1904 *Voluspa* Dall & Bartsch, p. 4. Type species (by original designation), *Pyramidella auricoma* Dall, 1889, Recent, Gulf of California.

1959 *Wingenella* Laseron, p. 190. Type species (by original designation) *Wingenella eburnea* Laseron, 1959, Queensland, Australia, Recent.

**Discussion** – As noted by Laseron (1959, p. 190) and Faber (2005, p. 86), there are problems with the type species designation for *Longchaeus* Mörch, 1875. Dall & Bartsch (1904, p. 4) selected *Pyramidella punctata* Chemnitz, 1780 as type species. In the combination *Obeliscus punctatus* Chemn., it is one of the three originally included species of *Longchaeus*, along with *O[beliscus] monilis* Ad. and *Obeliscus (Longchaeus) candidus* Meusch' [= ‘*Trochus candens* D. C. Meuschen, 1787’ of Sherborn? - non-binomial, Sherborn does not index a *candidus* Meuschen. The name is made available by Mörch, 1875], but *Turbo punctatus* Chemnitz, 1780 is not an available name, as Martini & Chemnitz (1769-1795) *Neues systematisches Conchylien-Cabinet* is not binomial (ICZN Opinion 184, 1944, Declaration 1, 1954). Dall & Bartsch (1909, p. 9) considered *Pyramidella punctata* Schubert & Wagner (1829) as type for *Longchaeus*, but this was not among the originally included species. Dall & Bartsch’s intention is clear enough; the question is whether their type designation can stand within the provisions of the ICZN Code, particularly Articles 69.2.1, 50, and 51. It is not necessary for *Obeliscus punctatus* Chemn. to have been cited correctly for it to be designated as type, so long as the name was available in 1875 when Mörch included it in *Longchaeus*.

Subsequent to Chemnitz, 1780, the name *Pyramidella punctata* was introduced twice, first by Férussac (1821, p. 106), then by Schubert & Wagner (1829, p. 152-153). When Férussac named ‘*P[yr]amidella punctata* Nobis’, Chemnitz’ species was included only as distinct variant  $\alpha$ . It is thus not part of the type series (Article 72.4.1). The type series on which Férussac’s name is based are those of Buonani 1684 and 1709, classe 3, fig. 72, and Lister, 1685 [or 1770], tablet 844, fig. 72b. Férussac does not validate Chemnitz’ name. Additionally, Chemnitz’ figures are included doubtfully, at least in part. Férussac wrote ‘ $\alpha$ ) Chemnitz, *Conch.*, tom. IV, p. 329, tab. 157, fig. 1493, 1494? *an Spec. dist.*?’ We interpret the query and comment as referring to figure 1494 only, which is consistent with the figures, though the brief statement is ambiguous and could refer to both figures, or the reference as a whole. Figure 1493 is *Pyramidella punctata* (with some liberties in the colouring), while figure 1494 is of a different species, likely *Pyramidella sulcata* (A. Adams, 1854). Schubert & Wagner (1829), in their description of ‘*Pyramidella punctata* nob.’ mention neither Chemnitz nor Férussac, but do include Lister (1685, 1770) tablet 844,

figure 72b, as does Férussac, 1821. *Pyramidella punctata* Schubert & Wagner, 1829 is both a primary homonym and a synonym of *Pyramidella punctata* Férussac, 1821. It is Adams in G.B. Sowerby II (1854, p. 806) who finally makes the connection between Chemnitz' species and an available name by including *Pyram[idella] punctata* Schub[ert] et Wagn[er, 1828] in the synonymy of *Obeliscus punctatus* Chemnitz. As the first author to make *Pyramidella punctata* available was Férussac (ICZN Art. 50.1), authorship of the type species is here corrected to Férussac, 1821 (pers. com. Gary Rosenberg, January 26, 2015 [PIL]).

*Plotia punctata* Röding, 1798 p. 96, no. 1239, is based on *Trochus dolabratus* Gmelin, sp. 113. *Plotia* Röding was suppressed in favour of *Pyramidella* Lamarck, 1799 (ICZN opinion 386, 1956, ICZN 1958a, 1958b). Though *Trochus dolabratus* Linnaeus, 1758 is type species of *Pyramidella*, Röding's *punctata* appears never to have been published in combination with *Pyramidella*, so is not a homonym of *Pyramidella punctata* Férussac, 1821. The type series for *Voluta acus* Gmelin, 1791, is Chemnitz' (1780) plate 157, figures 1493 and 1494. We here restrict the type series to figure 1493. It is a senior synonym of *Pyramidella punctata* Férussac. Cernohorsky (1972, p. 199) described the last whorl of *Longchaeus acus* as either regularly rounded or keeled. The periphery of other species of *Longchaeus* vary from keeled, corded, or angulate to smoothly rounded to grooved or sulcate. A suite of specimens of *Pyramidella grateloupi* d'Orbigny, 1952 at hand from the Aquitanian of France (BL) shows the entire range of variation of the periphery from keeled to sulcate. Dall & Bartsch (1904, 1909) confused subsequent workers by distinguishing *Longchaeus* from *Voluspa* by the presence of a peripheral sulcus. The defining characters of *Longchaeus* are: shell turritiform, relatively flat sided, smooth, polished, not umbilicate, columella with three plications, helicoid protoconch strongly tilted and partially submerged in the first teleoconch whorl. By comparison, *Pyramidella* Lamarck, 1799 (type species *Trochus dolabratus* Linnaeus, 1758, by monotypy) is umbilicate, the apical angle broader, the whorls more inflated, aperture proportionately higher, about one-third the height of the shell (compared to one-quarter in *Longchaeus*).

#### ***Longchaeus olssoni* (Maury, 1917)**

Plate 1, figs 1, 2

- 1917 (April) *Pyramidella Olssoni* Maury, p. 309, pl. 25, fig. 8.
- 1917 (May 5) *Pyramidella forulata famelica* Pilsbry & Johnson, p. 174.
- 1922 *Pyramidella forulata famelica* Pils. and Johns. – Pilsbry, 1922, p. 391, pl. 35, fig. 13.

*Type material* – *Pyramidella olssoni*: holotype PRI 28870, height 10.0 mm, width 3.0 mm, Bluff 3, 5 mi. above Cercado de Mao, Dominican Republic, Cercado Formation, Dominican Republic, Messinian, Upper Mio-

cene. *Pyramidella forulata famelica*: holotype ANSP 4079, height 10.5 mm, width 3.0 mm, exact locality unknown, Dominican Republic.

*Cantaure material examined* – Maximum height 4.4 mm (incomplete). NMB H20612-H20613 (2) + 11 unnumbered, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material examined* – NHMW (12), NMB locality 16926, Arroyo Bajón, Río Mao, Dominican Republic, Cercado Formation, Messinian, Upper Miocene.

*Remarks* – Pilsbry (1922, pl. 35, fig. 13) offered a very clear illustration of *Longchaeus forulata famelica*. We would agree with the author that it and *L. olssoni* (Maury, 1917) are synonyms, but Maury has priority. The Cantaure shells are very similar to specimens at hand from the type locality in the Dominican Republic. *Longchaeus olssoni* is characterised by having a relatively narrowly canalculated suture and the periphery of the last whorl is marked by an angular ridge.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper). Upper Miocene: Cercado Formation, Dominican Republic (Maury, 1917, Pilsbry & Johnson, 1917)

#### ***Longchaeus suturalis* (Lea, 1843)**

Plate 1, figs 3, 4

- 1843a *Pyramidella suturalis* Lea, p. 164 [*nomen nudum*].
- 1843b *Pyramidella suturalis* Lea, p. 8.
- 1845 *Pyramidella suturalis* Lea, p. 32, pl. 36, fig. 63.
- 1846 *Pyramidella suturalis* Lea, p. 258, pl. 36, fig. 63.
- 1843 *Pyramidella arenosa* Conrad, p. 309.
- 1859 *Obeliscus crenulatus* Holmes, p. 88, pl. 13, figs 14-14a.
- 1875 *Obeliscus floridanus* Mörch, p. 158.
- 1917 *Pyramidella semicanaliculatas* [*sic*] Maury, p. 308, pl. 25, fig. 6 (spelt *semicanaliculata* in plate caption).
- 1917 *Pyramidella diademata* Maury, p. 309, pl. 25, fig. 7.
- 1955 *Longchaeus (Pharcidella) calesi* Bartsch, p. 9, pl. 1, fig. 4.
- 1955 *Longchaeus (Longchaeus) marionae* Bartsch, p. 10, pl. 1, figs 2, 3.
- 1969 *Pyramidella (Callolongchaeus) cf. diademata* Maury – Jung, p. 563, pl. 60, fig. 12.
- 1974 *Pyramidella crenulata* (Holmes, 1859) – Abbott, p. 291, fig. 3462.
- 1983 *Pyramidella (Longchaeus) crenulata* (Holmes, 1860 [*sic*]) – H.E. Vokes & E.H. Vokes, p. 32, 59, pl. 22, fig. 2.
- 1993 *Longchaeus suturalis* (H.C. Lea, 1843) – Campbell, p. 100, pl. 41, fig. 492.

- 2009 *Pyramidella crenulata* (Holmes, 1859) – Rios, p. 371, fig. 983.  
 2011 *Pyramidella crenulata* (Holmes, 1860 [sic]) – Daccarett & Bossio, p. 145, fig. 950.  
 2013 *Longchaeus suturalis* (H.C. Lea, 1846 [sic]) – Redfern, p. 232, fig. 648.

*Type material* – *Pyramidella semicanaliculata*: holotype PRI 28868, height 8.9, width 2.7 mm, Cercado de Mao, Dominican Republic, Cercado Formation, Upper Miocene. *Pyramidella diademata*: holotype PRI 28869, height 9.5, width 2.8 mm, Cercado de Mao, Dominican Republic, Cercado Formation, Upper Miocene. *Longchaeus (Pharacidella) calesi*: holotype USNM 561593, height 10 mm, width 4.5 mm, St Petersburg, Florida, USA, Pliocene. *Longchaeus (Longchaeus) marionae*: holotype USNM 561591, height 11.2 mm, width 3.1 mm, St Petersburg, Florida, USA, Pliocene.

*Cantaure material examined* – Maximum height 5.4 mm (incomplete). NMB H20614-H20615 (2) + 16 unnumbered, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material examined* – NHMW (20), NMB locality 16926, Arroyo Bajón, Río Mao, Dominican Republic, Cercado Formation, Messinian, Upper Miocene. NHMW (4), Quality Aggregates, Sarasota, Sarasota County, Florida, Tamiami Formation, Piacenzian, Upper Pliocene. NHMW (1), TU locality 1240, Los Corales, Puerto Limon, Costa Rica, Moin Formation, Gelasian, Lower Pleistocene. NHMW (3), Griffin Brother Pit, Palm Beach County, Florida, Caloosahatchee Formation, Gelasian, Lower Pleistocene. NHMW (2), Palm Beach Rock, Palm Beach County, Bermont Formation, Upper Pleistocene.

*Remarks* – Lea's (1845) reprint/preprint 'Description of some new fossil shells, from the Tertiary of Petersburg' has frequently been erroneously dated 1843, and is often dated 1845 though without stated basis. Whether the publication date is 1845 or 1846 is of no practical importance as the new names were all validated in the previously overlooked Lea (1843b) 12 page privately published abstract of similar title.

The Cantaure shells have the fine adapical crenulations at the suture well developed compared to some of the Recent shells seen, however, if the synonymy given by Campbell (1993) is accepted, *Longchaeus suturalis* (Lea, 1843) is quite a variable species. The Dominican species described by Maury (1917): *P. semicanaliculata* and *P. diademata* are from the same outcrop and in our opinion fit within the range of variability for *L. suturalis*. Specimens at hand from the Cercado de Mao locality show both forms, the *diademata* forms, with more strongly developed sutural crenulations, are similar to the Cantaure shells. *Longchaeus canaliculatus* (Gabb, 1873), also from the Cercado Formation of the Dominican Republic is a distinct species, with a wider channelled su-

ture, thereby giving the whorls a squatter appearance. A third pyramidellid species occurs in the Dominican Cercado de Mao outcrops: *P. olssoni* Maury, 1917 (= *P. famelica* Pilsbry & Johnson, 1917). It differs in not having crenulations at the suture, being more narrowly canalculated than in the other two species, and having a peripheral ridge rather than sulcus on the last whorl. *Longchaeus jamaicensis* (Dall, in Guppy & Dall, 1896) from the Pliocene Bowden Formation of Jamaica has a much broader peripheral sulcus crossed by numerous fine axials and broader sutural groove. *Longchaeus forulatus* (Dall, in Guppy & Dall, 1896), also from the Pliocene of Jamaica is slightly pupoid, with a narrow impressed suture and a narrow peripheral sulcus.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper). Upper Miocene: Cercado Formation, Dominican Republic (this paper). Pliocene: Yorktown Formation, North Carolina, USA (Campbell, 1993). Upper Pliocene: Tamiami Formation, Florida, USA (Bartsch, 1955). Lower Pleistocene: Moin Formation, Costa Rica (this paper); Caloosahatchee Formation, Florida, USA (this paper). Upper Pleistocene: Bermont Formation, Florida, USA (this paper). Recent: western Atlantic, Carolinas to Brazil (Abbott, 1974; Rios, 2009; Redfern, 2013).

Subfamily Odostomiinae Pelseneer, 1928

Tribe Odostomiini Pelseneer, 1928

Genus *Eulimastoma* Bartsch, 1916

- 1916 *Eulimastoma* Bartsch, p. 73. Type species (by original designation): *Odostomia (Scalenostoma) dotella* Dall & Bartsch, 1909, Recent, Gulf of California. 'Scalenostoma' of Dall & Bartsch, 1904, p. 13, not Deshayes, 1863 [Eulimidae].  
 1917 *Goniodostomia* Pilsbry & Johnson, p. 63, 180. Type species (by original designation): *Odostomia (Goniodostomia) superans* Pilsbry & Johnson, 1917, Neogene, Dominican Republic.  
 1951 *Telloda* Hertlein & Strong, p. 104. Type species (by original designation): *Odostomia (Scalenostoma) dotella* Dall & Bartsch, 1909, Recent, Gulf of California.

*Note* – The main diagnostic characters of this genus are the helicoid protoconch somewhat tilted and partially submerged in the first teleoconch whorl, teleoconch smooth or microscopically striate, periphery more or less sharply angled, sutural insertion below the periphery giving the whorls an in-stepped profile or the suture a channelled appearance (Odé & Speers, 1972; Odé, 1994).

***Eulimastoma pyrgulopsis* (Pilsbry & Johnson, 1917)**

Plate 1, figs 5, 6

- 1917 *Odostomia (Eulimastoma) pyrgulopsis* Pilsbry & Johnson, p. 179.

- 1922 *Odostomia (Eulimastoma) pyrgulopsis* Pilsb. and Johns. – Pilsbry, p. 392, fig. 25.

*Type material* – Holotype ANSP 3092, height 1.8 mm, width 0.7 mm, Neogene, Dominican Republic.

*Cantaure material examined* – Maximum height 2.2 mm. NMB(56), NMB H20616-H20618 (3), NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Remarks* – The Cantaure shells are characterised by their very small, helocoid protoconch with rounded spiral cord visible close to the protoconch/teleoconch transition (Pl. 1, fig. 6b), moderately tilted, all but the last half whorl covered by the first teleoconch whorl, teleoconch of roundly shouldered whorls, the shoulder placed a short distance above the suture, forming an obtuse angle of about 130° with the following whorl, and lack of sculpture. There is some variability in the slenderness of the shell and the peripheral angulation varies from sharp to slightly rounded. These Cantaure shells are indistinguishable from the illustration of *Odostomia (Eulimastoma) pyrgulopsis* Pilsbry & Johnson, 1917 from the Neogene of the Dominican Republic, exact locality and stratum unknown. Pilsbry & Johnson (1917) also noted strong variation within the Dominican population.

