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## TAXONOMIC REVISION OF THE FOSSIL PULMONATE MOLLUSKS OF ITABORAÍ BASIN (PALEOCENE), BRAZIL

RODRIGO BRINCALEPE SALVADOR<sup>1,2</sup>  
LUIZ RICARDO LOPES DE SIMONE<sup>1,3</sup>

### ABSTRACT

The limestones of Itaboraí Basin (Middle Paleocene), Rio de Janeiro, Brazil, harbor a rich fossil molluscan fauna consisting exclusively of pulmonate snails, both terrestrial and freshwater. An extensive taxonomic revision of this paleofauna is conducted here. A new genus, *Cortana*, is described as well as two new species, *Eoborus fusiforme* and *Gastrocopta itaboraiensis*. The revised classification is as follows: *Austrodiscus lopesi* (*Charopidae*); *Biomphalaria itaboraiensis* (*Planorbidae*); "Brachypodella" *britoi* (*Urocoptidae*); *Brasilennea arethusae*, *Brasilennea guttula*, *Brasilennea minor* (*Cerionidae*); *Bulimulus fazendicus*, *Bulimulus trindadeae*, *Cortana carvalhoi*, *Cyclodontina coelhoi*, *Itaborahia lamegoi*, *Leiostracus ferreirai*, *Plagiodontes aff. dentatus* (*Orthalicidae*); *Cecilioides sommeri* (*Ferussaciidae*); *Eoborus rotundus*, *Eoborus sanctijosephi*, *Eoborus fusiforme* (*Strophocheilidae*); *Gastrocopta mezzalirai*, *Gastrocopta itaboraiensis* (*Gastrocoptidae*); *Temesa magalhaesi* (*Clausiliidae*). The species *Strobilopsis maurya* was considered a synonym of *Brasilennea arethusae*; *Bulimulus sommeri* a synonym of *Itaborahia lamegoi*; and *Vorticifex fluminensis* a synonym of *Eoborus sanctijosephi*. Itaboraí Basin has the most ancient records of the families *Orthalicidae*, *Gastrocoptidae*, *Ferussaciidae* and *Strophocheilidae*. Moreover, the basin's records of *Charopidae*, *Clausiliidae*, *Cerionidae*, and *Urocoptidae* are among the most ancient in the world and, among these, those of *Cerionidae*, *Clausiliidae* and *Urocoptidae* deserve special attention since they are greatly removed from these families' current distribution. Additionally, Itaboraí has the most ancient records for the genera *Austrodiscus*, *Brachypodella*, *Bulimulus*, *Cecilioides*, *Cyclodontina*, *Eoborus*, *Gastrocopta*, *Leiostracus*, *Plagiodontes* and *Temesa*. There are three endemic genera in the basin: *Brasilennea*, *Cortana* and *Itaborahia*. Further discussion on paleobiogeography and evolution of this paleofauna is also provided.

KEY-WORDS: Itaboraí; Middle Paleocene; Mollusca; Pulmonata; Rio de Janeiro.

### INTRODUCTION

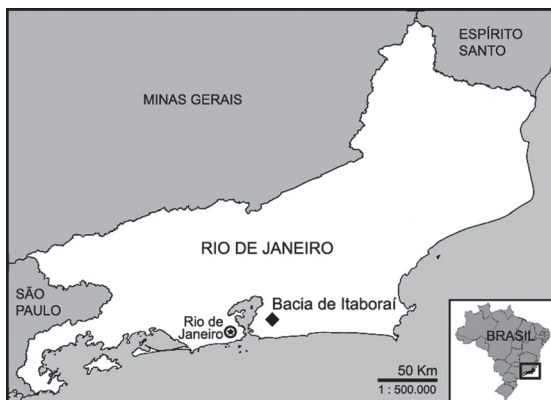
Itaboraí Basin is located in the municipality of Itaboraí (Fig. 1), Rio de Janeiro state, Brazil, and is one

of the smallest basins in the country: it has an elliptical shape, with ~1,400 m in its biggest axis, ~500 m in the smallest and ~125 m of maximum depth (Rodrigues Francisco & Cunha, 1978; Bergqvist *et al.*,

1. Museu de Zoologia, Universidade de São Paulo. Caixa Postal 42.494, 04218-970, São Paulo, SP, Brasil.

2. E-mail: salvador.rodrigo.b@gmail.com

3. E-mails: lrsimone@usp.br, lrsimone@gmail.com



**FIGURE 1:** Location of Itaboraí Basin, Rio de Janeiro state, Brazil. Adopted from <http://commons.wikimedia.org>.

2006). Despite its small size, Itaboraí Basin houses an astounding fossil record in its limestones.

These limestones started to be explored in 1933 for the production of cement, and fossils were found there almost as soon as the excavations had begun. The first fossils discovered were the gastropods, but, as excavations proceeded, many other were found, including plants, mammals, reptiles, birds, palynomorphs, coprolites and, of course, more mollusks (Maury, 1929, 1935; Bergqvist *et al.*, 2006). These fossils alongside the basin's geology were studied almost exclusively by researchers of two institutions from Rio de Janeiro: the *Museu Nacional* (National Museum) and the *Divisão de Geologia e Mineralogia* of the *Departamento Nacional de Produção Mineral* (Division of Geology and Mineralogy of the National Department of Mineral Production).

The exploration lasted until 1984, at which point the vast majority of Itaboraí's outcrops were already destroyed by the quarrying, and little of its limestone remained. After the limestone extraction ceased, the quarry was abandoned and a lake formed in the basin, leaving the few remaining outcrops underwater (Bergqvist *et al.*, 2008). Therefore, it is currently hard to obtain new fossil specimens from Itaboraí, as they can only be found in a few restricted sites above water level. As such, any posterior work depended heavily upon data from the literature and museum specimens (*e.g.*, Medeiros & Bergqvist, 1999). Still, Itaboraí is a very important fossiliferous site and on December 12, 1985 a park was created for its preservation, called *Parque Paleontológico de São José de Itaboraí* (Beltrão *et al.*, 2001; Bergqvist *et al.*, 2008).

According to the last works that listed the fossil mollusks from Itaboraí, there are 18 (Simone & Mezzalana, 1994) or 17 species (Bergqvist *et al.*, 2006) in the basin. Three more (two new species and a new

occurrence) were added to this list by Salvador & Simone (2012). In any case, up to this moment the studies dealing with Itaboraí Basin's molluscan fauna consist almost exclusively of the original descriptions; no taxonomic revision under a larger scope has been so far produced. As such, many taxonomic problems and inconsistencies have been readily identified, most stemming from the fact that the original descriptions were overly based on comparisons with European genera and species. Therefore, this work intends to review the taxonomy of the entire Itaborahian molluscan fauna. As the original descriptions (with the exception of Maury, 1935) are too brief and incomplete, we expand and complement them, figuring all type material and other well-preserved specimens, and offering a proper diagnosis for each taxon. Additionally, two new species, previously misidentified, were found in museum collections and are described herein.

## Geological Setting

Itaboraí Basin is a small tectonic depression dating from the Mesozoic, probably related to the tectonic activities during the separation of Gondwana; it rests on a Pre-Cambrian crystalline basement, over the Brazilian Southeastern Continental Rift (Beurlen & Sommer, 1954; Rodrigues Francisco & Cunha, 1978; Rodrigues Francisco, 1989; Medeiros & Bergqvist, 1999; Sant'Anna & Riccomini, 2001; Sant'Anna *et al.*, 2004). The basin was then filled by carbonatic sediments during the Paleocene (Rodrigues Francisco & Cunha, 1978; Medeiros & Bergqvist, 1999). The resulting limestones were named "Itaboraí Formation" by Oliveira (1956), but this name was almost never used afterwards; the majority of authors prefer simply "Itaboraí Basin". We follow this practice here.