*Eulimastoma engonium* (Bush, 1885) is similar in shape to the Cantaure shells, but differs in having a sharper, finely carinate periphery, shoulder stronger and more angulate, giving the suture a channelled appearance, and the base bears subobsolete spiral sculpture. *Eulimastoma surinamense* van Regteren Altena, 1975, although also similar in shape to the Cantaure species and *E. engonium*, differs in having two suprasutural spiral cords.

The most similar congener, found in the tropical Panamic Pacific, is the genotype, *Eulimastoma dotella* (Dall & Bartsch, 1909). *Eulimastoma subdotella* (Hertlein & Strong, 1951) is a synonym, the type series falling within the range of variability of *E. dotella*. It differs from *E. pyrgulopsis* in being larger (up to 3 mm), slimmer, and the periphery being more sharply angulated. In some specimens the periphery is so sharply angulated that it is slightly keeled, the whorl above slightly concave in outline. The cord depicted at the periphery in the figure (pl. 30, fig. 5) of Dall & Bartsch (1909) is not visible in photographs of the holotype.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper). Upper Miocene: Cercado Formation, Dominican Republic (Pilsbry & Johnson, 1917).

Genus *Brachystomia* Monterosato, 1884

- 1884 *Brachystomia* Monterosato, p. 94. Type species (by subsequent designation, Crosse, 1885, p. 141): *Odostomia rissoides* Hanley, 1844, Recent, Europe.

- 1915 *Zastoma* Iredale, p. 336. Type species (by typification of replacement name): *Odostomia rissoides* Hanley, 1844, Recent, Europe. Unnecessary replacement name. *Brachystomia* Monterosato, 1884 is not a homonym of *Brachystoma* Meigen, 1822 [Insecta].

*Note* – We agree with Robba's (2013) conclusion that protoconch type is diagnostic at the generic level for many pyramidellid groups, and with Fretter *et al.* (1986) and separate *Brachystomia* from *Odostomia* on this basis. In *Brachystomia rissoides* (Hanley, 1844), the type species, the protoconch is little to moderately tilted and intorted, the apex immersed in the first teleoconch whorl. In *Odostomia plicata* (Montagu, 1803), type species of *Odostomia* Fleming, 1813, the protoconch is tilted at a right angle to, and lying across the teleoconch, the apex visible. The teleoconch of *Brachystomia* is smooth or with microscopic spiral striations, typically with columellar plication obsolete to strong. Many New World species previously placed in *Odostomia* s.s. and *Odostomia (Evalea)* probably belong here.

***Brachystomia cantaurana* nov. sp.**

Plate 1, fig. 7

*Type material* – Holotype NMB H20619, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – NMB (8), locality 17516.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell minute, cylindrical. Protoconch heliocoid, moderately tilted, more than half immersed in first teleoconch whorl. Teleoconch consisting of 3.5 smooth, straight-sided whorls. Suture impressed, linear. Last whorl rather slender, elongated. Aperture ovate; outer lip somewhat flared abapically and smooth within, lacking lirae. Columella bearing a strong, sharp fold placed mid-aperture.

*Dimensions* – Holotype: height 2.1 mm, width 0.9 mm.

*Remarks* – *Odostomia nuttalli* van Aartsen & Wesselingh, 2000 from the upper Middle- lower Upper Miocene Pebas Formation of Columbian and Peruvian Amazonia is similar in shape and aperture, but is larger shelled and differs in having more inflated whorls, the suture is more pronounced, with a subsutural cord, and the columellar fold is not as strong. None of the *Odostomia* species illustrated by Pilsbry (1922) from the Neogene of the Dominican Republic are particularly similar to the Cantaure shell. Most have deeper channelled sutures and/or less cylindrical-slender shell profiles. Of the *Odostomia* species described by Bartsch (1955) from the Plio/Pleis-

tocene of Florida, *O. gunteri* Bartsch, 1955 is the most similar in shape, but differs in being larger shelled, with more numerous teleoconch whorls and in having a weaker columellar fold.

None of the living Caribbean *Odostomia* species compared are particularly similar to the Cantaure shells. In the present-day tropical American Pacific, *O. parella* Dall & Bartsch, 1909 from the Galapagos Islands, is much larger shelled, with slightly more inflated whorls, a more impressed suture, a proportionately shorter aperture, and a weaker columellar fold.

*Odostomia granadensis* Dall & Bartsch, 1909 from Panama Bay is similar in size and shape, but lacks a strong columellar fold.

*Etymology* – Named after the type locality of Cantaure. *Brachystomia* gender feminine.

Genus *Goniodostomia* Pilsbry & Johnson, 1917

- 1917 *Goniodostomia* Pilsbry & Johnson, p. 180. Type species (by original designation): *Odostomia (Goniodostomia) superans* Pilsbry & Johnson, 1917, Neogene, Dominican Republic.

*Note* – Species included in the genus *Goniodostomia* Pilsbry & Johnson, 1917 have a helicoid protoconch, which is moderately tilted and intorted. The teleoconch is keeled at the periphery, with further spiral sculpture, no axial sculpture, and the columellar fold is well-developed.

***Goniodostomia bicarinata* nov. sp.**

Plate 1, figs 8

*Type material* – Holotype NMB H20620, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – Known only from holotype.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell small, fusiform. Protoconch large, little tilted, intorted so that only the last whorl is visible above teleoconch. Teleoconch of three bicarinate whorls, carinae elevated, placed a short distance below and above suture, abapical carina strongest, forming periphery. Whorl surface between sutures and spiral elements concave. Axial sculpture of irregular opisthocline growth lines visible in the interspaces between the spiral cords. Suture impressed. Last whorl 66% total height, with peripheral cord placed mid-whorl, base bearing three further weak spiral cords. Aperture ovate, widening abapically; outer lip simple. Columella obscured by matrix. Umbilical chink absent.

*Dimensions* – Holotype: height 2.2 mm, width 1.1 mm.

*Differentiation* – *Goniodostomia bicarinata* nov. sp. is represented by a single shell in the NMB collection, but it is very distinctive and merits description. We have placed this species within the genus *Goniodostomia* Pilsbry & Johnson, 1917 on the basis of the strongly intorted protoconch and keeled teleoconch whorls. It would have been useful to see if the Cantaure shell has the strong columellar fold typical for the genus, but this is obscured by matrix, which was not removed for fear of damaging this fragile single specimen. The Cantaure shell lacks the fine spiral sculpture seen in the Dominican species, although the surface is somewhat eroded and it is possible some surface microsculpture may have been present.

In the Dominican assemblages two species are described: *G. superans* Pilsbry & Johnson, 1917 and *G. circumvincta* Pilsbry & Johnson, 1917, both of which differ from the Cantaure shell in lacking the adapical carina, and therefore only having the abapical one, which is more strongly developed in *G. superans* than in *G. circumvincta*. The Dominican species, although having the teleoconch covered in fine spiral lines, lack coarser cords on the base, as seen in *G. bicarinata*.

*Remarks* – The genus *Goniodostomia* has not, so far, been recognised in the Recent tropical American faunas on either side of the Isthmus of Panama.

*Etymology* – Latin ‘*carina*’, noun, meaning keel, ‘*bi-*’, prefix, two, describing to two keels per whorl. *Goniodostoma* gender feminine.

Genus *Iolaea* A. Adams, 1867

- 1860 *Iole* A. Adams, p. 300. Type species (by monotypy): *Iole scitula* A. Adams, 1860, Recent, Japan. Invalid: junior homonym of *Iole* Blyth, 1844 [Aves] and *Iole* Pascoe, 1858 [Coleoptera].
- 1867 *Iolaea* A. Adams, p. 310. Type species (by typification of replaced name): *Iole scitula* A. Adams, 1860, Recent, Japan.
- 1948 *Iolina* Baily, p. 107. Type species (by typification of replaced name): *Iole scitula* A. Adams, 1860, Recent, Japan. Invalid: unnecessary nom. nov. pro *Iolaea* A. Adams, 1860, considered by Baily to be a junior homonym of *Iolea* Pascoe, 1858 [Coleoptera].

*Note* – Species included in the genus *Iolaea* A. Adams, 1867 have a strongly intorted helicoid protoconch, the teleoconch is turreted, the spire whorls have three smooth, strong spiral cords per whorl, with numerous axial riblets in the interspaces, and the base is perforate.

***Iolaea miocenica* nov. sp.**

Plate 1, fig. 9; Plate 2, figs 1, 2

*Type material* – Holotype NMB H20621; paratype 1 NMB H20622; paratype 2 NMB H19118, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – NMB unnumbered (6), same locality.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell small, turreted. Protoconch little tilted, intorted, only the last whorl is visible above teleoconch, diameter about 250  $\mu\text{m}$ . Teleoconch of three convex whorls, with periphery just below mid-whorl. Suture impressed. Sculpture on spire whorls of three strong, smooth, rounded, equidistant cords, with numerous irregular axial riblets in the interspaces. Last whorl 65% total height, evenly convex, bearing three cords between suture and insertion of outer lip, four weaker cords on base. Aperture ovate, relatively small; outer lip simple, slightly flared abapically. Columella bearing medium-strength fold at mid-height. Umbilical chink present.

*Dimensions* – Holotype: height 1.2 mm, width 615  $\mu\text{m}$ ; paratype 1: height 1.7 mm, width 755  $\mu\text{m}$ ; paratype 2: height 1.5 mm.

*Differentiation* – *Iolaea miocenica* nov. sp. is a very distinctive species, although there is some variability as to the height of the shell. The holotype is somewhat squatter and the spire is less turreted than most specimens, which are more like paratype 1. We have chosen the holotype as the sculpture is better preserved.

The most similar species is *Miralda robertsoni* van Regteren Altena, 1975, subfossil from Surinam, which is an *Iolaea*. It is similar in size, has a similar protoconch, and three spiral cords per whorl on the spire, but has slightly less inflated whorls, a more cylindrical form, and six stronger cords on the base. The spiral cords are crossed by fine, regularly spaced, somewhat sinuous axial ribs on the spire, terminating just below the sutural cord. The columellar fold is weak, and it lacks an umbilical chink. *Iolaea amazonica* van Aartsen & Wesselingh, 2005, from the Miocene Pebas Formation of Peru (western Amazonia), is also similar in size and shape, is variable in width but on average is narrower, aperture more elongate, sculpture generally more delicate, with four thinner, sharper, cords per whorl, the protoconch more steeply tilted.

*Iolaea eucosmia* Dall & Bartsch, 1907, from the present-day temporate Californian marine faunal province, is the most similar, differing in being larger, more strongly turreted, with stronger spiral cords, and more numerous teleoconch whorls. *Iolaea amianta* Dall & Bartsch, 1907 differs in being larger, broader, with a wider aperture, four cords between sutures and more numerous cords on the base. Several less similar *Iolaea* occur in the Panamic Pacific and Japan.

*Etymology* – From the Miocene epoch in which it found. *Iolaea* gender feminine.

Tribe Chrysallidini Saurin, 1958

Genus *Chrysallida* Carpenter, 1856

1856 *Chrysallida* Carpenter, p. 170. Type species (by subsequent designation, Carpenter, 1863): *Chemnitzia communis* C.B. Adams, 1852, Recent, tropical American Pacific.

***Chrysallida cantaurana* nov. sp.**

Plate 2, figs 3-5

*Type material* – Holotype NMB H20623; paratype 1 NMB H20624; paratype 2 NMB H20625, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – Maximum height 2.7 mm. NMB H20626 (35), same locality.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell small, fusiform. Protoconch helicoid, moderately tilted, more than half exposed above first teleoconch whorl, diameter about 150  $\mu\text{m}$ . Teleoconch of 4½ weakly convex whorls. Suture deeply impressed, lying in small V-shaped groove. Sculpture of about 15 prosocline elevated, rounded ribs, about half the width of their interspaces, crossed by five elevated rounded spiral cords on spire whorls, with a sixth cord appearing at abapical suture on penultimate whorl. Small tubercles formed at sculptural intersections. Last whorl not particularly inflated, evenly rounded, the sixth cord forming an elevated basal cord, at which axial ribs stop abruptly. Base bearing 7-10 spiral cords and prominent, irregular growth lines in the interspaces. Aperture ovate; outer lip simple, rounded, slightly flared abapically. Columella bearing prominent central fold. Very small umbilical chink present.

*Dimensions* – Holotype: height 2.6 mm, width 1.1 mm; paratype 1: height 2.0 mm, width 0.9 mm; paratype 2: height 2.6 mm, width 1.1 mm.

*Differentiation* – *Chrysallida cantaurana* nov. sp. is characterised by having relatively fine sculpture, composed of five spiral cords on all spire whorls, the axial component only slightly stronger than the spiral, and 7-10 spiral cords on the base.

*Chrysallida cantaurana* is most closely comparable to *Chrysallida jadisi* (Olsson & McGinty, 1958), present-day Caribbean Panama to Brazil. It differs in being slightly larger (2.6 to 3.5 mm), having a more strongly tilted, less deeply immersed protoconch, so that part of the first whorl is exposed, a sixth cord at the suture, and the aper-



ture narrower, pinched apically (van Regteren Altena, 1975, figs. 32a, b). The type species *C. communis* (C.B. Adams, 1852) is from the Recent Panamic Pacific, where the genus is very speciose. It differs from *C. cantaurana* in having four spiral cords on the spire whorls, in having a narrower aperture, pinched apically, and the outer lip is straighter. Indeed, most of the Recent Panamic Pacific species similar to the Cantaure one differ in only having four spiral cords per whorl. *Chrysallida acrybia* Dall & Bartsch, 1909 has only four spiral cords and differs from *C. communis* in having weaker cords and stronger ribs. *Chrysallida excelsa* Dall & Bartsch, 1909, another species with only four spiral cords differs from its Recent Panamic Pacific congeners in having weaker sculpture. *Chrysallida telescopium* Carpenter, 1857 has four spiral cords, but more numerous and stronger axial ribs. It is possible that many of these present-day Pacific taxa, including *C. acrybia*, *C. excelsa*, and *C. telescopium* should be synonymised with *C. communis*, as attempts to reliably separate several hundred lots identified as *C. communis s.l.* in the LACM collections was unsuccessful and the considerable variability of characters observed appear to overlap (Pat LaFollette, unpublished data). In the Recent Caribbean the genus is represented by *C. buijesei* de Jong & Coomans, 1988, which has two tubercular spiral cords, with a prominent smooth third cord below on the spire whorls. *Chrysallida cancellata* (d'Orbigny, 1841) differs from *C. cantaurana* in having only three spiral cords on the spire whorls, all of which are beaded. *Chrysallida nioba* (Dall & Bartsch, 1911) differs in having four beaded spiral cords per whorl. *Chrysallida gemmulosa* (C.B. Adams, 1850) has three, four and five beaded spiral cords on the last three whorls respectively. *Chrysallida medialuna* Faber, 2008 has a similar number of spiral cords, but more numerous axial ribs and far more convex spire whorls.

**Remarks** – As far as we are aware, this is the first record for the genus in the tropical Panamic Neogene, although it does occur in the western exposures of the tropical late Miocene Imperial Formation of Riverside County, California (Bramkamp, 1934). Despite extensive collecting, we have not found this species in the Dominican Neogene. A single specimen of *C. buijesei* from the Lower Pleistocene Moin Formation of Costa Rica is present in the NHMW collection.

**Etymology** – Named after the type locality of Cantaure. *Chrysallida* gender feminine.

Genus *Kleinella* A. Adams, 1860

1860 *Kleinella* A. Adams, p. 302. Type species (by monotypy) *Kleinella cancellaris* A. Adams, 1860, Recent, Japan Sea.