The first work dealing with the basin's geology (Leinz, 1938) defined three rock horizons: laminated limestone, gray limestone and eluvial sediment. This definition still remains basically valid, having received only posterior refinements. The most up-to-date geological profile (Medeiros & Bergqvist, 1999) defines and names two stratigraphic sequences for the basin's Paleocene limestones: Sequence S1 lies at the bottom, directly above the Pre-Cambrian rocks; and Sequence S2 consists of sediments that filled fissures opened in S1 by water activity.

Sequence S1 is composed of an intercalation of carbonatic rocks of chemical and detrital origins. The chemically originated rocks (named Facies A) are mainly travertine, linked to hydrothermal activity inside the basin. The grey detrital limestones (Facies B)

are the product of gravitational and hydrodynamic fluxes towards the basin's interior and contain all known fossil mollusks as well as some plant, reptilian and mammalian remains. Facies C is composed of oolitic-pisolitic limestone, being associated to Facies A.

Sequence S2 is also carbonatic and the result of torrent and gravitational flows. Its clastic rocks contain the bulk of the basin's fossil vertebrate fauna as well as plants and palynomorphs. A third sequence, named S3, is composed of conglomerates and was deposited on top of the others much later, in the Eocene-Oligocene. It harbors reptilian and mammalian fossils.

After much disagreement about Itaboraí Basin's age, the mammalian fossils allowed the correlation with the Upper Paleocene fauna of Rio Chico Formation, Argentina (Paula Couto, 1952). It is currently agreed that both Sequences S1 and S2 belong to a time interval ranging from the end of the Lower Paleocene to the beginning of the Upper Paleocene (from about 59 to 57 Ma, according to Bergqvist *et al.* 2006), which has been informally named "Middle Paleocene" (Marshall, 1985; Medeiros & Bergqvist, 1999). Sequence S1 is younger, of Itaborahian age (according to the nomenclature of the *South American Land Mammalian Age*), while S2 is partly Itaborahian and partly Riochican (Bergqvist & Ribeiro, 1998).

## MATERIAL AND METHODS

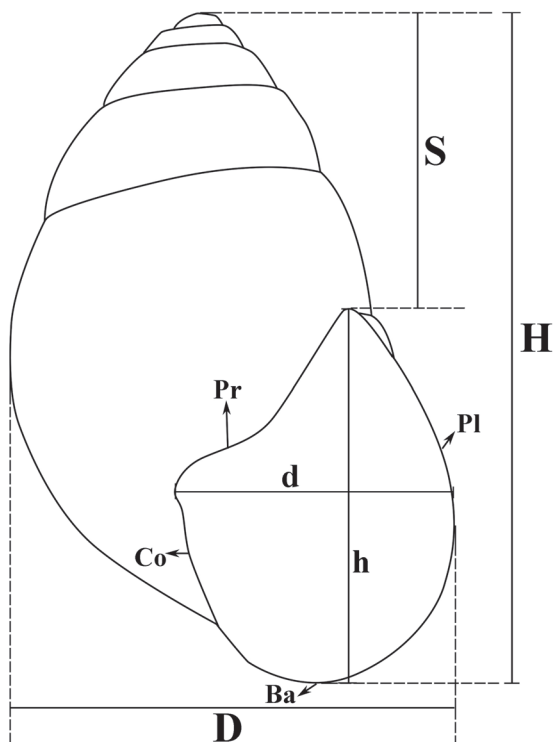
*Institutional abbreviations:* **AMNH:** American Museum of Natural History, New York, USA. **DGM:** Divisão de Geologia e Mineralogia (recently transformed into the MCT), Rio de Janeiro, RJ, Brazil. **MCT:** Museu de Ciências da Terra, Rio de Janeiro, RJ, Brazil. **MNRJ:** Museu Nacional, Rio de Janeiro, RJ, Brazil. **MZSP:** Museu de Zoologia da Universidade de São Paulo, São Paulo, SP, Brazil.

*Examined material:* The material from Itaboraí analyzed here (79 lots; 322 specimens) includes all the types and is housed in the collections of the above mentioned institutions. Unfortunately, the holotypes of two species (*Austrodiscus lopesi* and *Biomphalaria itaboraiensis*) are lost, *i.e.* they could not be located in the museums that housed them, respectively MNRJ and DGM. Only the reasonably well-preserved specimens, *i.e.* those useful for analysis, were included. The specimens in bad preservational state, including internal molds, were mostly excluded. Since most of the basin's outcrops are gone and further explorations commonly do not result in good material, all the specimens presented here are from museum collections. In large part, this is the same

material used in the species' original descriptions, but it also contains specimens from later collecting.

Unfortunately, the specimens' labels are very incomplete and stratigraphical information is always lacking. Also, there is no information regarding the quarry localities (however, their precise location would not be of much help, for the basin was almost completely destroyed by the limestone exploration and the old quarries do not exist anymore). Therefore, the stratigraphic occurrences of the species presented here are extracted from the original works and also from the compilations made by Medeiros & Bergqvist (1999) and Bergqvist *et al.* (2006). For the new species described herein, stratigraphic occurrence is assumed to be the same as their congeneric Itaborahian species. All pulmonate species occur in Facies B of Sequence S1 *sensu* Medeiros & Bergqvist (1999). However, a few species are also believed to occur in Sequence S2 (Bergqvist *et al.*, 2006): *Bulimulus fazendicus*, *Eoborus sanctijosephi*, and *Itaborahia lamegoi*. Still, these records are somewhat doubtful, since mistakes can be easily made at this point: in their original works, some authors were not clear enough about the facies of precedence (although it should be noted that they make no clear mention of the clastic Sequence S2 and all fossil seem to stem from S1). Besides, the presence of mollusks in S2 is contested by some authors (*e.g.*, Ferreira & Coelho, 1971; Rodrigues Francisco & Cunha, 1978; Cunha *et al.*, 1984). It is even possible that the mollusks present in S2 were actually eroded from S1 and re-deposited in S2 (Lilian P. Bergqvist, *pers. comm.*), and thus all supposed stratigraphic occurrence in Sequence S2 should be treated with care.

*Shell terminology and measures:* We follow here the terminology of Moore *et al.* (1952) and Cox (1955) for molluscan shells and their structures. Additionally, we follow Breure (1979; p. 10, figs. 1-7) for the terminology of whorl convexity and the umbilicus and Tillier (1989; p. 7, fig. 1C) for the terminology of the peristome regions (Fig. 2). All shell measures presented here (Fig. 2) are in accordance with Moore *et al.* (1952): H = shell length (or height); D = greatest width (or diameter) of shell; S = spire length (without the aperture); h = aperture height; d = aperture width;  $\theta$  = spire angle (the "mean spire angle" *sensu* Moore, 1960, approximated to the closest multiple of five). All measures were taken with a digital caliper or, in the case of microgastropods (smaller than 5 mm), with the aid of CorelDRAW® Graphics Suit X5. Unfortunately, not every shell is well-preserved or even completely preserved and thus some measures could not be precisely taken or taken at all (such imprecise



**FIGURE 2:** Measures used in shell description (see text for abbreviations) and terminology for peristome regions: parietal (Pr), palatal (Pl), basal (Ba) and columellar (Co).

measures are indicated by *italicized numbers*). When specimens are abundant, the mean and standard deviation is presented. The whorl counting method follows Janssen (2007), *i.e.*, excluding the semicircular nucleus of the protoconch, and thus the total number of whorls can vary a little ( $\frac{1}{4}$  to  $\frac{1}{2}$  whorl) when compared to other works.

**Nomenclatural update:** Here we follow the work of Bouchet *et al.* (2005) for the nomenclature of families and sub-families, with the addition of the more recent work of Uit de Weerd (2008) with the Urocoptoidea. Therefore, a few nomenclatural changes had to be made in the classic literature of Itaborahian molluscan fauna: (1) the family Bulimulidae is now considered a subfamily of Orthalicidae; (2) likewise, Odontostomidae is now considered a subfamily of Orthalicidae; (3) the family Megalobulimidae is now considered a subfamily of Strophocheilidae.

We also follow the works of Schileyko (1998a, 1998b, 1999a, 1999b, 2000, 2001), which offers the description and diagnosis of families, subfamilies and genera based on morphological characters. Other works, dealing more specifically with one or other taxon, were also followed; among these, the works of Breure (1978, 1979) on the Bulimulinae stand out.

## Systematics

### Stylommatophora Family Cerionidae Genus *Brasilennea* Maury, 1935 (Figs. 3-26)

*Brasilennea* Maury, 1935: 3; Oliveira, 1936: 4; Mezzalira, 1946: 18; Magalhães & Mezzalira, 1953: 221; Trindade, 1956: 15; Zilch *in* Wenz, 1959-60: 578; Brito, 1967: 18; Jaekel, 1969: 822; Parodiz, 1969: 186; Palma & Brito, 1974: 396; Simone & Mezzalira, 1994: 51; Bergqvist *et al.*, 2006: 59; Salvador *et al.*, 2011: 445; Salvador & Simone, 2012: 2.

*Type species:* *B. arethusae* Maury, 1935.

*Included species:* *B. arethusae* Maury, 1935; *B. guttula* Salvador & Simone, 2012; *B. minor* Trindade, 1956.

**Geographic and stratigraphic occurrence:** Known only from Itaboraí Basin: limestone Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

**Age:** Tertiary, Middle Paleocene.

**Etymology:** Maury (1935) considered the newfound species very similar to the African genus *Ennea* and thus named the new genus *Brasilennea*, meaning “Brazilian *Ennea*”.

**Diagnosis:** Shell pupiform (expect for *B. guttula*: spire sharply acuminate). Ribs regularly spaced. Greatest width in central portion of shell length. Body whorl with two well-marked spiral furrows, one central and the other basal. Peristome complete, well-marked and with duplicated aspect. Single and strong median parietal lamella, reaching the peristome. Columellar lamella present.

**Re-Description:** Shell dextral, pupiform (expect for *B. guttula*: spire sharply acuminate), with greatest width in central portion of shell length. Columella hollow, at least in first whorls. Whorls flat to slightly convex. Suture well-marked, linear, practically perpendicular (horizontal) to columellar axis, becoming more oblique towards last whorls. Shell sculptured by well-defined and raised ribs, regularly spaced, becoming less oblique towards last whorls. First two to three whorls (protoconch) smooth; transition to teleoconch clear. Body whorl with two well-marked spiral furrows (one central and the other basal), that

can be seen as two parallel folds in shell's inner surface. Aperture large, approximately semicircular, with parietal and columellar lips straight; other lip regions rounded. Peristome complete, well-marked, virtually straight parietally, with duplicated aspect (parallel lamella *sensu* Maury, 1935, projecting itself forward). Single and strong median parietal lamella reaching peristome. Columellar lamella present. Umbilicus narrow.

*Discussion:* *Brasilennea* was originally placed in the family Streptaxidae. However, due to many morphological characters shared with Cerionidae, and also to the fact that the similarities shared with Streptaxidae were superficial, the genus was recently transferred to Cerionidae by Salvador *et al.* (2011). Since this topic was well explored elsewhere, it will not be discussed here; instead we present only the formal diagnosis and description and limit ourselves to comparisons with other Cerionidae (and Urocoptidae, when informative, since these two families were deemed sister taxa by Uit de Weerd, 2008).

*Shell shape, structure and Sculpture:* In respect to the general shell shape, *Brasilennea* strongly resembles the typical Cerionidae: a thick, pupiform and multispiral shell, with acuminate apex (triphasic *sensu* Gould, 1989), hollow columella (at least in first whorls), and the shape, placement and size of aperture (Schileyko, 1999b). Also, *B. arethusae* has strong and regularly-spaced ribs that become less oblique towards the shell aperture, as commonly seen in cerionids (Schileyko, 1999b). The ribs in the other *Brasilennea* species are weaker, but still raised and well-marked.

*Spiral furrows on body whorl:* The furrows in *Brasilennea*'s body whorl are well-marked and deeply set and comprise the most striking diagnostic feature of the genus. This feature is not known in Cerionidae, but some urocoptids do show a single furrow in their body whorl (Schileyko, 1999a), such as in the genera *Apoma* Beck, 1837, *Brachypodella* Beck, 1837, *Mychostoma* Albers, 1850 and *Spirostemma* Pilsbry & Vanatta, 1898.

*Aperture, peristome and lamellae:* The basic shape of *Brasilennea*'s aperture is the same as in Cerionidae, especially when considered together with the complete peristome, virtually straight parietally, and its duplicated aspect (parallel lamella *sensu* Maury, 1935, projecting itself forwards, away from the lip, for a couple of millimeters). The apertural dentition is also very similar to the typical Cerionidae, with a single, strong

median parietal lamella reaching the peristome and also a spiral columellar lamella.

Therefore, during the beginning of the Cenozoic, it seems likely that the morphological variation in the shells of Cerionidae would be greater, as shown by *Brasilennea*. This would not be a complete surprise, since the family's ancestral stock may have also originated the Urocoptidae as suggested by Uit de Weerd (2008), a family with great morphological variation (Schileyko, 1999a).

### ***Brasilennea arethusae* Maury, 1935 (Figs. 3-16)**

*Brasilennea arethusae* Maury, 1935: 4 (figs. 1-5); Oliveira, 1936: 4; Mezzalira, 1946: 18; Paula Couto, 1949: 11; Magalhães & Mezzalira, 1953: 221 (pl. 64, fig. 262, 262<sup>o</sup>); Trindade, 1956: 15 (pl. 3, figs. 1c, 2c); Zilch *in* Wenz, 1959-60: 578 (fig. 2025); Brito, 1967: 18 (pl. 3, fig. 6); Jaeckel, 1969: 822; Parodiz, 1969: 186 (pl. 19, figs. 3, 12); Palma & Brito, 1974: 396 (pl. 1, fig. 9); Simone & Mezzalira, 1994: 51 (pl. 15, fig. 430); Bergqvist *et al.*, 2006: 59 (fig. 74); Salvador *et al.*, 2011: 445 (fig. 1A-G, L); Salvador & Simone, 2012: 2 (figs. 5-6).

*Strobilops mauryae* Ferreira & Coelho, 1971: 469 (fig. 6); Palma & Brito, 1974: 397.

*Strobilopsis mauryae*: Simone & Mezzalira, 1994: 49 (pl. 14, fig. 413); Bergqvist *et al.*, 2006: 60 (fig. 76). (Error)

*Holotype:* AMNH 24237 (examined; Figs. 10-11).

*Paratypes:* AMNH 24238 (1 specimen, examined; Fig. 12), 24239 (1 specimen, examined; Fig. 16).

*Type Locality:* Limestones of Parque Paleontológico de São José de Itaboraí, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence:* Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age:* Tertiary, Middle Paleocene.

*Etymology:* Due to the terrestrial habits of the species, Maury (1935) dedicated it to Arethusa (sometimes also spelled Arethousa), a nymph from Greek mythology. There are mentions to two nymphs of such name in the myths: one is a Nereid (or even a goddess

of springs) while the other is one of the Hesperides (Kerényi, 1951). Maury did not specify which one she was referring to, stating only that it was a “sylvan nymph”. Thus, the name probably refers to the latter since the previous is a water-related being.