***Kleinella pumila* nov. sp.**

Plate 2, figs 6, 7

**Type material** – Holotype NMB H18931; paratype 1NMB H20627; paratype 2 NMB H20628, NMB locality 17516. South of Casa Cantaure, Paraguana Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

**Other material** – Known from type series only.

**Distribution** – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

**Description** – Shell minute, squat, deeply umbilicate. Protoconch large, helicoid, little tilted, intorted so that only the last whorl is visible above teleoconch, giving the shell a flat-topped appearance, diameter about 330  $\mu$ m. Teleoconch of 2.5 convex whorls, with periphery just below mid-whorl. Suture deeply impressed. Sculpture of eight spiral cords on the penultimate whorl, roughly equal in width to their interspaces, crossed by close-set axial ribs, extending between the sutures, roughly equal in width to their interspaces, about 45 on the penultimate whorl, giving surface a finely and regularly reticulated pattern. Last whorl broad, 75% of total height, roundly shouldered at suture, evenly convex below, reticulate sculpture continuing onto base, stopping abruptly at the umbilicus, with five spiral cords between suture and the edge of the umbilicus. Aperture ovate; interior obscured by matrix; outer lip simple; lower lip evenly rounded, slightly flared. inner lip thin, sharp, evenly rounded. Umbilicus wide, deep, edge rounded, smooth within, except for axial growth lines.

**Dimensions** – Holotype: height 1.3 mm, width 860  $\mu$ m; paratype 1: height 1.0 mm, width 700  $\mu$ m; paratype 2: height 1.0 mm.

**Differentiation** – These specimens are quite similar to *Kleinella cancellaris* A. Adams, 1860, type species of *Kleinella*, from the present-day Japan Sea. *Kleinella cancellaris* has three or four strongly inflated whorls, a deep suture, squat flat-topped outline, oval aperture, widely open umbilicus, and fine reticulate sculpture. It differs from *K. pumila* nov. sp. in being slightly broader, more strongly shouldered, the insertion placed higher on the whorl, spiral cords somewhat stronger than axial ribs, and being larger, 3.7 mm vs. 1.3 mm. *Kleinella delicatula* Saurin, 1962, from the present-day Gulf of Thailand, is similar in size, 1.2 mm, but differs in its narrower outline, less prominent umbilicus, and more irregular sculpture. *Kleinella sympiesta* Melvill & Standen, 1903, from the present-day Gulf of Oman, has similar, but finer reticulate sculpture, is proportionately broader, more globose, and significantly larger at 5.0 mm. We note that the figure given by Melvill & Standen (1903, pl. D, fig. 16) seems to show a deep anal canal, although this feature is not mentioned in the description.

**Remarks** – *Kleinella* was generally misunderstood before Higo *et al.* (2001, p. 135, fig. G4695) figured the type species. *Kleinella* has been something of a catch-

all for a heterogenous mix of species. For example, the turbonillid *Parthenia cedrosa* Dall, 1884, from Florida and the Gulf of Mexico, was placed in *Kleinella* by Abbott (1974, p. 309) and succeeding authors. In our opinion, this species should be placed in the genus *Pyrgiscus* Philippi, 1841. The suprageneric placement of *Kleinella* is uncertain, but *Chrysallidini* is not unreasonable.

*Etymology* – Latin ‘*pumilus*’, noun, meaning dwarf, pygmy. *Chrysallida* gender feminine.

Genus *Parthenina* Bucquoy, Dautzenberg & Dollfus, 1883

- 1883 *Parthenina* Bucquoy, Dautzenberg & Dollfus, p. 158, 168. Type species (by original designation): *Turbo interstinctus* J. Adams, 1797, p. 66, present-day, Europe.

*Note* – Bucquoy, Dautzenberg & Dollfus (1883), noting that *Parthenia* Lowe, 1841, was preoccupied by *Parthenia* Robineau-Desvoidy, 1830 [Diptera], proposed a new genus, *Parthenina*, to replace it with ‘*Odostomia interstincta* Montagu, [1803]’ as type species by original designation. In doing so, they overlooked Montagu’s (1803) reference to J. Adams, but such errors of attribution do not invalidate the type designation, but are to be corrected (ICZN, 2000, Art. 67.7). The type species of *Parthenina* is correctly *Turbo interstinctus* J. Adams, 1797. Warén (1991, p. 95, fig 39C) eliminated any possible ambiguity by designating and figuring a neotype (RAMME no. 4241) for *Turbo interstinctus* J. Adams, the specimen having been identified as *interstinctus* by Montagu himself. *Parthenina* was explicitly introduced as a new genus ‘nov. s.-g.’ (p. 158) not as a nom. nov. [The Code seems to favour new names over replacement names. For the name to be a replacement, they would have had to explicitly made that intention clear. As it is, they said new subgenus, and designated a type species, so whatever their intention, their action and the Code are clear. [Van Aartsen applied the same misunderstanding of the Code to several Dall & Bartsch genera, trying to turn them into replacement names with different type species.] The statement by van Aartsen, Gittenberger, & Goud (2000, p. 28-29), in their treatment of *Chrysallida* (*Parthenina*) *obtusa* (Brown, 1827), that the type of *Parthenina* was *Turbo interstinctus* sensu Jeffreys, 1867. is unjustified. Bucquoy *et al.*’s type designation is explicit. Warén’s designation of a neotype fixes the identity of *interstinctus* and makes ‘*sensu* J. Adams’ and ‘*sensu* Montagu’ irrelevant. Van Aartsen, Gittenberger, & Goud (2000) fixed the same specimen as neotype for *Jaminia obtusa* Brown, 1827, which made *J. obtusa* Brown an objective junior synonym of *T. interstinctus* J. Adams. As it turns out, the attempt by Bucquoy, *et al.* (1883) to provide a new name for *Parthenia* Lowe went amiss. The type species of *Parthenia*, *P. bulinea* Lowe, 1841, by subsequent designation, Monterosato (1880), is not a *Parthenina*.

*Parthenia* Lowe finally got a replacement when Thiele (1929), introduced *Euparthenia* nom. nov., with the same type. The species figured in van Aartsen, Gittenberger, & Goud (2000) and Peñas & Rolán (1999) as *Parthenina* show a sufficient variability in characters that we are comfortable to range this Cantaure shell among them. Only the somewhat sinuous opisthocline axials on the last whorl set it apart.

The genus *Besla* Dall & Bartsch, 1904 [type species (by original designation): *Odostomia* (*Chryallida*) *convexa* Carpenter, 1857, Recent, Panamic Pacific] differs from *Parthenina* in having a spirally sculptured base according to Dall & Bartsch (1909, pp. 13-14). The type species has a protoconch of 2.5 whorls, forming a moderately elevated helicoid spire, whose axis is at right angles to that of the succeeding turns, in the first of which it is about one-fifth immersed. *Besla* species with both this type of protoconch and a slightly tilted intorted protoconch have been described (Dall & Bartsch, 1909, p. 136; Robba *et al.*, 2003) and we agree with Robba (2013) that *Besla* is probably polyphyletic.

#### ***Parthenina martae* nov. sp.**

Plate 3, fig. 1

*Type material* – Holotype NMB H19116, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – Known only from holotype.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell very small, elongate-ovate. Protoconch slightly tilted, deeply intorted. Teleoconch of four weakly convex whorls, with periphery placed a short distance above suture, angular on early whorls, rounded on last whorl. Suture deeply impressed, V-shaped. Axial sculpture of 15 strong, elevated ribs, orthocline on early whorls, strongly opisthocline on last whorl. Spiral sculpture on spire whorls of three weak cords, the abapical cord placed at the periphery, two below. Last whorl 55% of total height, regularly convex. Base rounded, covered in spiral cords; axial ribs continuous over base. Aperture ovate, slightly expanded abapically; outer lip simple, smooth within. Columella weakly excavated, bearing a weak fold. Umbilical chink narrow.

*Dimensions* – Holotype: height 1.6 mm, width 680µm.

*Differentiation* – *Parthenina martae* nov. sp. from the Cantaure assemblage is characterised by its strongly intorted protoconch, its teleoconch composed of four weakly convex whorls separated by a deep V-shaped suture. The sculpture is composed of prominent, elevated axial ribs, about 15 on the penultimate whorl, and spiral sculpture composed of three cords placed very low, at and

below the periphery, weaker than the axial elements, and four spiral cords on the base. It is most similar in shape and sculpture to *Besla convexa* (Carpenter, 1857), type species of *Besla* Dall & Bartsch, 1904, from the present-day tropical Panamic Pacific, but differs in the character of the protoconch, which is multi-spiral helicoid and strongly tilted in *B. convexa*, whereas the protoconch in the *Cantaure* shell is slightly tilted and strongly intorted. *Besla arnoldoi* de Jong & Coomans, 1988 differs in being taller-spined, with more convex whorls and in having a high spired, more strongly tilted larval shell, the tip visible above the teleoconch.

Robba *et al.* (2004) discussed and described several *Besla* species from Thailand, also with intorted protoconchs. Of these only *B. cossmanni* (Hornung & Mermod, 1924), which is widely distributed in the Pacific, is similar, but it differs in having the base devoid of sculpture. It should be placed in the genus *Parthenina*.

*Remarks* – Unfortunately, the holotype was damaged on handling after SEM microscopy.

*Etymology* – Named after Marta Camacho, an enthusiastic young Portuguese neuroscientist and friend of the senior author. *Parthenina* gender feminine.

#### Genus *Ividella* Dall & Bartsch, 1909

- 1884 *Funicularia* Monterosato, p. 85. Type species (by subsequent designation, Dall & Bartsch, 1909, p. 172): *Rissoa excavata* Philippi, 1836, Recent, Mediterranean (*non* Forbes, 1845 [Cnidaria: Penatulidae]). Also unavailable due to being proposed conditionally *vide* Gofas pers. com. 2012 [PIL]; Dall & Bartsch, 1909, p. 172, senior homonym ‘*Funicularia* Lamarck’ is probably an error for *Furcularia* Lamarck, 1816 [Rotifera].
- 1907 *Ividia* spp. of Dall & Bartsch, p. 517 (based on a misinterpretation of the type species, *Parthenia armata* Carpenter, 1857).
- 1909 *Ividella* Dall & Bartsch, pp. 14, 172. Type species (by original designation): *Odostomia (Ividia) navisa* Dall & Bartsch, 1904, Recent, Californian and Panamic Pacific.

#### *Ividella abbotti* (Olsson & McGinty, 1958)

Plate 3, fig. 3

- 1958 *Miralda abbotti* Olsson & McGinty p. 44, pl. 1, fig. 7.
- 1974 *Odostomia abbotti* Olsson and McGinty, 1958 [*sic*] – Abbott, p. 298, no. 3628.
- 1983 *Odostomia (Miralda) abbotti* Olsson and McGinty, 1958 – H.E. Vokes & E.H. Vokes, p. 32, pl. 30, fig. 11.
- 1988 *Miralda abbotti* Olsson & McGinty, 1958 – de Jong & Coomans, p. 124, pl. 6, fig. 650.
- 2011 *Odostomia abbotti* Olsson & McGinty, 1958 [*sic*]

– Daccarett & Bossio, p. 144, fig. 936.

- 2008 *Ividia abbotti* Olsson and McGinty, 1958 – Pimenta *et al.*, p. 173, fig. 1F (holotype).

*Type material* – Holotype ANSP 211912, height 2.0 mm, width 1.0 mm, Recent, Bocas Island, Colon, Panama.

*Cantaure material examined* – Maximum height 1.2 mm. NHMW 2013/0566/0416 (1), NMB H20629 (1), NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Remarks* – Odé (1993) argued that the genus *Ividia* Dall & Bartsch, 1904 (type species *Parthenia armata* Carpenter, 1857) is not a synonym of *Miralda* A. Adams, 1863 (type species *Parthenia diadema* A. Adams, 1860), as suggested by Dall & Bartsch (1909). The publication of a figure of a syntype of *P. diadema* by Higo *et al.* (2001, p. 125, fig. G4422) confirms Odé’s interpretation. This position has been followed by most subsequent authors (Redfern, 2013; Pimenta *et al.*, 2008), but not by Schander *et al.* (1999), who apparently overlooked Odé (1993). We would agree with Pimenta *et al.* (2008), who pointed out the differences between the type species of the two genera and considered *Ividia* and *Miralda* separate genera.

Although Dall & Bartsch (1909) were wrong in concluding that *Ividia* was a synonym of *Miralda*, they were correct in recognising that *Ividella* form a distinct group. Both *Ividia* and *Ividella* are characterised by a helicoid, moderately tilted, intorted protoconch, and a pagodiform shell with two strong spiral cords on the spire whorls, but *Ividella* also has strong axial ribs on the spire, sometimes continuing weakly onto the base, while *Ividia* lacks axial ribs. In *Ividella*, nodes form, sometimes quite strongly, at the intersections of the spiral and axial sculpture. In *Ividia*, the upper cord, or both cords, are ornamented with nodes, but when both cords are nodose, those on the lower cord are slightly more numerous, so that the upper and lower rows do not exactly line up. *Ividia* has three additional strong smooth cords, one at the insertion, two on the base. *Ividella* also has a cord at the periphery, and two or three on the base. Among Caribbean species, *Miralda abbotti* Olsson & McGinty, 1958, is *Ividella* (for illustration of holotype, see Pimenta *et al.*, 2008, fig. 1F); *Odostomia (Miralda) havanensis* Pilsbry & Aguayo, 1933 is *Ividia*. *Lia decorata* de Folin, 1873, may be a synonym of *havanensis*, or be congeneric. The type specimen of *L. decorata*, however, is reported missing from the de Folin collection at the Muséum National d’Histoire Naturelle, Paris (Kisch, 1959, p. 112). Additional material is needed to establish the identity of de Folin’s figure. If *decorata* is shown to be a synonym of, or congeneric with *I. havanensis*, then *Liamorpha* Pilsbry, 1898, p. 323, new name for *Lia* de Folin, 1873 *non* Eschscholtz, 1829 [Coleoptera] (and other homonyms) would have priority over *Ividia*. In the eastern Pacific, in addition to the type species of each genus, *Odostomia (Miralda) aepynota* Dall & Bartsch, 1909 is *Ividia*. Assigned to *Ividella* are *Rissoa notabilis* C.B. Adams, 1852 (= *Cingula* (?) *turrata* C.B.

Adams, 1852, new name *Odostomia (Ividella) orariana* Dall & Bartsch, 1909), *Odostomia (Ividella) mendozae* Baker, Hanna & Strong, 1928, *Odostomia (Ividella) ulloana* Strong, 1949, *Odostomia (Miralda) rhizophorae* Hertlein & Strong, 1951, *Parthenia quinquecincta* Carpenter, 1857, and *Odostomia (Ivadella) mariae* Bartsch, 1928. The Mediterranean *Rissoa excavata* Philippi, 1836, type species of *Funicularia* Monterosato, 1884, is also *Ividella*.

Van Aartsen's statement (1984, p. 136, repeated by van Aartsen, *et al.*, 1998) that the name *Ividella* Dall & Bartsch, 1909 was introduced as a replacement name for *Funicularia* Monterosato, 1884, and should therefore take *Rissoa excavata* as type, is incorrect. Dall & Bartsch (1909) explicitly state '*Ividella*, new subgenus' and designate *I. navisa* (Dall & Bartsch, 1907) as type. *Folinella* Dall & Bartsch, 1904, type *Amoura anguliferens* de Folin, 1873, from Mauritius, western Indian Ocean, is not, in our opinion, congeneric with *Ividella* as suggested by van Aartsen (1984).

The teleoconch of the fossil specimens from Cantaure is indistinguishable from that of *I. abbotti*. The fossil specimens from Cantaure differ from the Recent holotype of *I. abbotti* in having the protoconch less tilted and more deeply immersed into the adapical part of the teleoconch. Changes in protoconch character over time have been recorded in other pyramidellids (Micali, 1994). Whilst pointing out the difference between the fossil and Recent populations, we consider it insufficient to erect a new taxon. Micali (1994) found that the protoconch changes in the Pliocene to Recent Mediterranean *Turbonilla striata* (Linnaeus, 1758) were gradual. We have insufficient fossil material to see if this is the case in *I. abbotti*. As far as we are aware, this is the oldest record for the genus.