*Diagnosis:* Shell bigger than other species. Greatest width in central portion of shell. Sculptured by stronger whorls, usually in lesser quantity. In some specimens, weaker ribs, in greater quantity (similar to the other *Brasilennea* species), may also occur in some specimens.

*Re-Description:* Shell medium-sized, multispiral, pupiform, with acuminate apex. Greatest width in central portion of shell; diameter  $\sim 1/2$  shell length. Spire angle  $\sim 45^\circ$ . Protoconch dome-shaped, blunt, smooth; transition to teleoconch clear. Columella hollow (at least on first whorls). Profile of whorls flat. Suture well-marked, linear, practically perpendicular (horizontal) to columellar axis, becoming more oblique towards last whorls. Sculptured by strong, raised and well-marked ribs, regularly distributed, becoming less oblique towards last whorls, and usually in lesser quantity than other *Brasilennea* species ( $\sim 35$  on penultimate whorl). Body whorl with two well-marked and deeply set spiral furrows, one central and the other basal, placed equidistantly from upper furrow and shell bottom. Aperture large, orthocone, approximately semicircular (parietal and columellar lips straight, others rounded);  $\sim 1/3$  shell length. Peristome complete, well-marked, with duplicated aspect (parallel lamella *sensu* Maury, 1935). Single and strong median parietal lamella, reaching peristome and extending itself towards interior up to  $\sim 1/4$  of body whorl. Columellar spiral lamella extending itself towards shell's interior. Body whorl  $\sim 2/5$  shell length. Umbilicus narrow.

*Measures (in mm):* **Holotype:** 11 whorls; H = 23.6; D = 13.2; S = 15.9; h = 7.5; d = 6.1. **Paratypes:** AMNH 24238: 11 whorls; D = 12.6; S = 15.8. AMNH 24239 (juvenile): 6 or 7 whorls (shell apex covered by sediment); H = 4.1; D = 7.7; S = 1.8; d = 3.2. **Mean (n = 35):** 11 whorls (eventually 10); H =  $21.6 \pm 2.2$  (max 24.9; min 17.3); D =  $11.6 \pm 1.2$  (max 14.4; min 9.4); S =  $14.9 \pm 1.7$ ; h =  $6.9 \pm 0.9$  (max 7.8; min 5.2); d =  $5.5 \pm 1.0$  (max 6.9; min 3.2).

*Examined material:* Types. DGM 4222-I (1 specimen), 4998-I (8 specimens), 5002-I (25 specimens), unnumbered (7 specimens); MNRJ 3346-I (2 specimens), 3348-I (2 specimens), 4338-I (5 specimens);

MZSP 86321 (20 specimens), 86322 (1 specimens), 86324 (4 specimens). Type material of *Strobilops mauryae*: MNRJ 5020-I (holotype), 5021-I (paratype, 4 specimens).

*Discussion:* *B. arethusae* is the type species of the genus by original designation and monotypy (Maury, 1935). It is larger than the other species, presenting usually 11 whorls, though a few specimens have 10 whorls. A single specimen has 9 whorls (Fig. 13), but it seems to be anomalous, since it also shows a slightly different shell shape, with the lip largely reflected and without the doubled aspect, and does not have the parietal lamella. The shell shape can vary slightly in the last whorls, which can be thinner and present the aperture more centrally located (notably in the holotype, Figs. 10-11). In the same manner, the ribs in some specimens ( $\sim 40\%$ ) can be weaker and more abundant (Figs. 10-12), like those of other *Brasilennea* species.

*B. arethusae* usually has stronger ribs (and fewer per whorl) than other *Brasilennea* species. Quensen & Woodruff (1997) attribute such strong ribs to protection against predators in *Cerion* Röding, 1798; the ribs strengthen the shell structure and make it harder for predators (in this case, crabs) to crush it. However, *B. arethusae*'s possible predators are unknown: there is no record of crabs in Itaboraí or other possible predators known for crushing shells, such as beetles (Symondson, 2004); still, some small mammals, also potential predators (Allen, 2004), do occur in Itaboraí, but possibly not in the same sequence as the *Brasilennea* (Bergqvist *et al.*, 2006). In any case, the shell of *B. arethusae* would be more resistant to predation due to its strong ribs.

Ferreira & Coelho (1971) described *Strobilops mauryae* (Figs. 14-15), stating that it could be taken for fragments of *B. arethusae* and also that Maury (1935) had committed such error when defining the paratype of *B. arethusae* (AMNH, 24239; Fig. 16) as a juvenile. Ferreira & Coelho (1971) gave the key character to place their specimens in the genus *Strobilops* Pilsbry, 1893: a tooth (or “well-developed basal fold”) in the aperture's basal region. Teeth and lamellae are typical of the family Strobilopsidae, which, for many authors, contain only the genus *Strobilops*, and are essential to the family's taxonomy (Schileyko, 1998a). In the illustration of *S. mauryae* presented by Ferreira & Coelho (1971: 469, fig. 6), such tooth can be clearly seen. However, examining the type material, we saw that only the holotype (Figs. 14-15) presented such tooth. Further examination revealed that the supposed tooth was in fact a grain of sediment attached to the shell.

Therefore, here we propose that the specimens previously classified as *S. mauryae* are in fact juveniles of *B. arethusae* (or fragments of it, namely the top of the spire). Besides all the characters of the supposed specimens of *S. mauryae* being identical to what is found in the top region of the shell of *B. arethusae* (like sculpture pattern, aperture shape, umbilicus shape, absence of teeth and lamellae etc.), they do not present a single character that could allow their classification as strobilopsids, such as long parietal lamellae, greatly extending themselves towards the shell's interior, and a thickened and reflected lip (Schileyko, 1998a). Moreover, no deflection of the peristome was detected in the specimens identifiable as *S. mauryae*, another necessary character for confirming the generic attribution.

***Brasilennea guttula* Salvador & Simone, 2012**  
(Figs. 17-21)

*Brasilennea guttula* Salvador & Simone, 2012: 2 (figs. 1-4).

*Holotype*: MCT 6940-I (examined; Figs. 17-21).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality. The precise stratigraphic occurrence can't be assessed; probably Sequence S1, the same sequence of occurrence of the other *Brasilennea* species (Medeiros & Bergqvist, 1999; Bergqvist *et al.* 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: The name refers to the species' intriguing shell shaped as a water drop.

*Diagnosis*: Outline shaped like water drop (spire sharply acuminate) instead of pupiform. Greatest width on body whorl. Larger number of whorls (about 14).

*Description*: See Salvador & Simone (2012).

*Measures (in mm)*: **Holotype**: 14 whorls; H = 13.6 (aperture broken); D = 6.5; S = 11.3.

*Examined material*: Holotype.

*Discussion*: *B. guttula* is smaller than *B. arethusae* but larger than *B. minor*, and has more whorls than both (*B. guttula* has 14, while *B. arethusae* has 10-11 and *B. minor* has 8-9). The most striking difference, however, is its "water drop" shape, *i.e.*, an acuminate spire (the other species have wide, dome-shaped first whorls). Regarding the other typical features of the genus, *B. guttula* shares all of them: the shell strength, the smooth protoconch, the sculpture pattern, the suture pattern and the most prominent feature of the genus, the two furrows on the body whorl. Nevertheless, the holotype (the only specimen known) has the last portion of the body whorl broken, so for now there is no clue indicating if the peristome has a doubled aspect or if there was a parietal lamella and/or a columellar lamella as in the other two *Brasilennea* species.