**Distribution** – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper). Recent Caribbean (Abbott, 1974; H.E. Vokes & E.H. Vokes, 1983; Daccarett & Bosio, 2011).

#### *Ividella guppyi* nov. sp.

Plate 3, fig. 2

**Type material** – Holotype NMB H20630; paratype 1 NMB H20631; paratype 2 NMB H20632, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

**Other material** – Known only from type series.

**Distribution** – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

**Description** – Shell small, relatively tall, turreted. Protoconch little tilted, intorted, only the last whorl visible above teleoconch, diameter 250  $\mu\text{m}$ . Teleoconch of four and one half slightly convex whorls, periphery a little below mid-whorl. Suture impressed, shoulder tabulate. Sculpture on

the spire of three spiral cords, strong ones at the shoulder and a little below mid-whorl, and a weak one just above the suture, crossed by axial ribs that form strong axially elongated nodes at the shoulder, weaker more rounded beads at the middle cord, only small irregularities at the third. Axial cords obsolete on the first teleoconch whorl, about 16 on the second, 18 on the third, 23 on the third. Last whorl about half of total height, convex, with three cords between suture and insertion, and two more of about equal strength on the base. Axial cords weaker and more closely packed than above, extending weakly onto the base between the basal cords. Aperture ovate, about one-third total height, outer lip thin, sinuous, reflecting the sculpture, columella not visible.

**Dimensions** – Holotype: height 2.1 mm, width 850  $\mu\text{m}$ ; paratype 1: height 2.0 mm; paratype 2: height 2.1 mm.

**Differentiation** – The sculpture in *Ividella guppyi* nov. sp. is similar in almost every point to that of *I. abbotti*, but comparatively much subdued, presenting an almost melted aspect. The base bears two cords rather than three as in *I. abbotti*. The material available to us does suggest that *I. guppyi* is specifically distinct, not an extreme variation of *Ividella abbotti*. The final whorl of the type specimen of *guppyi* suggests senility. An undescribed species with similarly reduced sculpture occurs in the Panamic Pacific (P. LaFollette, unpublished data).

Subfamily Turbonillinae Bronn, 1849

Tribe Turbonillini Bronn, 1849

**Note** – In most recent works almost all turbonillids are placed in a single genus *Turbonilla* Risso, 1826 (Absalão & Pimenta, 1999; Pimenta & Absalão, 2002, 2004; Rios, 2009; Peñas & Rolán, 2010). Although our understanding of the phylogenetics of the group is still rudimentary, the likelihood of the genus *Turbonilla* used in this way to be monophyletic is remote. In the spirit of this work, in which we use a more restricted generic concept to hopefully include monophyletic groups, we have chosen to follow Dall & Bartsch (1909) and recognise different groups based on shell characters, which we use at full genus rank. Whilst these more restricted groups may still not be truly monophyletic, they do emphasise the very diverse sculpture in this group, which at first glance seems to be very similar. This approach was also taken by Robba *et al.* (2004), Lee (2009), Robba (2013) and Redfern (2013).

Genus *Chemnitzia* D'Orbigny, 1840

1840 *Chemnitzia* d'Orbigny, p. 77. Type species (by monotypy): *Melania campanellae* Philippi, 1836, Recent, Mediterranean.

**Note** – Species in this group are characterised by having prominent axial ribs, which fuse or terminate at the

suture, deeply-sunken interspaces starting at the adapical suture and terminating at or just above the abapical suture, no spiral sculpture beyond microscopic spiral striations, a smooth base and a straight columella (Dall & Bartsch, 1909).

***Chemnitzia macsotayi* nov. sp.**

Plate 3, figs 4, 5, Plates 4, fig. 1

*Type material* – Holotype NMB H20633; paratype 1 NMB H20634, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – NMB (15), NMB locality 17516.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell tall, conical, slender, with acuminate apex. Protoconch helicoid, of two to two and a half whorls, tilted at right angle, elevated apex extending beyond first teleoconch whorl in which it is barely immersed, diameter about 270 µm. Teleoconch of up to eight weakly convex whorls, with accentuated convexity in the anterior half, above the suture. Suture impressed. Axial ribs elevated, opisthocline, straight, slender 12-14 per whorl; summits of the ribs not projected over adapical suture, at which the edge of the whorl is slightly thickened, most noticeably in the earlier whorls. Interspaces about three times as wide as the ribs, ending just above the abapical suture, leaving a narrow, plain band above the suture. Spiral sculpture absent. Base rounded, smooth. Aperture rhomboid, well rounded anteriorly. Columella obliquely arcuate, without fold. Outer lip thin. Umbilicus imperforate.

*Dimensions* – Holotype: height 3.4 mm; paratype 1, height 3.6 mm.

*Differentiation* – Pilsby (1922) illustrated several species from the Neogene Dominican Republic, which can be attributed to the genus *Chemnitzia* (Pilsbry, 1922, pl. 36, figs 6-12). Pilsbry & Johnson (1917) attributed many of these species to the genus *Nisiturris* Dall & Bartsch, 1906 (type species *Turbonilla (Nisiturris) crystallina* Dall & Bartsch, 1906, Recent, southwest Pacific), but this species has an odd pupoid protoconch projecting upwards, tilted at a 45° angle from the axis of the teleoconch (Dall & Bartsch, 1906, pl. 24, fig. 3), which does not seem to be the case in the Dominican shells. The teleoconch characters of *Nisiturris* appear to be the same as those for *Chemnitzia*. *Chemnitzia peraequa* (Pilsbry & Johnson, 1917) is immediately separated from the Cantaure species by its more pupoid shell shape. *Chemnitzia angustula* (Pilsbry & Johnson, 1917) is separated by having microscopic spiral sculpture. *Chemnitzia angustula* was introduced as a *nom. nov. pro. Turbonilla angusta* Gabb, 1873, *non* Carpenter, 1864. *Chrysallida angusta*

Carpenter, 1863, from present-day Cabo San Lucas, Baja California, Mexico, is a *Chrysallida* species, not turbonillid (see Dall & Bartsch, 1909, pl. 8, fig. 6), therefore the replacement was unnecessary. However, ICZN Art 59.3 states that: ‘A junior secondary homonym replaced before 1961 is permanently invalid unless the substitute name is not in use...’. *Chemnitzia* (or *Turbonilla*) *angustula* has been used at least twice since it was introduced, most recently by Perrilliat (1974). Therefore the replacement name must take preference.

*Chemnitzia aratibacillum* (Pilsbry & Johnson, 1917) is most similar in shape to the Cantaure shells, but differs in having the ribs orthocline on the later adult whorls instead of opisthocline as in the Cantaure species, and whilst the ribs fade out just before the sutures in the Dominican species, the smooth band above the abapical suture is not as well defined nor as broad as it is in the Cantaure species. *Chemnitzia insititia* (Pilsbry & Johnson, 1917), *C. pertenuis* (Gabb, 1873) and *C. contexta* (Pilsbry & Johnson, 1917) are all far more slender than the Cantaure species. Finally, *C. undecimcostata* (Pilsbry & Johnson, 1917) has broader ribs. Maury (1917) described three species within the subgenus *Chemnitzia*, but the figures are so poor these species are difficult to interpret without consulting the type material. It is likely that some, if not all, are the same species described by Pilsbry & Johnson (1917). If so, Maury’s work would have priority, published in April 1917, whereas Pilsbry & Johnson’s work was published May 5, 1917.

In the Recent Caribbean *Chemnitzia heilprini* (Bush, 1899) is very similar indeed to the Cantaure species, also with a smooth suprasutural band developed and no spiral sculpture, but differs in having slightly more numerous axial ribs, which are orthocline on later adult whorls rather than opisthocline as seen in the Cantaure species (for illustration of holotype see Absalão & Pimenta, 1999). *Chemnitzia hemphilli* (Bush, 1899) differs in having microscopic spiral sculpture. *Chemnitzia penistonii* (Bush, 1899) has more numerous axial ribs, which are more sinuous, and extend to the abapical suture. *Chemnitzia unilirata* (Bush, 1899) has more numerous axial ribs, and a single spiral cord a short distance below the suture. *Chemnitzia compsa* (Bush, 1899) has a more pupoid shell shape.

Two Recent Panamic Pacific species are similar in having small shells, with non-tabulated whorls and the intercostal spaces terminating just above the abapical suture: *C. santarosana* Dall & Bartsch, 1909 and *C. paramoea* Dall & Bartsch, 1909, both of which differ from the Cantaure shells in having more numerous axial ribs, which are wider than the interspaces.

Although trans-Atlantic distribution of turbonillids has not been recognized, it might be noted that *Turbonilla (Turbonilla)* sp. of Janssen (1984, p. 382, pl. 17, fig. 3a, b), from the Breda Formation, Aalten Member, Miste Bed, upper Burdigalian-Langhian, upper Lower to lower Middle Miocene of Winterswijk, Miste, The Netherlands, which we would assign to *Chemnitzia*, is rather similar in shape and appearance to *C. macsotayi*, but differs in having more numerous axial ribs, (18 vs. 14), the ribs thicker,

the grooves between proportionately narrower, and in lacking the thickened abapertural edge of the whorls. Janssen compared his species with *Turbonilla gastaldi* Semper, 1861 “auct.” Semper (1861, p. 406-407) gave dimensions for his species of length 17 mm, width 4.5 mm, a much larger shell.

*Etymology* – Named after Oliver Macsotay, Venezuelan geologist and fieldwork companion to the senior author, in recognition of his contributions to Venezuelan geology and palaeontology. *Chemnitzia* gender feminine.

#### Genus *Turbonilla* Risso, 1826

- 1826 *Turbonilla* Risso, p. 224. Type species (by subsequent designation, Herrmannsen, 1852, p. 136): *Turbonilla costulata* Risso, 1826, Pleistocene, Mediterranean France.

*Note* – *Turbonilla costulata* Risso, 1826, type species of *Turbonilla*, has been confused in the literature with *T. campanellae* (Philippi, 1836), type species of *Chemnitzia* d’Orbigny, 1840, *Turbonilla elegantissima* (Montagu, 1803), and *T. lactea* (Linnaeus, 1758). Monterosato (1884, p. 91) doubtfully synonymised *T. costulata* with *T. elegantissima*. Kobelt (1903, p. 139) doubtfully synonymized it with *T. lactea* (Linnaeus, 1758). Thiele (1929, p. 237) and Wenz (1940, p. 869) both erroneously stated that *T. lactea* was type species of *Turbonilla* without mention of *T. costulata*. Arnaud (1978, p. 113) in his review of Risso’s species, directly synonymized *T. costulata* with *T. lactea*, possibly due to the tiny figure he provided (pl. 11, fig. 205), supposedly of *T. costulata*, but apparently a juvenile of *T. lactea*. It does not resemble Risso’s type figure and was obviously drawn from a different shell. Van Aartsen (1981, p. 75) synonymized *T. elegantissima*, and *T. campanellae* with *T. lactea*. *Turbonilla costulata* is known only from Risso’s original figure (pl. 5, fig. 72) and terse description. Arnaud (1978) reported the type specimen presumed lost. Risso’s figure shows a high spired conical shell of eight somewhat inflated whorls, with no spiral sculpture, axial ribs widely spaced, about twelve on the penultimate whorl, that cross the periphery and extend to the umbilical region, height 7 mm. *T. lactea* is well known and widely illustrated. It is readily distinguished from *T. costulata* by its axial ribs, or rather the grooves between the ribs, terminating abruptly at the periphery, the ribs being the same height as the smooth basal disk. Peñas & Rolán (2010, p. 40) noted this, writing “Risso’s figure ... clearly represents ribs reaching the aperture whereas *T. lactea* have ribs interrupted at the periphery.” Perhaps with both Thiele and Wenz having *T. lactea* as type of *Turbonilla*, subsequent authors assumed Risso’s figure to be defective, though another Risso figure, that of *T. plicatula* Risso, 1826 (pl. 5, fig. 70), is very similar, perhaps conspecific, and also shows the axials continuing onto the base. Dall & Bartsch (1903, p. 269) erroneously selected this species as type of *Turbonilla*, renaming it *T. typica* Dall & Bartsch, 1903, but this had little effect as

the two species are very similar. Several authors, including Dall & Bartsch (1904, 1909, etc.), Laws (1937a, b), Laseron (1959), and Beu & Maxwell (1990), have found this distinction, whether the axial ribs terminate abruptly at the periphery, or not, significant and use *Turbonilla* and *Chemnitzia* as distinct subgenera in the case of Dall & Bartsch, or genera, as do we.

Species in this group are characterised by having the axial ribs and grooves fading away at or below the periphery or continuing onto the base, whilst in *Chemnitzia*, the axial grooves terminate abruptly at the periphery, the termination squared off or U shaped, the smooth base starts at the abapical end of the axial ribs (see *Chemnitzia macsotayi* nov. sp. above). Both *Turbonilla* and *Chemnitzia* lack spiral sculpture. The only Caribbean species we attribute to *Turbonilla* is the middle Oligocene *Turbonilla plastica* Guppy in Guppy & Dall, 1896. There are five nominal Panamic Pacific species. Therefore *Turbonilla* should be added to the list paciphile genera.

#### *Turbonilla paraganensis* nov. sp.

Plate 4, figs 2-4

*Type material* – Holotype NMB H19121; paratype 1 NMB H19122; paratype 2 NMB H20635, NMB locality 17516. South of Casa Cantaure, Paraganá Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – NMB H19119 (24), NMB locality 17516.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell tall, slender, with rounded apex. Protoconch umboniform, thick, flat spired, of 2.5 whorls, diameter similar to first teleoconch whorl, in which it is one third immersed, diameter about 280 µm. Teleoconch of up to eight weakly convex whorls, with accentuated convexity in the anterior half, above the suture. Suture impressed. Axial ribs elevated, orthocone, straight, slender, about 15 per whorl; summits of the ribs slightly projected over adapical suture. Interspaces about twice width of ribs, ribs fading out at periphery without terminal band, often continuing faintly onto base. Spiral sculpture absent. Base rounded. Aperture rhomboid, well rounded anteriorly. Columella bearing a weak fold a short distance within the aperture. Outer lip thin, slightly flared anteriorly. Umbilicus imperforate.

*Dimensions* – Holotype: height 3.6 mm; paratype 1, height 2.6 mm; paratype 2, height 3.0 mm.

*Differentiation* – *Turbonilla paraganensis* nov. sp. differs from *Turbonilla plastica* Guppy in Guppy & Dall, 1896 in having a larger protoconch, the axial ribs are thinner and more sharply defined, in lacking microscopic striations in the interspaces, and the aperture is rhomboid rather than ovate. In the present-day Panamic

Pacific several *Turbonilla* species occur. *Turbonilla prolongata* (Carpenter, 1857) differs in the spire of the protoconch being moderately elevated, the axial ribs on the teleoconch continuing to the umbilical region, and the aperture oval with a slight umbilical chink. *Turbonilla ima* Dall & Bartsch, 1909, differs in being considerably larger with more numerous axial ribs continuing further onto the base. *Turbonilla lucana* Dall & Bartsch, 1909, is broader with far more numerous close-packed axials extending onto the base. Further north, off the present-day coast of California, *T. diegensis* Dall & Bartsch, 1909 and *T. acra* Dall & Bartsch, 1909 have ribs that persist onto the base.

*Turbonilla paraguayensis* differs from all other Caribbean fossil and present-day turbonillids in having the axial grooves between the ribs fading away at the periphery, as opposed to terminating abruptly at the periphery. We consider this a diagnostic character of the genus *Turbonilla* (see above under generic note). All other Caribbean fossil and Recent species with abruptly terminating grooves we place in the genus *Chemnitzia*. *Chemnitzia macsotayi* described above not only differs in the character of the grooves, but has a helicoid protoconch with moderately elevated apex rather than an umboniiform protoconch with a flat spire, and its ribs are orthocone rather than opisthocline.