***Brasilennea minor* Trindade, 1956**  
(Figs. 22-26)

*Brasilennea arethusae* var. *minor* Trindade, 1956: 18 (pl. 3, figs. 1e, 2e).

*Brasilennea minor*: Brito, 1967: 19 (pl. 3, figs. 7, 8); Palma & Brito, 1974: 397 (pl. 1, fig. 10); Simone & Mezzalira, 1994: 51 (pl. 15, fig. 431); Bergqvist *et al.*, 2006: 60 (fig. 75); Salvador *et al.*, 2011: 445 (fig. 1H-K); Salvador & Simone, 2012: 2 (figs. 7-8).

*Holotype*: DGM 4221-I (examined; Fig. 22).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: The name refers to the species' small size.

*Diagnosis*: Shell small (smallest species in genus). Greatest width in central portion of shell. Profile of whorls slightly convex. Sculptured by large number fine ribs. Basal furrow in body whorl more weakly marked.

*Re-Description*: Shell small, multispiral, pupiform, with acuminate apex. Greatest width in central portion of shell; diameter  $\sim$ 1/2 shell length. Spire angle

~45°. Protoconch dome shaped, blunt, smooth; transition to teleoconch clear. Columella hollow (at least on first whorls). Profile of whorls slightly convex. Suture well-marked, linear, practically perpendicular (horizontal) to columellar axis, becoming more oblique towards last whorls. Sculptured by fine and raised ribs, regularly distributed, becoming less oblique towards last whorls, and in large numbers (~70 on penultimate whorl). Body whorl with two spiral furrows, one central and the other basal, placed equidistantly from the upper furrow and the bottom of the shell; basal furrow more weakly marked than the upper one. Aperture large, orthocone, approximately semicircular (parietal and columellar lips straight, others rounded); ~1/3 shell length. Peristome complete and well-marked, with duplicated aspect (parallel lamella *sensu* Maury, 1935, projecting itself forwards away from the lip for a couple of millimeters). Single and strong median parietal lamella, reaching the peristome and extending itself towards shell's interior up until ~1/4 of body whorl. Columellar spiral lamella extending itself towards interior. Body whorl ~1/2 shell length. Umbilicus narrow.

**Measures (in mm):** **Holotype:** 9 whorls; H = 9.0; D = 5.0; S = 6.3; d = 2.1. **Mean (n = 16):** 9 whorls (eventually 8 or 10); H = 11.6 ± 1.9 (max 14.9; min 8.4); D = 5.8 ± 0.6 (max 6.7; min 4.8); S = 7.9 ± 1.2; h = 3.6 ± 0.2 (max 3.9; min 3.2); d = 3.2 ± 0.4 (max 4.0; min 2.5).

**Examined material:** Holotype. DGM 4224-I (1 specimen), 4999-I (9 specimens), unnumbered (1 specimen); MNRJ 3346-I (1 specimen), 4338-I (2 specimens); MZSP 86323 (2 specimens).

**Discussion:** *B. minor* was originally described as a smaller sympatric variety of *B. arethusae* by Trindade (1956), but it was lately elevated to the category of species by Brito (1967), using the sympatry as one of the reasons for such. *B. minor* specimens are smaller than the smallest specimen of *B. arethusae*, showing no overlapping in size distribution. *B. minor* shows a smaller number of whorls than the other *Brasilennea* species: usually 9 (8 or 10 whorls are not uncommon). The whorls of *B. minor* are more convex and its shell is weaker and thinner than the other species. It has a greater number of ribs and they are also weaker. The basal furrow in the body whorl is more weakly marked. *B. minor* also shows some variation in shell shape besides whorl number as, for example, thinner and more elongated specimens (Fig. 25); however, in a broader sense, this variation seems to be less than what is seen in *B. arethusae*.

## Family Charopidae

### Genus *Austrodiscus* Parodiz, 1957

#### *Austrodiscus lopesi* Ferreira & Coelho, 1989

*Austrodiscus lopesi* Ferreira & Coelho, 1989: 193 (figs. 1-2); Simone & Mezzalana, 1994: 50 (pl. 15, fig. 417); Bergqvist *et al.*, 2006: 59.

**Holotype:** MNRJ 5645-I.

**Paratypes:** MNRJ 5646-I, MNRJ 5647-I.

**Type Locality:** Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

**Geographic and stratigraphic occurrence:** Known only from the type locality. There is no information in the literature about which sequence this species occurs.

**Age:** Tertiary, Middle Paleocene.

**Etymology:** Species dedicated to the zoologist Dr. Hugo S. Lopes (*Instituto Oswaldo Cruz*, Rio de Janeiro, Brazil).

**Discussion:** The genus *Austrodiscus* Parodiz, 1957 is normally allocated to the family Endodontidae (Schileyko, 2001), a family endemic to the Pacific islands (Solem, 1976, 1979, 1981). Schileyko (2001) still considers that Endodontidae contains some species in South America and on Saint Helena Island, but other authors state that these species actually belong to Charopidae, a family with a broader distribution: the Americas, the Pacific Islands, Oceania Southern Africa and Saint Helena Island (Solem, 1981; Fonseca & Thomé, 1993). It has been a common practice in revisionary work dealing with the supposed American endodontids to reallocate them in Charopidae, as in Fonseca & Thomé (1993), who dealt specifically with *Austrodiscus*. Such resolution is here adopted.

All type material of *Austrodiscus lopesi* (totaling 9 specimens, according to Ferreira & Coelho, 1989) has disappeared; it could not be found in the museum's collection (MNRJ) or in the records of lent material (since it is common practice in this institution not to lend type material). Unfortunately, no additional material exists.

Ferreira & Coelho (1989), when describing the species, decided for its placement in the genus *Austrodiscus* due to its smooth protoconch. However, this character was contested for the genus by Fonseca & Thomé (1993), who stated that the protoconch is



sculptured. However, this character cannot be confirmed only by the illustration in the species original description. Without having the type material, it is impossible to conduct a proper taxonomic revision and thus the allocation of *A. lopesi* in the genus *Austrodiscus* could not be confirmed or contested. As such, the only alteration proposed here is the change in *A. lopesi*'s familiar allocation, transferring it from Endodontidae to Charopidae.

### Family Clausiliidae

#### Subfamily Neniinae

#### Genus *Temesa* H. & A. Adams, 1855

#### *Temesa magalhaesi* (Trindade, 1953) comb. nov.

(Figs. 27-33)

*Clausilia magalhaesi* Trindade, 1953: 40 (fig. 1); Brito, 1967: 14 (pl. 3, figs. 4, 5); Palma & Brito, 1974: 397 (pl. 1, fig. 6); Simone & Mezzalana, 1994: 50 (pl. 14, fig. 414); Bergqvist *et al.*, 2006: 59 (fig. 71).

*Holotype*: DGM 4220-I (examined; Fig. 27).

*Type Locality*: Limestones of Parque Paleontológico de São José de Itaboraí, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: Species dedicated to Prof. Júlio de Magalhães (*Faculdade Nacional de Filosofia*, Rio de Janeiro, Brazil).

*Diagnosis*: Shell cylindrical-fusiform, broad and robust, with acuminate apex. Ribs very thin and weak. Parietal lamella high, vertical; apparently the single lamella present.

*Re-Description*: Shell medium-sized, sinistral, multispiral, thin (but broad for genus), cylindrical-fusiform, with acuminate apex. Greatest width in central portion of shell (antepenultimate whorl); diameter  $\sim 1/3$  shell length. Spire angle  $\sim 20^\circ$ . Protoconch flattened, blunt, smooth. Profile of whorls slightly convex, eventually flat. Suture well-marked, oblique (diagonal) to columellar axis. Sculptured by fine ribs ( $\sim 85$  on penultimate whorl), oblique to columellar

axis. Body whorl not thinned, adnate to the spire. Peristome weakly reflected, supposedly complete. Parietal lamella high, vertical, median, reaching the peristome and extending itself towards interior. Apparently without other teeth and/or lamellae.

*Mean measures (in mm; n = 4)*: 10 whorls (eventually 11); D =  $5.1 \pm 0.2$  (min 4.8; max 5.3).

*Examined material*: Holotype. DGM 4997-I (8 specimens).

*Discussion*: The only clausiliid from Itaboraí Basin was originally placed in the genus *Clausilia* Dreparnaud, 1805. However, *Clausilia* is a Recent genus from central Europe, of the European subfamily Clausiliinae. Due to this biogeographical incongruence and additional morphological characters, here we opted for the reallocation of *C. magalhaesi* in a genus of Neniinae, a strictly Latin American subfamily (Schileyko, 2000). It is also important to emphasize that all Latin American species of *Clausilia* have been reallocated in genera of Neniinae (Schileyko, 2000).

There is only a single recent clausiliid in Brazil, *Nenia orbigny* Ancey, 1892, in the state of Mato Grosso (Simone, 2006), despite *Nenia* H. & A. Adams, 1855 being a Caribbean-endemic genus (Loosjes & Loosjes-van Bemmelen, 1966). Moreover, Schileyko (2000) restricted the genus to a single species, *N. tridens* (Chemnitz, 1786), from Puerto Rico. As such, the most obvious choice for the generic reallocation of *C. magalhaesi* would perhaps be the genus *Nenia*, which supposedly occurs in Brazil. However, due to doubts regarding the classification of the Brazilian species *N. orbigny* and also to the astounding similarity of the Itaborahian fossil to the Recent South-American genus *Temesa* H. & A. Adams, 1855, *C. magalhaesi* is here reallocated to this later genus. Despite being absent in Brazil, *Temesa* occurs in various neighboring countries: Peru, Bolivia, Colombia, and, with some doubt, in Argentina (Loosjes & Loosjes-van Bemmelen, 1966; Schileyko, 2000; Nordsieck, 2005).

The decision for the reallocation in *Temesa* is due to a vast array of shared morphological characters: cylindrical-fusiform and thin shell, spire with acuminate apex, protoconch present (*i.e.*, non-decollated), number of whorls (10 or 11), body whorl not thinned and adnate to the spire, peristome weakly deflected, absence of lamellae or teeth in the aperture (besides the parietal lamella). Usually, the lamellae of *Temesa* species cannot be seen in the aperture; they can be found in the inner portion of shell. Unfortunately, the

presence of additional lamellae could not be assessed in this fossil due to the specimens' state of preservation; there is not even one specimen with an intact aperture, only one has part of the aperture preserved (Figs. 28-33). However, to discover if the other lamellae are present or not, it would be necessary to break the aperture and part of the body whorl and, due to the small number of specimens, this course of action was discarded.

*Temesa magalhaesi* differs from the other species in the genus mainly by its broader and more robust shell and the spire apex sharply acuminate. The genus does not possess the clausilial apparatus, a typical structure in the family; however, such structure is not often preserved in the fossil record.

### Family Ferussaciidae

#### Genus *Cecilioides* Férussac, 1814

#### *Cecilioides sommeri* (Ferreira & Coelho, 1971)

comb. nov.

(Figs. 34-35)

*Carychium sommeri* Ferreira & Coelho, 1971: 467 (fig. 4); Palma & Brito, 1974: 391; Simone & Mezzalana, 1994: 49 (pl. 14, fig. 405); Bergqvist *et al.*, 2006: 59 (fig. 70).

*Holotype*: MNRJ 5016-I (examined; Figs. 34-35).

*Paratype*: MNRJ 5017-I (7 specimens, examined).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: Species dedicated to Prof. Friedrich W. Sommer (*Divisão de Geologia e Mineralogia do Departamento Nacional de Produção Mineral*, DNPM, Rio de Janeiro, Brazil).

*Diagnosis*: Shell oval. Aperture sub-oval. Peristome reflected, slightly thickened.

*Re-Description*: Shell diminutive, oval, smooth, with blunt spire apex; 6 whorls (eventually 5). Greatest width on body whorl; width  $\approx 1/2$  shell length. Spire

angle  $\approx 50^\circ$ . Protoconch smooth, blunt, broad, dome-shaped. Profile of whorls flattened. Suture weakly marked, practically perpendicular (horizontal) to columellar axis. Aperture small, orthocone, sub-oval;  $\approx 2/5$  shell length. Teeth or lamellae absent. Peristome reflected, slightly thickened. Body whorl  $\approx 1/2$  shell length. Umbilicus imperforated.

*Measures (in mm)*: **Holotype**: 6 whorls; H = 2.6; D = 1.3; S = 1.5; h = 1.0; d = 0.8.

*Examined material*: Types.

*Discussion*: The species was originally described in the genus *Carychium*, a Holarctic genus and one of the few exclusively terrestrial animals of the family Ellobiidae (Morton, 1955; Barker, 2001). The apertural dentition is conspicuous in the family (Martins, 1996) and was the single character used by Ferreira & Coelho (1971) in their original classification. These authors stated that the species presented a "greatly evident" single columellar tooth. In the original illustration presented by them (Ferreira & Coelho, 1971: 468, fig. 4), such tooth can be clearly seen. However, after examining the type specimens, only the holotype seemed to possess this tooth. Further examination under stereomicroscope revealed that the supposed tooth was in fact a grain of sediment placed in such a manner that a quick glance could take it for an actual shell structure. After this grain was removed, a toothless aperture was revealed. Therefore, the original classification of this species in that genus, done exclusively due to the apertural dentition, is mistaken. In the absence of such dentition, we propose here the reallocation in the family Ferussaciidae.

Ferussaciidae has an almost global distribution: Europe, Middle East, Asia (tropical regions), Africa and Americas. Its fossil record goes back to the Eocene of Europe, but due to the simplicity and fragility of the shells, such fossils are considered dubious by some authors (Solem, 1976, 1979). The Itaborahian species is surprisingly similar to recent Ferussaciidae, showing a thin, fragile and diminutive shell, the suture weakly marked and the protoconch dome-shaped, broad and robust. The sequence of rock where this species occurs in the stratigraphical record has been regarded as deposited in calm conditions, allowing the preservation of mollusks with fragile shell (Rodrigues Francisco & Cunha, 1978; Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

There are two recent ferussaciid genera in Brazil (Simone, 2006), *Geostilbia* Crosse, 1867, with two species, and *Cecilioides* Férussac, 1814, with only

*Ceciliooides consobrina* (Orbigny, 1841). The two species of *Geostilbia*, *G. gundlachi* (Pfeiffer, 1850) and *G. blandiana* Crosse, 1886, were both previously classified in the genus *Ceciliooides* (Morretes, 1949; Salgado & Coelho, 2003). We propose here that the Itaborahian species is reallocated in the genus *Ceciliooides*.

The oval shell shape of *Ceciliooides sommeri* is very similar to the norm in this genus and is especially similar to *C. consobrina* due to the more cylindrical shell and to the aperture less elongated in the upper palatal region. Meanwhile, *Geostilbia* species show more acuminate spires, giving a more conical aspect to their shells. *C. sommeri* differs from the other species in the genus by the sub-oval aperture and by the reflected and lightly thickened peristome. Such characters are not uncommon in the family, occurring in some species of the European genus *Ferussacia* Risso, 1826; however, the latter show more acuminate spires and much larger sizes.