Several of the '*Turbonilla*' species from the Neogene Dominican Republic have similarly slender shells. All have abruptly terminating axial grooves and therefore placed in the genus *Chemnitzia*. *Chemnitzia insititia* (Pilsbry & Johnson, 1917), *C. pertenuis* (Gabb, 1873) and *C. undecimcostata* (Pilsbry & Johnson, 1917) all have fewer axial ribs than *Turbonilla paraguayensis*, which are broader in *C. undecimcostata*. *Chemnitzia contexta* (Pilsbry & Johnson, 1917) is very similar in the character of the axial sculpture, but has microscopic spiral sculpture, not seen in the Cantaure species.

*Remarks* – Specimens of *Turbonilla paraguayensis* are somewhat variable in width, the paratypes proportionately broader than the holotype, the width varying from 21% to 29% of height. Although it is premature to draw any strong conclusions based on our very rudimentary knowledge of the Caribbean Neogene turbonillids, *Turbonilla paraguayensis* seems to be more similar to *T. diegensis* Dall & Bartsch, 1909, from San Diego, California, from which it differs in being smaller, with narrower axial ribs that do not extend to the umbilical region, than it is to any described tropical American fossil or present-day species.

*Etymology* – Named after the Paraguaná Peninsula, locality of the Cantaure assemblage. *Turbonilla* gender feminine.

#### Genus *Pyrgiscus* Philippi, 1841

- 1841 *Pyrgiscus* Philippi, p. 50. Type species (by subsequent designation, Dall & Bartsch in Arnold,

1903): *Melania rufa* Philippi, 1836, Recent, Mediterranean.

- 1841 *Ortostelis* Aradas & Maggiore, p. 27. Type species (by subsequent designation, Dall & Bartsch, 1909, p. 74): *Melania rufa* Philippi, 1836, Recent, Mediterranean; an objective synonym of *Pyrgiscus*. Priority of *Pyrgiscus* over *Ortostelis* established by first reviser, Dall & Bartsch, 1907, p. 504).
- 1884 *Pyrgostelis* Monterosato, p. 89. Type species (by subsequent designation, Crosse, 1885): *Melania rufa* Philippi, 1836, Recent, Mediterranean; an objective synonym of *Pyrgiscus*.

*Remarks* – *Ortostelis* Aradas & Maggiore, 1841 has the same type species and same year of publication as *Pyrgiscus* Philippi, 1841. Determined efforts to establish a specific date of publication for Philippi, 1841 by A. Kabat (pers. comm. October, 2014 [PIL]) and for Aradas & Maggiore, 1841, by the junior author were unsuccessful. Both works must therefore be considered to have been published on December 31, 1841. Priority must therefore be established by application of the Principle of the First Reviser (ICZN Art. 24.2). The first authors to use one name as valid and the other as its synonym were Dall & Bartsch (1907, p. 504), with *Pyrgiscus* as the valid name, and *Ortostelis* as junior synonym.

*Note* – Because of uncertainties as to the taxonomic significance of the various characters used to assign high spired turbonillids with axial ribs and spiral grooves to the various available generic names, we have chosen to use *Pyrgiscus*, the earliest available name for this group of turbonillids, for the Cantaure species that share these characters. We characterize *Pyrgiscus* as having a protoconch that is helicoid or umboniiform, its axis at or near right angles to the teleoconch and little imbedded in it, teleoconch high spired, multispiral, whorls little to moderately inflated, with sculpture of axial ribs and weaker spiral grooves. The sculpture may continue weakly onto the base.

#### *Pyrgiscus silvai* nov. sp.

Plate 6, figs 3, 4

*Type material* – Holotype NMB H20636; paratype 1 NMB H20637, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – NMB (1 incomplete), NMB locality 17516.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell small, slender. Protoconch umboniiform, flat spired, about 2 whorled, at right angles to the teleoconch, in which it is barely emersed, diameter

about 180  $\mu\text{m}$ . Teleoconch of 4.5 weakly convex whorls, with accentuated convexity mid-whorl, below suture. Suture impressed, indented by ribs projection. Axial ribs close-set, about 30 on penultimate whorl, slightly wider than interspaces, straight or slightly sinuous, orthocone. Interspaces sculptured by microscopic axial striae. Spiral sculpture formed by about eight rows of shallow grooves along interspaces. Base rounded, with evanescent ribs and very thin spiral furrows. Aperture pyriform tending to rhomboid. Columella obliquely straight, with very obsolete fold. Outer lip thin. Umbilicus imperforate.

*Dimensions* – Holotype: height 2.4 mm; paratype 1, height 2.8 mm.

*Differentiation* – Within the generic description, *Pyrgiscus silvai* nov. sp. is characterised by its tall whorls (height 85% of width), relatively broad, close-set axial ribs, about 30 on penultimate whorl and elongate last whorl. The only vaguely similar fossil species is *Odosotomia* (*Parthenina*?) *cyclocephala* Pilsbry & Johnson, 1917 (for figure see Pilsbry 1922, pl. 36, fig. 14) from the Neogene of the Dominican Republic, which differs in having the axial ribs narrower than the interspaces and far more numerous and closer-set spiral grooves in the interspaces. The base is also more strongly constricted. The tall whorls seen in *P. silvae* separate it from the numerous *Pyrgiscus* species described by Bartsch (1955) from the Plio/Pleistocene of Florida.

The tall rounded whorls in the Cantaure species again separate it from the many *Pyrgiscus* species described by Dall & Bartsch (1909) from the present-day Panamic Pacific. The most similar is possibly *P. cervalva* Dall & Bartsch, 1909, but this species has even more axial ribs (36–40) and the adapical portion of the spire whorls and base are more convex.

*Etymology* – Named after Carlos Marques da Silva, palaeontologist at the University of Lisbon and long-time friend and collaborator with the senior author. *Pyrgiscus* gender masculine.

***Pyrgiscus caribbaeus* nov. sp.**

Plate 5, figs 3, 4, Plate 6, figs 1, 2

*Type material* – Holotype NMB H20638; paratype 1 NMB H20639; paratype 2 NMB H20640, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – Maximum height 5.0 mm. NMB (30), NMB locality 17516.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell tall, broad, conical. Protoconch helioid, spire moderately elevated, suture prominent, about

2.5 whorls, inclined at right angles to the teleoconch, above which the apex overhangs, diameter about 440  $\mu\text{m}$ . Teleoconch of up to six convex whorls, with accentuated convexity in the anterior half, above the suture. Suture impressed. Axial ribs elevated, orthocone, straight, very slender, about 14 per whorl; summits of the ribs ending at suture. One or two ribs varicose on later adult whorls. Interspaces much broader than ribs, ending at abapical suture, bearing nine incised spiral grooves on spire whorls, which run over the axial ribs. Last whorl squat, roundly angled at base. Base depressed, smooth. Aperture rhomboid, well rounded anteriorly. Outer lip thin, slightly angled abapically, bearing four strong lirae internally (Pl. 6, fig. 1). Columella bearing strong fold at about one-third height. Umbilicus imperforate.

*Dimensions* – Holotype: height 3.8 mm; paratype 1, height 4.1 mm; paratype 2, height 3.7 mm.

*Differentiation* – The presence of lirae within the outer lip suggests comparison with species assigned to *Mormula* A. Adams, 1863 (where we had provisionally considered placing it, but see remarks below). As far as we are aware, this is the first reported Caribbean Neogene species with lirae. There is only one species recorded for the present-day Western Atlantic: *Turbonilla* (*Mormula*) *anira* Bartsch in Dall, 1927. We have not seen this species, but there is no mention of lirae within the outer lip in the original description.

Several species of *Mormula* were described by Bartsch (1955) from the Plio/Pleistocene of Florida. Of these the most similar to *Pyrgiscus caribbaeus* nov. sp. are *M. woodringi* Bartsch, 1955, which differs in having flatter spire whorls and closer-set, more irregular grooves in the interspaces between the axial ribs, and *M. palmerae* Bartsch, 1955 which has more numerous axial ribs and a less depressed base.

*Mormula* is well represented in the Recent Panamic Pacific, however, none of the species described and figured by Dall & Bartsch (1909) have the axial ribs as widely spaced as the Cantaure species.

*Remarks* – We [PIL] have observed that the presence of lirations or nodes within the outer lip of turbonillids is an inconsistent character, often present in only a small percentage of specimens in a sample, or present in one sample, but not in another, that are otherwise indistinguishable. As the character seems variable within a species, its utility for generic distinction seems dubious, unless present in combination with other diagnostic features. Robba (2013, p. 7) provided a useful discussion. Dall & Bartsch (1909) included lirations of the outer lip in their characterisation of the subgenus *Mormula* A. Adams, 1863 (type species *Mormula rissoina* A. Adams, 1863, by subsequent designation, Verrill & Bush, 1900). As a result, a number of turbonillids with this character have been placed in *Mormula* by them and subsequent authors. Habe *et al.* (2001, p. 135) published a figure of the type of *Mormula rissoina*, however, which shows a thickened lip without obvious lirations within, and a small appar-



ently intorted protoconch. Adams' (1863) descriptions of *Mormula* and *M. rissoina* do not mention lirations. We know of no New World pyramidellids congeneric with *M. rissoina*. New World species described as *Mormula* are in need of reassignment.

*Etymology* – Named after the Caribbean Sea, in which it lived. *Pyrgiscus* gender masculine.

#### ***Pyrgiscus* sp. A**

Plate 4, fig. 5

*Cantaure material examined* – Maximum height 3.5 mm. NMB H20641 (1), + 31 unnumbered specimens, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell tall, slender, aciculate. Protoconch helicoid, bulbous, low spired, 2.5 whorls, at right angles and barely immersed in the teleoconch. Teleoconch of up to eight very weakly convex whorls, with accentuated convexity in the anterior half, above the suture. Suture impressed. Axial ribs elevated, orthocone, straight, slender, about 16 per whorl; summits of the ribs slightly projected over adapical suture. Interspaces 2-3 times width of ribs, ending at abapical suture, bearing five incised spiral grooves on spire whorls, the raised areas formed by the spiral grooves are in turn crossed by microscopic irregular axial threads (pl. 4, fig. 5c). Base rounded, smooth. Aperture rhomboid, well rounded anteriorly. Columella bearing weak, oblique fold. Outer lip damaged. Umbilicus imperforate.

*Remarks* – See below.

#### ***Pyrgiscus* sp. B**

Plate 5, figs 1, 2

*Cantaure material examined* – Maximum height 3.7 mm. NMB H20642 (1), NMB H20643(1), NMB H20644 (1), + 18 unnumbered specimens, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell tall, slender, aciculate. Protoconch helicoid, bulbous, flat spired, inclined about 80° to the teleoconch axis, in which it is about one fourth emersed, diameter about 200 μm. Teleoconch of up to seven weakly convex whorls, with slightly accentuated convexity in the anterior half, above the suture. Suture impressed.

Axial ribs elevated, orthocone, straight, slender, about 18-19 per whorl; summits of the ribs slightly projected over adapical suture. Interspaces 3-4 times width of ribs, ending at abapical suture, bearing 12 incised spiral grooves on spire whorls, the raised areas between the spiral grooves are in turn crossed by microscopic axial threads, about 6-8 between each axial rib (pl. 5, fig. 1e). Base rounded, smooth. Aperture rhomboid, well rounded anteriorly. Columella bearing weak fold. Outer lip damaged. Umbilicus imperforate.

*Remarks* – We have provisionally separated *Pyrgiscus* sp. B from *Pyrgiscus* sp. A on the basis of having a slightly less pointed spire, in having slightly more axial ribs (18-19 vs. 16), and having more numerous spiral grooves in the interspaces between the axial ribs (12 vs. 5): If one examines the plates illustrated by Bartsch (1955, pl. 4-9) dealing with turbonillids from the Plio/Pleistocene of Florida and the key on page 37, one would deduce that the number and pattern of spiral grooves between the axial ribs was species specific. However, this is cast into doubt by plates 10-14 of the same publication that show a staggering variability in the number and disposition of these grooves in a single species: *Striopyrgus hybridus* Bartsch, 1955. Why this feature should be species specific for all but one species is unclear.

Several fossil species need to be compared to the Cantaure shells. Both *P. beatulus* (Pilsbry & Johnson, 1917) and *P. santodomingensis* (Pilsbry & Johnson, 1917) from the Dominican Neogene have similar sculpture, however, both have spiral grooves on the base, not seen in the Cantaure shells. Many of the forms illustrated by Bartsch (1955) are also similar. However, most of the Floridian specimens lack their protoconch.

Also in the present-day many similar species have been described from the tropical American Atlantic and Pacific faunas. We do not feel that with the present knowledge specific identification is possible.

Tribe Eulimellini Saurin, 1958

Genus *Eulimella* Forbes & MacAndrew, 1846

- 1846 *Eulimella* Forbes & MacAndrew, p. 1027. Type species (by original designation): *Eulima macandrei* Forbes, 1844 (= *Melania scillae* Scacchi, 1835), Recent, Europe.
- 1861 *Aciculina* Deshayes, p. 530. Type species (by typification of replacement name [ICZN art. 79.2.3] *Belonidium* Cossmann, 1893): *Aciculina gracilis* Deshayes, 1861, Eocene, France.
- 1880 *Anisocycla* Monterosato, p. 72. Type species (by monotypy): *Odostomia ventricosa* Forbes, 1844, Recent, Aegean Sea (see discussion by Warén, 2013, p. 3).
- 1893 *Belonidium* Cossmann, p. 350. Type species (by original designation): *Aciculina gracilis* Deshayes, 1861, Eocene, France. *Nom. nov. pro Aciculina* Deshayes, 1861, *non* A. Adams, 1853 (Gastropoda: Nassariidae).

- 1959 *Instarella*, Laseron, p. 249, figs 211, 212. Type species (by original designation): *Instarella subcarina* Laseron, 1959, present-day, Northern Territory, Australia.
- 1959 *Zonella*, Laseron, p. 248, figs 208, 209. Type species (by original designation): *Odostomia amoebaea* Watson, 1886, present-day, Queensland, Australia.

*Note* – Dall & Bartsch (1904, p. 5; 1909, p. 10), in their keys, have ‘Columellar folds two’ as a distinguishing character of *Eulimella*. Perhaps this is due to their having the wrong type species: ‘*Eulimella crassula* Fbs. [presumably an error for *Eulima crassula* Jeffreys, 1839, a *nomen nudum*] = *E. scillae* Scacchi [*Melania scillae* Scacchi, 1836]’. *Eulimella macandrei* (Forbes, 1844) does not have columellar folds. Forbes does not mention them, and they are not in his figure. *Eulimella scillae* is traditionally cited as a senior synonym of *E. macandrei*, although Forbes (1844) compared *macandrei* to *Eulima scillae* and commented that his shell had ‘much narrower whorls’. The two appear to be quite similar, so their synonymy has no effect on the identity of *Eulimella*.

***Eulimella dianae* nov. sp.**

Plate 6, figs 5, 6

*Type material* – Holotype NMB H20645; paratype 1 NMB H18936, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – NMB unnumbered (9), same locality.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell minute, very elongate-turritid. Protoconch helicoid, flat spired, about 1.5 whorls, at right angles to the teleoconch in which it is about one fourth immersed, the apex fully visible. Teleoconch broken, six apical whorls remaining, whorls smooth except for indistinct lines of growth, flat-sided to very slightly concave adapically, with strong, smoothly rounded periphery placed one third height above abapical suture, tapering to suture. Suture smooth, sharply defined, slightly angulated. Last whorl rounded at periphery; base rounded. Aperture [described from paratype] subquadrate, outer lip simple, evenly rounded, thin, columella smooth, straight, umbilicus imperforate.