### Family Orthalicidae

#### Subfamily Bulimulinae

#### Genus *Bulimulus* Leach, 1814

#### *Bulimulus fazendicus* Maury, 1935

(Figs. 36-37)

*Bulimulus fazendicus* Maury, 1935: 7 (figs. 10, 11); Oliveira, 1936: 5; Mezzalira, 1946: 18; Magalhães & Mezzalira, 1953: 218 (pl. 64, fig. 257); Trindade, 1956: 14 (pl. 3, figs. 1d, 2d); Brito, 1967: 16 (pl. 2, fig. 1); Palma & Brito, 1974: 393 (pl. 1, fig. 3); Breure, 1979: 137; Simone & Mezzalira, 1994: 50 (pl. 15, fig. 420); Bergqvist *et al.*, 2006: 57 (fig. 64).

*Bulimulus* (sensu lato) *fazendicus*: Parodiz, 1969: 182.  
*Itaborahia fazendicus*: Breure, 1978: 237.

*Holotype*: AMNH 24243 (examined; Fig. 36).

*Paratype*: AMNH 24242 (1 specimen, examined; Fig. 37).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequences S1 and S2 (Meireiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: Reference to place of discovery, the then called *Fazenda São José*, of which Itaboraí Basin was a part.

*Diagnosis*: Shell small, narrow. Spire high. Profile of whorls flat. Aperture small and narrow, elliptical and slightly trapezoid.

*Re-Description*: Shell small, conical-oval, narrow, with acuminate apex. Spire high; 8 whorls. Shell smooth, except for growth lines. Greatest width on body whorl; width  $\sim 1/2$  shell length. Spire angle  $\sim 55^\circ$ . Protoconch apparently smooth; transition to teleoconch not clear. Suture well-marked, slightly oblique (diagonal) to columellar axis. Profile of whorls flat. Aperture small and narrow, orthocone, elliptical and slightly trapezoid;  $\sim 1/3$  shell length. Lamellae or teeth absent. Peristome thin, weakly reflected (only in the columellar region). Body whorl  $\sim 1/3$  shell length. Umbilicus narrow, partially covered by the lip.

*Measures (in mm)*: **Holotype**: 8 whorls; H = 16.4; D = 9.1; S = 10.5; h = 6.1; d = 5.1. **Paratype**: 8 whorls; H = 16.3; D = 9.1; S = 10.6; h = 6.1; d = 5.5.

*Examined material*: Types. DGM unnumbered (8 specimens); MNRJ 4339-I (4 specimens); MZSP 86326 (1 specimen).

*Discussion*: Protoconch sculptural pattern is an important character in Bulimulinae taxonomy (Breure, 1978, 1979; Schileyko, 1999a). The shell of *Bulimulus fazendicus* is completely smooth, including the protoconch. This could be a diagnostic feature of this species but could also be a preservation artifact, since this kind of sculpture is very delicate and can be easily erased during fossil diagenesis. This same statement is valid for the others orthalicids from Itaboraí. Maury (1935) comments that one specimen showed vertical ribs on the second or third whorl and Breure (1978) says that the protoconch of *B. fazendicus* shows vertical ribs; however, this character could not be confirmed.

Maury (1935), citing a personal communication from Henry A. Pilsbry, stated that *B. fazendicus* does not seem to be closely related to any other *Bulimulus* species. However, *B. fazendicus* is very similar to high-spired species that also present a narrow aperture such as *B. felipponei* Marshall, 1930. *B. fazendicus* differs from the other species by its slightly flattened whorls, suture more weakly marked and trapezoid aperture (broader than tall).

***Bulimulus trindadeae* Ferreira & Coelho, 1971**  
(Figs. 38-39)

*Bulimulus trindadeae* Ferreira & Coelho, 1971: 470 (fig. 7); Palma & Brito, 1974: 394; Breure, 1979: 137; Simone & Mezzalira, 1994: 50 (pl. 15, fig. 424).

*Itaborahia trindadeae*: Bergqvist *et al.*, 2006: 58 (fig. 69).

*Holotype*: MNRJ 5022-I (examined; Figs. 38-39).

*Paratype*: MNRJ 5023-I (4 specimens, examined).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: Species dedicated to Prof. Nicéa M. Trindade (*Faculdade Nacional de Filosofia*, Rio de Janeiro, Brazil).

*Diagnosis*: Shell small, conical, narrow. Spire high. Aperture elliptical, tall and narrow.

*Re-Description*: Shell small, conical, narrow. Spire high. Shell smooth, except for growth lines. Greatest width (supposedly) on body whorl; width  $\sim 1/3$  shell length. Spire angle  $\sim 35^\circ$ . Protoconch blunt, apparently smooth; transition to teleoconch unclear. Profile of whorls slightly convex. Suture well-marked, oblique (diagonal) to columellar axis; less oblique on first whorls. Aperture supposed elliptical, tall and narrow, orthocline;  $\sim 2/5$  shell length.

*Measures (in mm)*: **Holotype**: probably 6 whorls; H = 9.4; D = 3.3; S = 5.4. **Paratype**: probably 6 whorls; H = 5.6; D = 2.6.

*Examined material*: Types.

*Discussion*: The few specimens of *B. trindadeae* are in a bad state of preservation, including the type specimens: the apertures are broken or completely covered by sediment. It is impossible to even tell if a shell is an adult or not and, therefore, the precise number of whorls could not be counted. In the same manner, it

is impossible to confirm the presence of teeth or lamellae. However, as stated below, there is a set of characters that guarantees its validity as a distinct species.

Palma & Brito (1974) say that they were able to study additional specimens of *B. trindadeae*, better preserved, but they did not indicate in their work in which collection the specimens are stored and did not figure the material. There is no record of this additional material at the MNRJ and DGM collections, where material from Itaboraí was commonly stored. The authors also stated that it was possible for them to analyze the shell aperture and indicate the existence of a columellar fold. This character was posteriorly used by Ribeiro (2003) and Bergqvist *et al.* (2006) to reallocate *B. trindadeae* in the genus *Itaborahia*. However, even if there is such a fold or lamella, not even a single other character can sustain this reallocation.

The tall and narrow shell as well as the supposed elliptical shape of the aperture of *B. trindadeae* is known in the genus *Bulimulus*, albeit rarely. However, it is also typical of other orthalicids, notably in the subfamily Odontostominae as, for example, in the genus *Cyclodontina* Beck, 1837, which also occurs in Itaboraí. To have a clearer idea of *B. trindadeae* generic allocation, the apertural dentition, an important character for Odontostominae, should be known. Unfortunately, the available specimens do not allow going further in the classification and, therefore, the original classification is maintained here, at least until better preserved specimens are obtained.

***Cortana* gen. nov.**  
(Figs. 40-42)

*Type species*: *Bulimulus carvalhoi* Brito, 1967.

*Included species*: *Cortana carvalhoi* (Brito, 1967).

*Geographic and stratigraphic occurrence*: Known only from Itaboraí Basin, limestone Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: The name was taken from a character of the science fiction franchise "Halo", and alludes to the convoluted markings on the shell surface of the holotype of *Cortana carvalhoi*. Grammatical gender: feminine.

*Diagnosis*: Shell fusiform. Spire apex acuminate, with straight outline. Profile of whorls flat. Peristome greatly reflected, with exception of upper palatal

region. Aperture oval, elongated anteroposteriorly, orthocline; median palatal tooth, columellar lamella and channel-like structure immediately above the lamella. Umbilicus imperforated.