*Dimensions* – Holotype: height 2.1 mm; paratype 1: height 2.7 mm.

*Remarks* – The holotype was selected for having a complete apex and protoconch, though judging from the thickness of the broken outer lip, it has lost several whorls. The paratype is larger, has a nearly complete ap-

erture, and is better preserved, but has lost several apical whorls. Estimating from the holotype and paratype, a complete specimen would have ten or more whorls, and be over 4 mm in height. We place the species in *Eulimella* Forbes & MacAndrew, 1846 based on the shape of the protoconch, smooth shell, and subquadrate aperture. Only one fossil species has been described from the tropical American Atlantic: *E. tampaensis* Bartsch, 1955 (pl. 2, fig. 1) from the Plio/Pleistocene of Florida, which differs from the Cantaure shells in having more evenly convex whorls, a more constricted suture, and two distinct folds on the columella. Bartsch’s specimens were decolate. The only present-day species we can find living in the Caribbean biogeographical province is *E. simplex* (d’Orbigny, 1841), which differs in having a broader shell, more convex whorls and deeper sutures. Further species congeners occur north and south of the Caribbean. The only *Eulimella* reported from the eastern Pacific is *E. lomana* (Dall, 1908), from abyssal depths in southern California and the Gulf of California. Provisionally placed in *Eulimella* by Warén & Bouchet (1993, p. 55-56), this 20 mm tall conical shell does not resemble *E. dianae*. *Instarella subcarina* Laseron, 1959, from Northern Australia, generally resembles *E. dianae*, but is larger (7.8 mm), the protoconch has an elevated apex, and the periphery is angulated rather than rounded.

*Etymology* – Named for Diane Jovee, life partner to the junior author, who cheerfully endures his eccentricities and obsessions, tends to his sanity, and picks micromolluscs from endless bags of sand, on the occasion of her 66<sup>th</sup> birthday. *Eulimella* gender feminine.

Family Amalthinidae Ponder, 1987

Genus *Iselica* Dall, 1918

- 1854 *Isapis* H. Adams & A. Adams, p. 320. Type species (by monotypy): *Narica anomala* C.B. Adams, 1850, Recent, Jamaica. Junior homonym of *Isapis* Doubleday, 1847 [Lepidoptera].
- 1918 *Iselica* Dall, p. 137. Type species (by typification of replaced name): *Narica anomala* C.B. Adams, 1850, Recent, Jamaica. Replacement name for *Isapis* H. Adams & A. Adams, 1854, not Doubleday, 1847 [Lepidoptera].

***Iselica globosa* (Lea, 1843)**

Plate 7, figs 2, 3

[See bibliographic discussion under *Longchaeus suturalis* (Lea, 1843)].

- 1843a *Actaeon globosus* Lea, p. 164 [*nomen nudum*].
- 1843b *Actaeon globosus* Lea, p. 7.
- 1845 *Actaeon globosus* Lea, p. 29, pl. 36, fig. 55.
- 1846 *Actaeon globosus* Lea, p. 255, pl. 36, fig. 55.
- 1850 *Narica* (?) *anomala* C.B. Adams, p. 109.
- 1858 *Dolium octocostatum* Emmons, p. 258, fig. 129a.
- 1890 *Isapis caloosaensis* Dall, p. 187, pl. 9, fig. 10.

- 1930 *Fossarus (Isapis) anomala floridana* Mansfield, p. 112, pl. 15, fig. 6.
- 1961 *Iselica anomala* C.B. Adams, 1850 [*sic*] – Warmke & Abbott, p. 85, pl. 15, fig. e.
- 1974 *Iselica anomala* (C.B. Adams, 1850) – Abbott, p. 136, fig. 1502.
- 1993 *Iselica globosa* (H.C. Lea, 1843) – Campbell, p. 69, fig. 332.
- 2005 *Iselica anomala* (C.B. Adams, 1850) – Rolán & Fernández-Garcés, p. 221, figs 1-3.
- 2009 *Isellica [sic] anomala* (C.B. Adams, 1850) – Rios, p. 387, fig. 1046.
- 2011 *Iselica anomala* (C.B. Adams, 1850) – Daccarett & Bossio, p. 148, fig. 977.

*Type material* – not known.

*Cantaure material examined* – Maximum height 2.0 mm. NMB H20648 (7 fragments), NMB H20646-H20647 (2), NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper). Upper Pliocene: Yorktown Formation, Virginia, USA (Campbell, 1993); Florida (Mansfield, 1930). Recent, eastern Florida to Brazil (Abbott, 1974).

*Remarks* – We cannot separate the Cantaure shells from the very characteristic *Iselica globosa* (Lea, 1843) [= *Narica* (?) *anomala* C.B. Adams, 1850; = *Dolium octocostatum* Emmons, 1858; = *Isapis caloosaensis* Dall, 1890] from the Recent Caribbean and Plio/Pleistocene of Florida. The relative strength of the axial and spiral sculpture is somewhat variable, as illustrated by the two Cantaure specimens figured and most specimens have eight spiral cords on the last whorl, although one of the Cantaure shells only has seven (Plate 7, fig. 2).

The genus is represented in the Recent Panamic Pacific by a similar species, *Iselica ovoidea* (Gould, 1853) [= *Fossarus (Isapis) maculosa* Carpenter, 1857, = *Isapis fenestrata* Carpenter, 1864], which is also rather variable, but differs in being considerably larger (to 9 mm), generally having more numerous spiral cords and a wider umbilicus. *Iselica obtusa* (Carpenter, 1864) is also larger, has a higher profile, and more subdued spiral sculpture. Another species from the Recent Pacific American coast, *Iselica kochi* Strong & Hertlein, 1939, probably a juvenile of two whorls, is distinguished by its heavier cords, more inflated whorls, and broader aperture. Members of this genus have been reported as parasites on large bivalves such as *Pinna* and *Pteria* (Rolán & Fernández-Garcés, 2005).

Two *Iselica* species were reported from the Lower Miocene Chipola Formation of Florida: *I. myttonis* (Maury, 1910), which is similar to *I. anomala* with eight spiral cords on the last whorl, but differs in being higher spired with a greater number of somewhat shouldered whorls.

According to Gardner (1947, p. 572) *I. myttonis* also has narrower spirals and less prominent axial lamellae, however, as illustrated above, the sculpture is variable. The second species, *I. psila* Gardner, 1947 is quite different, with far fewer and more subdued spiral cords which do not crenulate the edge of the outer lip, and a wider aperture. There is a further undescribed *Iselica* species from the Lower Miocene Baitoa Formation of the Dominican Republic (NHMW coll.), which is tall-spined and has numerous whorls, like *I. myttonis*, but differs from it in having rounded rather than shouldered whorls, with ten spiral cords on the last whorl.

***Iselica belliata* nov. sp.**

Plate 8, figs 1-3

*Type material* – Holotype NMB H20649; paratype 1 NMB H20650; paratype 2 NMB H20651, NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Other material* – Maximum height 2.4 mm. NMB H20652 (20), same locality.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Description* – Shell small, elongate-ovate, with relatively tall spire. Protoconch obliquely intorted, final whorl visible above the first teleoconch whorl, diameter about 270 µm. Teleoconch of 3.5 convex whorls, with periphery at abapical suture. Suture linear, strongly impressed. Sculpture of six flattened spiral cords on spire whorls, separated by narrow grooves crossed by axial riblets, giving the grooves a finely punctate appearance. Last whorl inflated, evenly convex, bearing six spiral cords between the suture and the insertion of the outer lip, six cords on the base; cords of somewhat variable width. Aperture ovate, widening abapically; outer lip simple, rounded, flared abapically. Columella thickened, slightly raised, forming medial border of umbilical chink, bearing weak central fold. Umbilical chink relatively wide.

*Dimensions* – Holotype: 2.4 mm, width 1.5 mm; paratype 1: height 2.7 mm, width 1.2 mm; paratype 2: height 1.8 mm.

*Differentiation* – *Iselica belliata* nov. sp. is unlike any *Iselica* of which we are aware, but differs only by degree. Characters it shares with other *Iselica* species include an intorted protoconch, much like *I. globosa*, broad sturdy shell, spiral grooves divided by short axial riblets, and in the shape of the aperture, columella, and umbilicus. It differs from other *Iselica* species in its higher spire and relatively broad flat cords separated by narrow grooves. It resembles some specimens of the rather variable Pacific coast *Iselica obtusa* (Carpenter, 1864) in its high profile and subdued sculpture, but *I. obtusa* is much larger (to

8 mm), has narrower cords and wider interspaces.

*Remarks* – Though we consider *I. belliata* to be an *Iselica* species, it seems not to be closely akin to any known Caribbean or eastern Pacific fossil or living congeners. We know of no other genus that would better receive it.

*Etymology* – Latin ‘belliatus’, adjective, meaning very nice, pretty, reflecting attractive sculpture. *Menestho* gender feminine.

Genus *Carinorbis* Conrad, 1862

1862 *Carinorbis* Conrad, p. 288. Type species (by subsequent designation, Campbell, 1993, p. 69): *Delphinula lyra* Conrad, 1834; Miocene, USA

*Note* – *Carinorbis* is distinguished from *Iselica* Dall, 1918 and the Indo-Pacific *Leucotina* A. Adams, 1860 by its very low spire and flaring aperture.

#### *Carinorbis* sp.

Plate 7, figs 4, 5

*Cantaure material examined* – Maximum height 2.0 mm. NMB H19110 (1), NMB H20653 (1), NMB H20654 (1), NMB locality 17516. South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

*Distribution* – Lower-Middle Miocene: Cantaure Formation, Venezuela (this paper).

*Remarks* – The genus *Carinorbis* Conrad, 1862 is characterised by shells with a deeply intorted protoconch and a teleoconch made up of one or two rapidly expanding whorls. Sculpture consists of strong spiral ribs or keels with prominent growth lamellae in the interspaces. Campbell (1993, p. 69) described the allometric growth pattern in the type species: *C. lyra* (Conrad, 1834) in which juveniles of 1-1.5 whorls were strikingly wider than high, whereas adults of 2-2.5 whorls were higher than wide.

We interpret these specimens from Cantaure as juveniles of a *Carinorbis* species, although we have not found any adult shells. Campbell (1993) also commented that whilst juvenile shells of *C. lyra* were quite abundant in the Pliocene of Virginia, adult specimens were extremely rare. The Cantaure specimens are unlikely to be conspecific with *C. lyra*, as this species has five spiral cords, whereas the Cantaure shells have six or seven.

#### Discussion

This work is the last specialist paper concentrating on a single group of gastropods from the upper Burdigalian-

lower Langhian, Lower-Middle Miocene Cantaure Formation assemblage of Venezuela. It will form part of the basis of a monograph on the entire gastropod assemblage, to be published shortly in the *Bulletins of American Paleontology*.

In this paper twenty-one species are recognised: 13 are described as new: *Brachystomia cantaurana* nov. sp., *Goniodostomia bicarinata* nov. sp., *Iolaea miocenica* nov. sp., *Chrysallida cantaurana* nov. sp., *Kleinella pumila* nov. sp., *Parthenina martae* nov. sp., *Ividella guppyi* nov. sp., *Chemnitzia macsotayi* nov. sp., *Turbonilla paraguayensis* nov. sp., *Pyrgiscus caribbaeus* nov. sp., *Pyrgiscus silvai* nov. sp., *Eulimella dianae* nov. sp. and *Iselica belliata* nov. sp., three are left in open nomenclature.

This work is only a first stepping-stone towards a greater understanding of the tropical American Neogene pyramidellids, as our present state of knowledge is rudimentary. Therefore, it is not possible to base any firm palaeobiogeographical conclusions on the assemblage at the present time. However, the assemblage is fairly typical at generic level to that of the tropical American Neogene today, with some species suggesting closer affinities with tropical American Pacific taxa.

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**Plate 1**

1. *Longchaeus olssoni* (Maury, 1917), NMB H20612, NMB locality 17516, height 4.4 mm.
2. *Longchaeus olssoni* (Maury, 1917), NMB H20613, NMB locality 17516, height 3.5 mm.
3. *Longchaeus suturalis* (Lea, 1843), NMB H20614, NMB locality 17516, height 4.5 mm.
4. *Longchaeus suturalis* (Lea, 1843), NMB H20615, NMB locality 17516, height 3.9 mm.
5. *Eulimastoma pyrgulopsis* (Pilsbry & Johnson, 1917), NMB H20617, NMB locality 17516, height 2.2 mm.
6. *Eulimastoma pyrgulopsis* (Pilsbry & Johnson, 1917), NMB H20618, NMB locality 17516, height 1.9 mm.
7. *Brachystomia cantaurana* nov. sp., holotype NMB H20619, NMB locality 17516, height 2.1 mm.
8. *Goniodostomia bicarinata* nov. sp., holotype NMH H20620, NMB locality 17516, height 1.4 mm.
9. *Iolaea miocenica* nov. sp., holotype NMB H20621, NMB locality 17516, height 1.2 mm.

All: South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

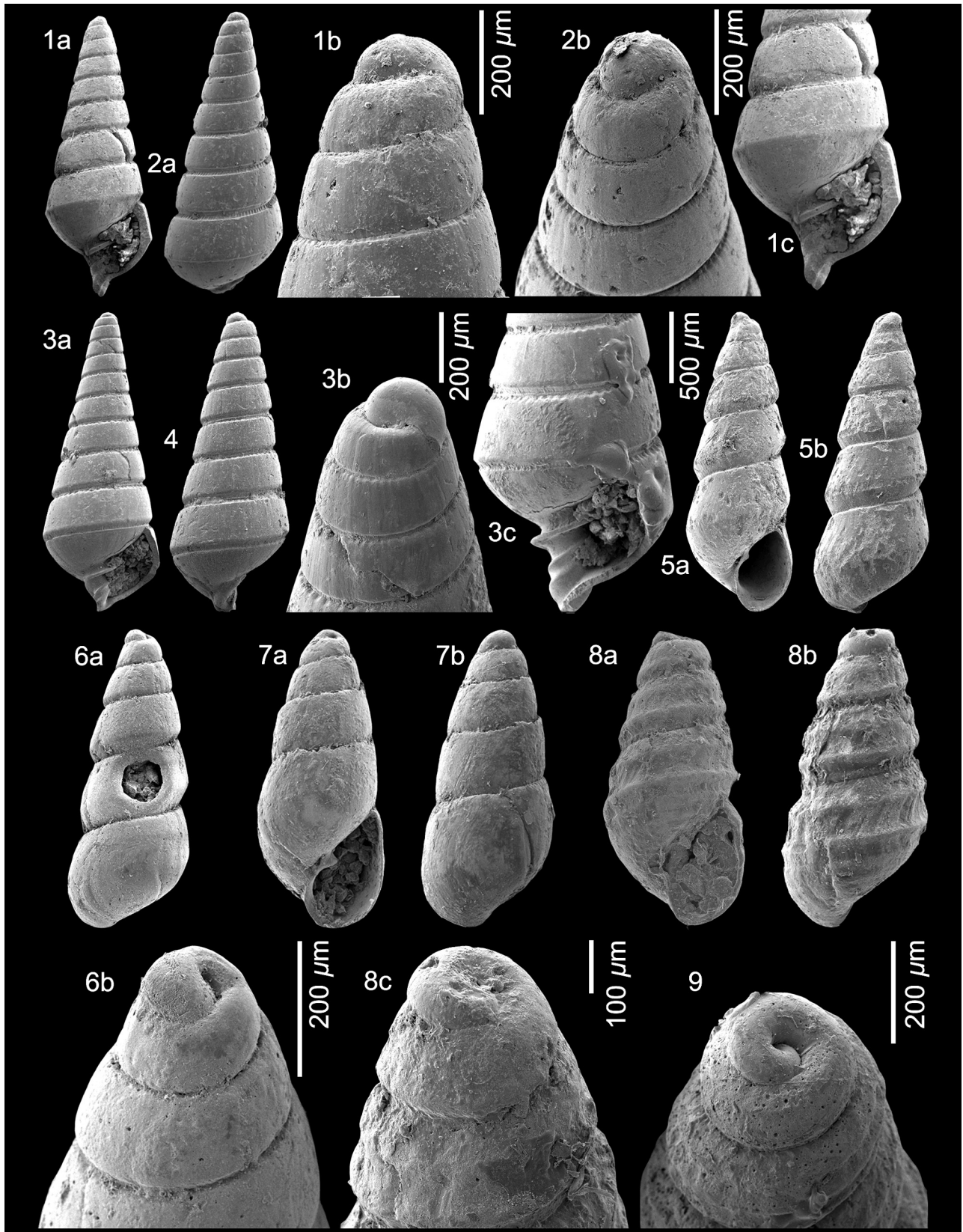


Plate 1

**Plate 2**

1. *Iolaea miocenica* nov. sp., holotype NMB H20621, NMB locality 17516, height 1.2 mm.
2. *Iolaea miocenica* nov. sp., paratype 1 NMB H20622, NMB locality 17516, height 1.5 mm.
3. *Chrysallida cantaurana* nov. sp., holotype NMB H20623, NMB locality 17516, height 2.6 mm.
4. *Chrysallida cantaurana* nov. sp., paratype 1 NMB H20624, NMB locality 17516, height 2.0 mm.
5. *Chrysallida cantaurana* nov. sp., paratype 2 NMB H20625, NMB locality 17516, height 2.6 mm.
6. *Kleinella pumila* nov. sp., holotype NMB H18931, NMB locality 17516, height 1.3 mm.
7. *Kleinella pumila* nov. sp., paratype 1 NMB HS193, NMB locality 17516, height 1.0 mm.

All: South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

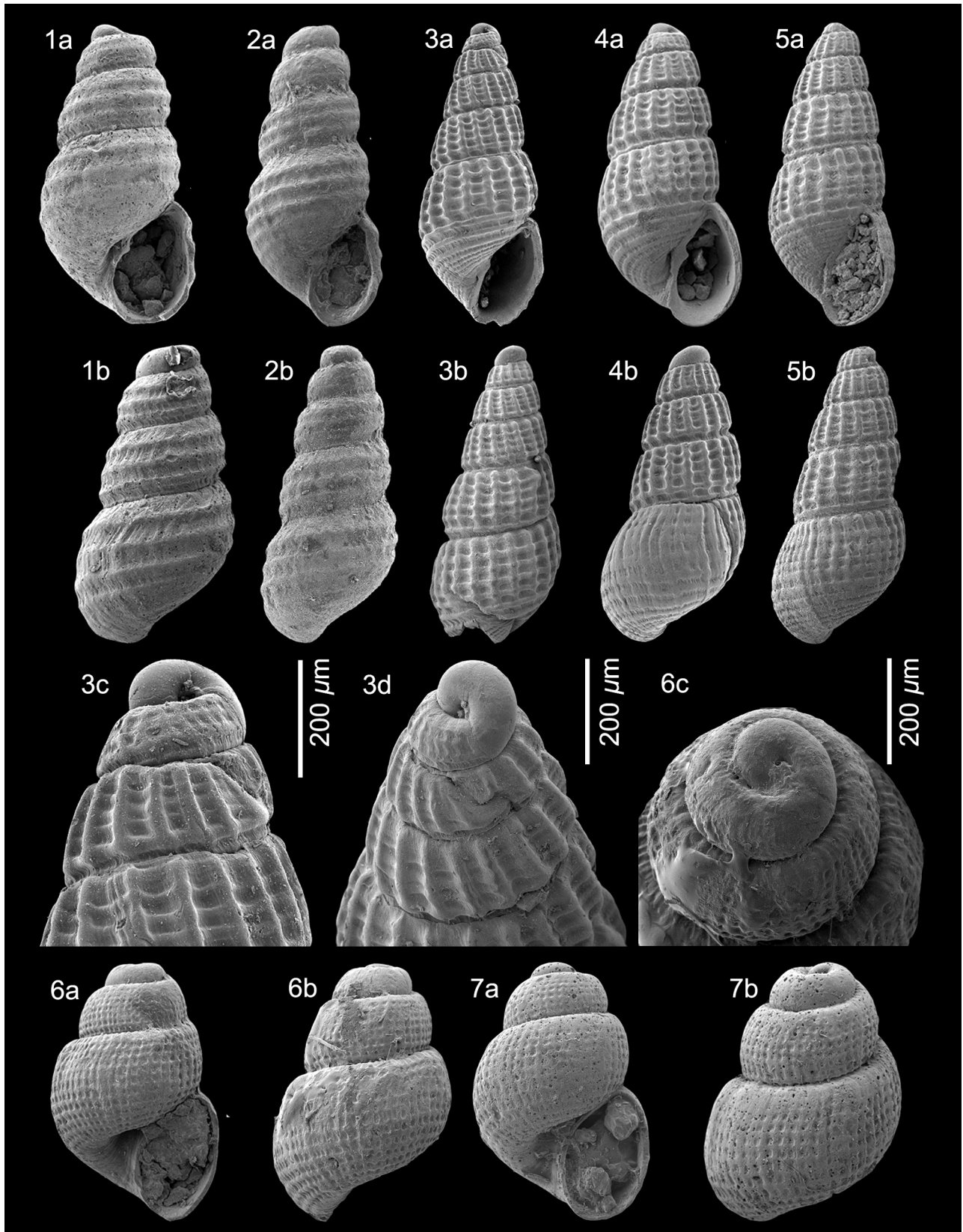


Plate 2

**Plate 3**

1. *Parthenina martae* nov. sp., holotype NMB H19116, NMB locality 17516, height 1.6 mm.
2. *Ividella guppyi* nov. sp., holotype NMB H20630, NMB locality 17516, height 2.1 mm.
3. *Ividia abbotti* (Olsson & McGinty, 1958), NMB H20629, NMB locality 17516, height 1.8 mm.
4. *Chemnitzia macsotayi* nov. sp., holotype NMB H20633, NMB locality 17516, height 3.4 mm.
5. *Chemnitzia macsotayi* nov. sp. paratype 1 NMB H20634, NMB locality 17516, height 3.6 mm.

All: South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.



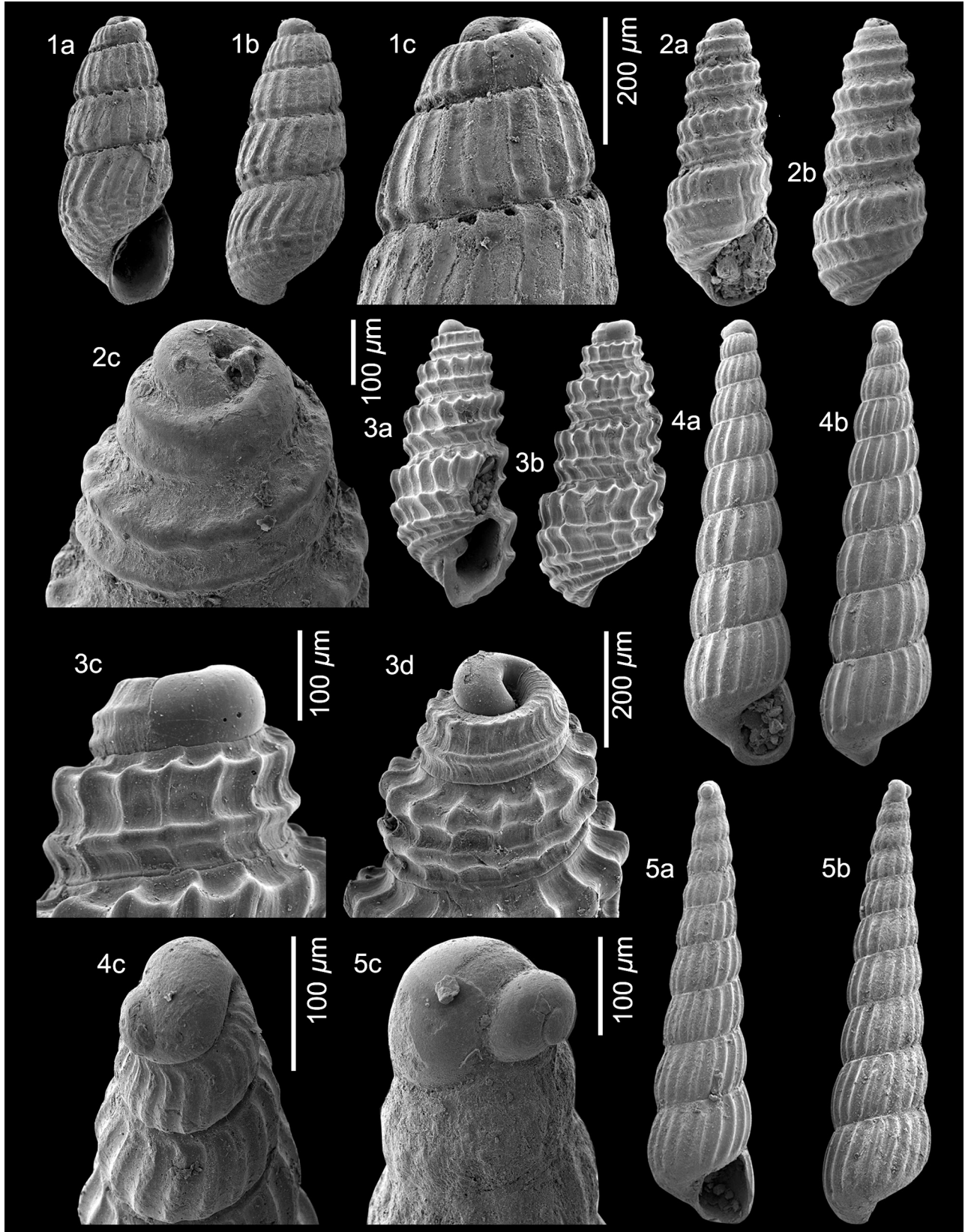


Plate 3

**Plate 4**

1. *Chemnitzia macsotayi* nov. sp., holotype. NMB H20633, NMB locality 17516, height 3.4 mm.
2. *Turbonilla paraganensis* nov. sp., holotype NMB H19121, NMB locality 17516, height 3.6 mm.
3. *Turbonilla paraganensis* nov. sp., paratype 1 NMB H19122, NMB locality 17516, height 2.6 mm.
4. *Turbonilla paraganensis* nov. sp., paratype 2 NMB H20635, NMB locality 17516, height 3.0 mm.
5. *Pyrgiscus* sp. A. NMB H20641, NMB locality 17516, height 3.5 mm.

All: South of Casa Cantaure, Paraganá Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

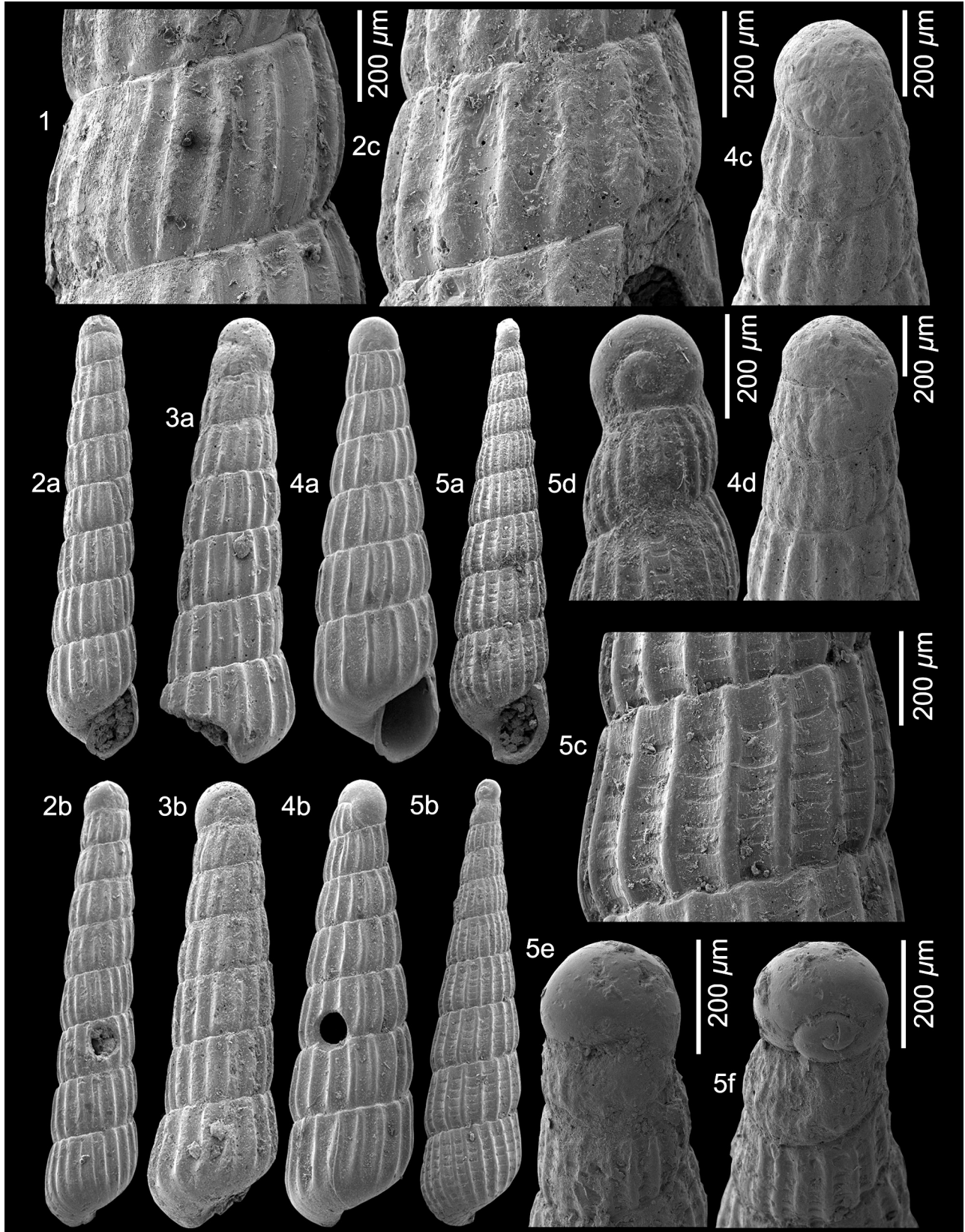


Plate 4

**Plate 5**

1. *Pyrgiscus* sp. B. NMB H20643, NMB locality 17516, height 3.7 mm.
2. *Pyrgiscus* sp. B. NMB H20644, NMB locality 17516, height 2.6 mm.
3. *Pyrgiscus caribbaeus* nov. sp., holotype NMB H20638, NMB locality 17516, height 3.8 mm.
4. *Pyrgiscus caribbaeus* nov. sp., paratype 1 NMB H20639, NMB locality 17516, height 4.1 mm.

All: South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

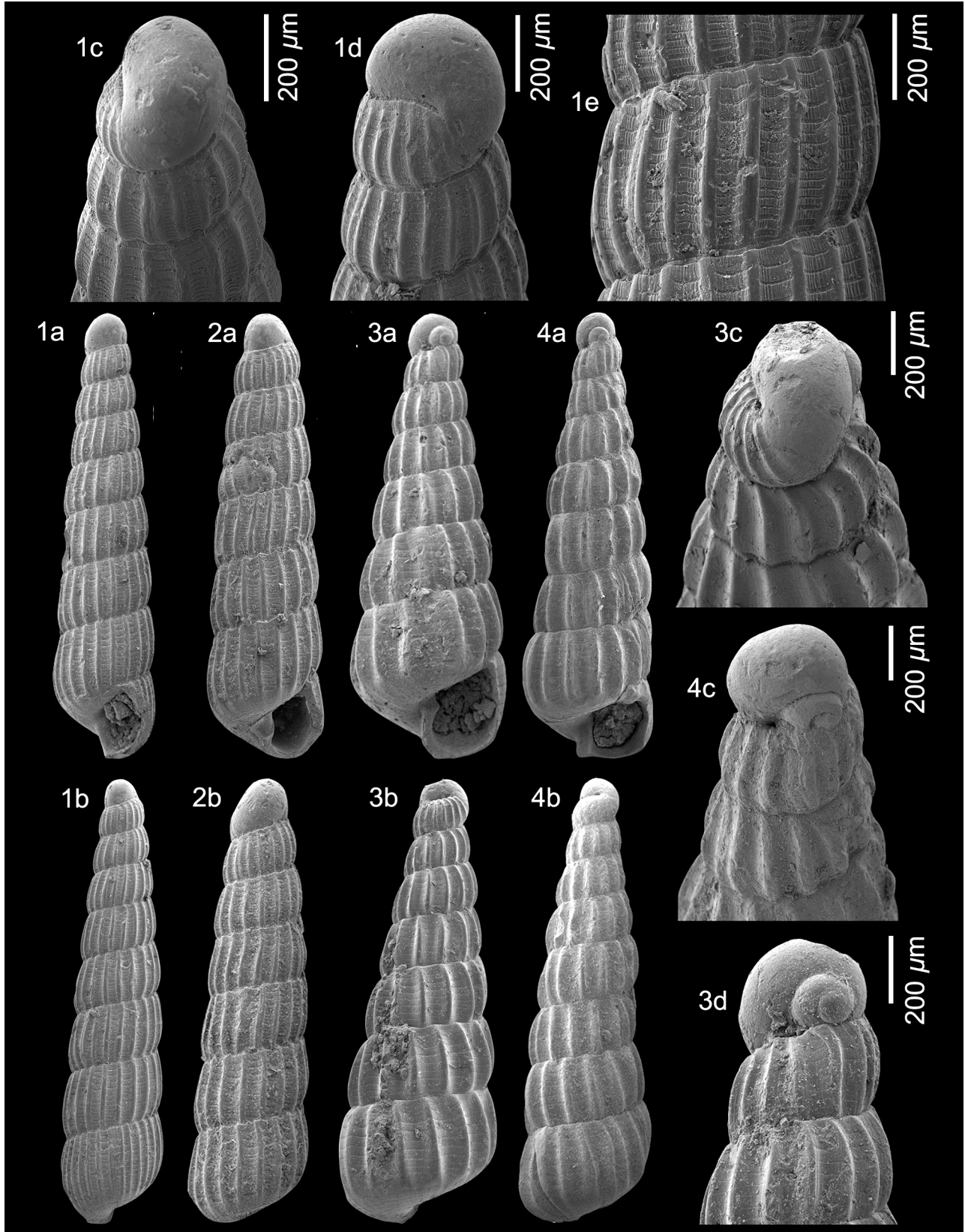


Plate 5

**Plate 6**

1. *Pyrgiscus caribbaeus* nov. sp., paratype 2 NMB H20640, NMB locality 17516, height 3.7 mm.
2. *Pyrgiscus caribbaeus* nov. sp., holotype NMB H20638, NMB locality 17516, height 3.8 mm.
3. *Pyrgiscus silvai* nov. sp., holotype NMB H20636, NMB locality 17516, height 2.4 mm.
4. *Pyrgiscus silvai* nov. sp., paratype 1 NMB H20637, NMB locality 17516, height 2.8 mm.
5. *Eulimella dianeae* nov. sp., holotype NMB H20645, NMB locality 17516, height 2.1 mm.
6. *Eulimella dianeae* nov. sp., paratype 1 NMB H18936, NMB locality 17516, height 2.7 mm.

All: South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.

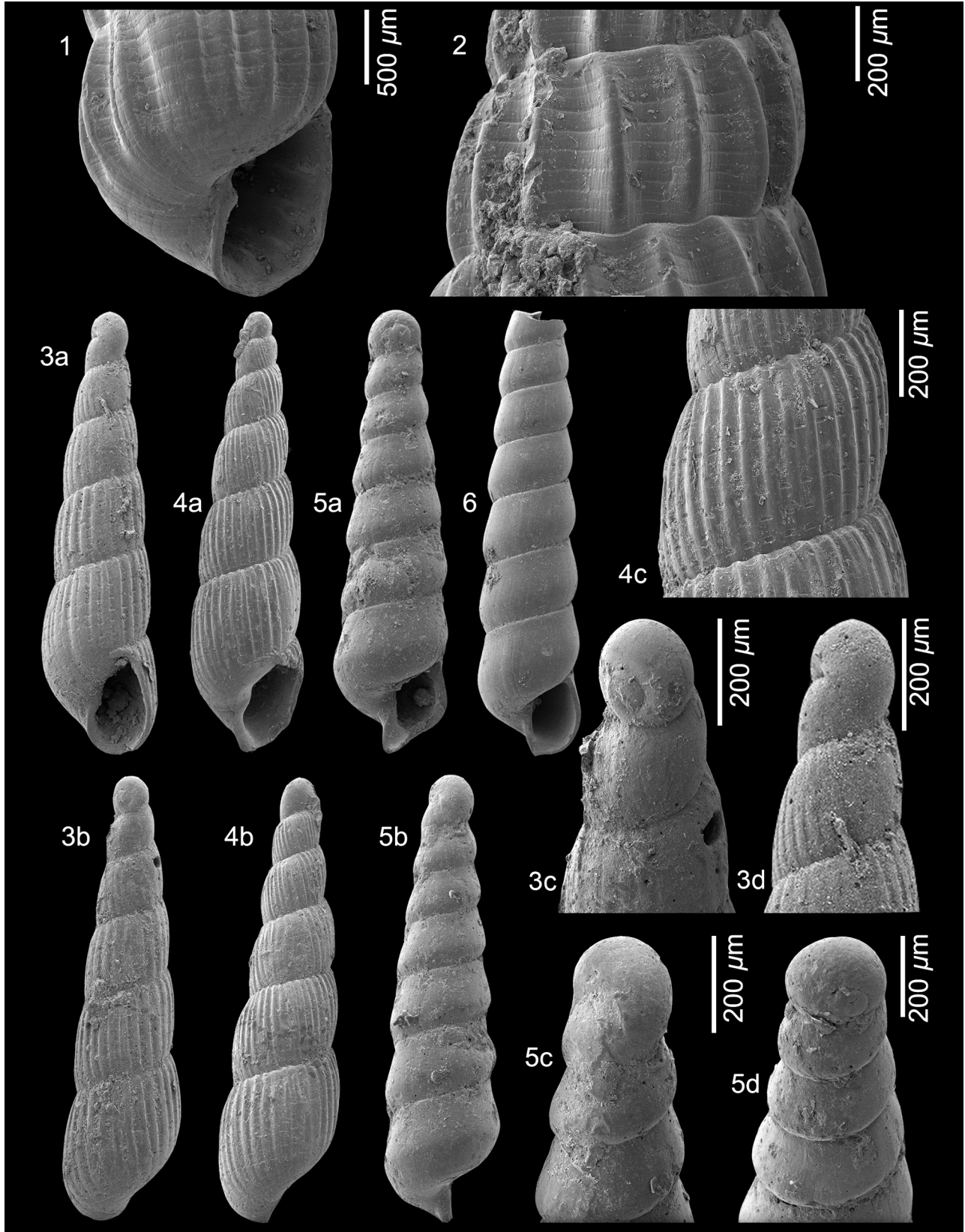


Plate 6

**Plate 7**

1. *Pyrgiscus silvai* nov. sp., paratype 1 NMB H20637, NMB locality 17516.
2. *Iselica globosa* (Lea, 1843), NMB H20646, NMB locality 17516, height 2.0 mm.
3. *Iselica globosa* (Lea, 1843), NMB H20647, NMB locality 17516, height 1.6 mm.
4. *Carinorbis* sp., NMB H19110, NMB locality 17516, height 2.5 mm.
5. *Carinorbis* sp., NMB H20653, NMB locality 17516, height 990  $\mu\text{m}$ .

All: South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.



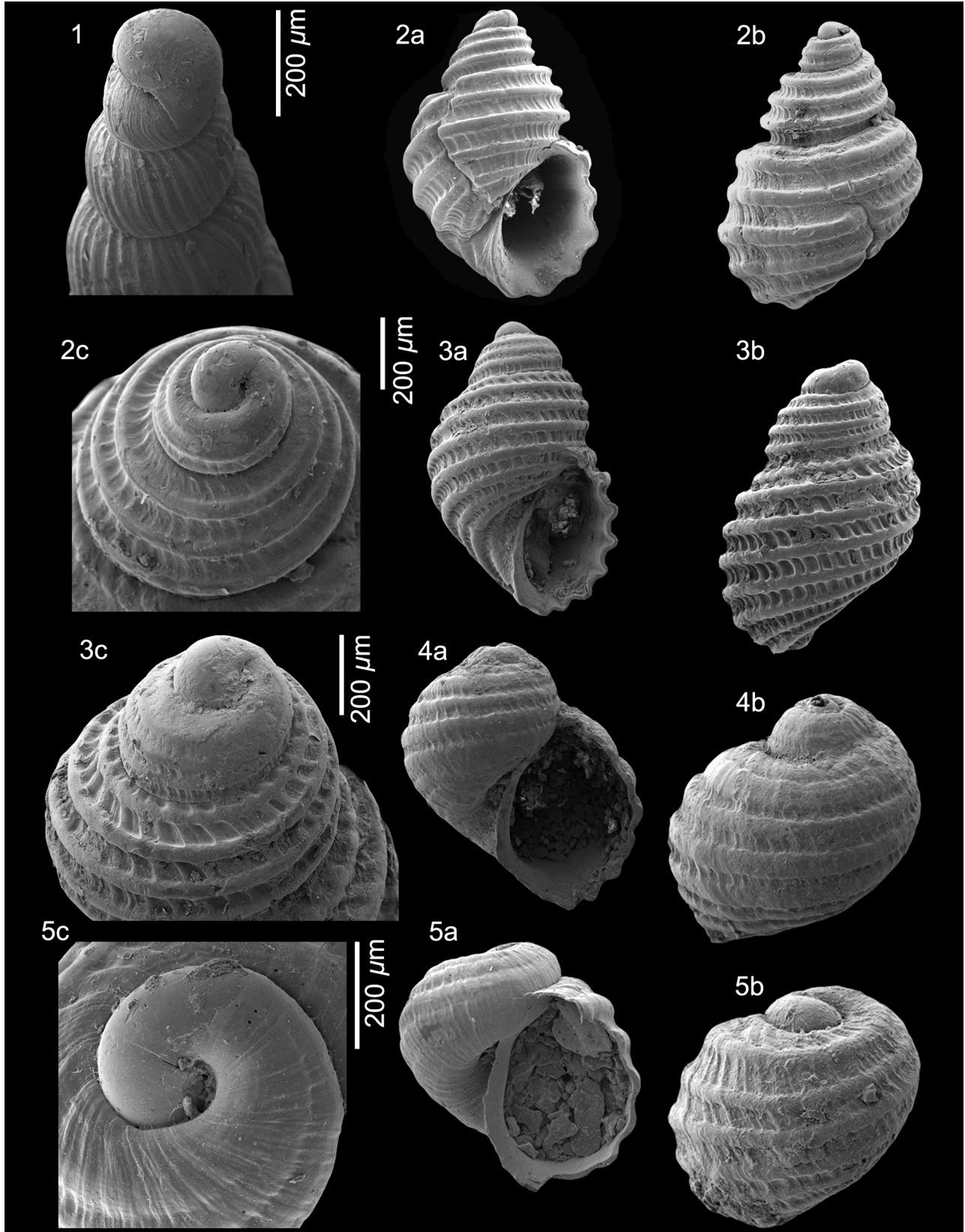
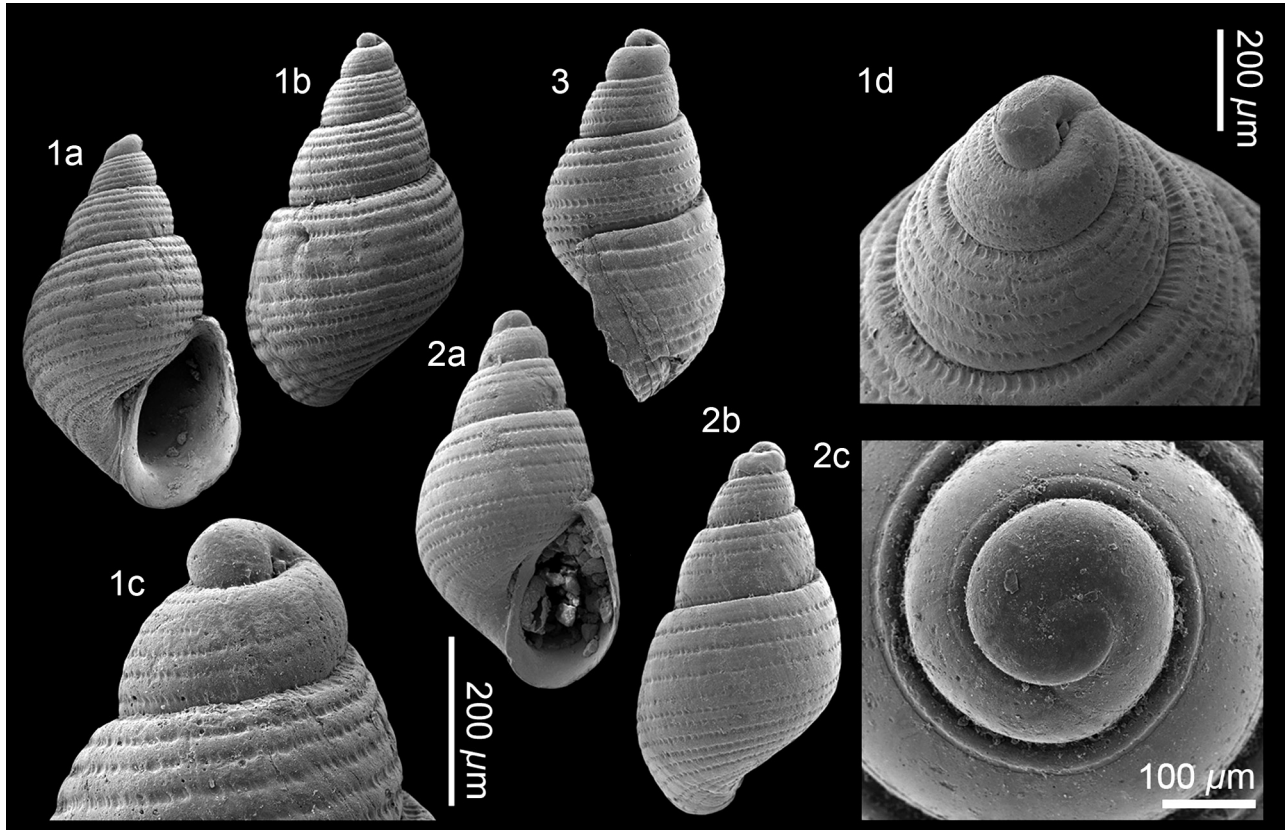


Plate 7



**Plate 8**

1. *Iselica belliata* nov. sp., holotype NMB H20649, NMB locality 17516, height 2.4 mm.
2. *Iselica belliata* nov. sp., paratype 1 NMB H20650, NMB locality 17516, height 2.7 mm.
3. *Iselica belliata* nov. sp., paratype 2 NMB H20651, NMB locality 17516, height 1.8 mm.

All: South of Casa Cantaure, Paraguaná Peninsula, Falcón State, Venezuela, Cantaure Formation, upper Burdigalian-lower Langhian, Lower-Middle Miocene.