*Description:* Shell dexterous, fusiform. Greatest width on body whorl. Spire apex acuminate, with straight outline. Profile of whorls flat. Suture well-marked, linear, oblique (diagonal) to columellar axis, Protoconch apparently smooth; transition to teleoconch unclear. Teleoconch smooth, except for growth lines. Aperture medium-sized, oval elongated anteroposteriorly, orthocline, occluded by a columellar lamella and palatal tooth in its median portion. Peristome greatly reflected, with exception of upper palatal region; incomplete (absent in parietal region). Aperture with a columellar lamella extending itself towards the shell interior and a median palatal tooth. Aperture with channel-like structure immediately above the columellar lamella, giving the impression of a twisted columella. Umbilicus imperforated.

*Discussion:* The species originally described as *Bulimulus carvalhoi*, is here transferred to a new genus because there is not an existing genus, fossil or recent, which can unequivocally house it. The new genus *Cortana* is based on its fusiform shell and the many characters of the shell aperture.

*Shell shape:* Despite the overall shell shape being typical of some genera of Orthalicidae, a shell as markedly fusiform as in the Itaborahian species, with the body whorl greatly thinning towards the shell's bottom, clearly does not occur in the genus *Bulimulus*. There are other fusiform genera, especially in the subfamily Odontostominae, but none of them has such a large body whorl, typical of Bulimulinae. As such, *Cortana* is most similar to the South-American bulimuline genus *Eudolichotis* Pilsbry, 1896, which is both fusiform and has a large body whorl.

*Aperture, peristome and lamellae:* The great differential in *Cortana* is in its aperture; there is nothing similar to it in any other orthalicid, recent or fossil. The peristome is greatly reflected in the lower half of the aperture, which is U-shaped; this region is delimited by a strong columellar lamella and a median palatal tooth. Besides, immediately above the lamella, there is a channel-like structure, which gives the impression of a twisted columella.

*Cortana carvalhoi* was already classified as *Itaborahia* (Bergqvist *et al.*, 2006) due to its "columellar fold". However, the lamella of *C. carvalhoi* is much

stronger and is located in a much lower position than in *Itaborahia*. This, when taken together with the fusiform shape of the shell, its straight spire, orthocline aperture and the channel-like structure, indicates clearly that *Cortana carvalhoi* cannot be allocated in the genus *Itaborahia*.

*C. carvalhoi* also shows similarities to the genus *Eudolichotis* regarding its aperture. Besides the similar shape, *Eudolichotis* has a strong columellar lamella and the peristome usually reflected. Moreover, some species as, for example, *E. distorta* (Bruguière, 1789), also have a thickening of the median palatal region. This thickening, however, does not form a proper tooth. Nevertheless, besides having a palatal tooth, *C. carvalhoi* also differentiates itself from *Eudolichotis* by the channel-like structure above the columellar lamella and by the upper palatal region of the peristome (above the tooth), which is not reflected. Another genus in which a similar configuration of the aperture is present is *Otostomus* Beck, 1837, from the east-central region of Brazil (Simone, 2006). This genus had two species, recently put in synonymy (Simone, 2006). The aperture of *Otostomus signatus* (Spix, 1827) shows a large parietal lamella and a parallel lamella extending itself from the basal region to the superior palatal region. Still, the shape of the aperture of *O. signatus*, as well as its shell shape and the presence of an umbilicus, makes it very different from *Cortana*.

***Cortana carvalhoi* (Brito, 1967) comb. nov.  
(Figs. 40-42)**

*Bulimulus carvalhoi* Brito, 1967: 18 (pl. 2, fig. 4-6);  
Palma & Brito, 1974: 394 (pl. 1, fig. 2); Breure,  
1979: 137; Simone & Mezzalira, 1994: 50  
(pl. 14, fig. 418).

*Itaborahia carvalhoi:* Bergqvist *et al.*, 2006: 58  
(fig. 66).

*Holotype:* DGM 4995-I (examined; Figs. 40-42).

*Paratype:* DGM 4996-I (1 specimen, examined).

*Type Locality:* Limestones of Parque Paleontológico de São José de Itaboraí, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence:* Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age:* Tertiary, Middle Paleocene.

*Etymology:* Species dedicated to its collector, Julio S. Carvalho (*Divisão de Geologia e Mineralogia do Departamento Nacional de Produção Mineral, DNPM, Rio de Janeiro, Brazil*).

*Diagnosis:* Shell fusiform. Spire apex acuminate, with straight outline. Profile of whorls flat. Peristome greatly reflected, with exception of upper palatal region. Aperture oval, elongated anteroposteriorly, orthocline; median palatal tooth, columellar lamella and channel-like structure immediately above the lamella. Umbilicus imperforated.

*Re-Description:* Shell large, fusiform. Greatest width on body whorl; width  $\sim 2/5$  shell length. Spire angle  $\sim 45^\circ$ . Spire apex acuminate, with straight outline. Profile of whorls flat. Suture well-marked, linear, oblique (diagonal) to columellar axis, Protoconch apparently smooth; transition to teleoconch unclear. Teleoconch smooth, except for growth lines. Aperture medium-sized, oval elongated anteroposteriorly (width  $\sim 1/2$  height), orthocline, occluded by columellar lamella and palatal tooth in its median portion; aperture  $\sim 2/5$  shell length. Peristome greatly reflected, with exception of upper palatal region; incomplete (absent in parietal region). Aperture with columellar lamella extending itself towards interior and a median palatal tooth. Aperture with channel-like structure immediately above columellar lamella (makes columella seem twisted). Body whorl  $\sim 1/2$  shell length. Umbilicus imperforated.

*Measures (in mm):* **Holotype:** 8 whorls; H = 30.5; D = 12.0; S = 17.9; h = 13.0; d = 6.1. **Paratype:** D = 9.1.

*Examined material:* Types.

*Discussion:* This species was originally classified in the genus *Bulimulus* by Brito (1967) and was posteriorly transferred to *Itaborahia* by Bergqvist *et al.* (2006). Clearly, this species differs greatly from species of both genera and from all other orthalicids (mainly due to its unique aperture) and was thus reallocated in the new genus *Cortana*, as stated above.

As explained in the discussion above for the genus, *C. carvalhoi*'s aperture shows some similarities to the genera *Eudolichotis* and *Otostomus*. However, the aperture still differs greatly from both due to the dentition and the channel-like structure. The aperture shows a partial occlusion in its median region due to the palatal tooth and the columellar lamella. Apertural occlusions by strong structures such as seen in

*C. carvalhoi* are typical barriers that protect against predators that attack through the aperture (Solem, 1972; Goodfriend, 1986; Stanley, 1988; Vermeij, 1993; Gittenberger, 1996; Barker & Efford, 2004).

*Remarks:* The holotype shows markings similar to a sculpture pattern on part of the body whorl (Fig. 40). However, this does not seem to be a natural pattern; instead, it seems to have been caused during fossil diagenesis.

### Genus *Itaborahia* Maury, 1935 (Figs. 43-50)

*Itaborahia* Maury, 1935: 9; Oliveira, 1936: 5; Magalhães & Mezzalira, 1953: 220; Trindade, 1956: 13; Parodiz, 1969: 182; Breure, 1978: 236; 1979: 137; Bergqvist *et al.*, 2006: 58.

*Itaborahya* (error): Mezzalira, 1946: 18.

*Bulimulus?* (*Itaborahia*): Zilch in Wenz, 1959-60: 485. (in synonymy, *non* Leach, 1814).

*Bulimulus:* Brito, 1967: 16; Palma & Brito, 1974: 393; Simone & Mezzalira, 1994: 50; Rodrigues & Fonseca, 2007: 253. (in synonymy, *non* Leach, 1814).

*Type species:* *Itaborahia lamegoi* Maury, 1935.

*Included species:* *I. lamegoi* Maury, 1935.

*Geographic and stratigraphic occurrence:* Known only from Itaboraí Basin, limestone Sequences S1 and S2 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age:* Tertiary, Middle Paleocene.

*Etymology:* Reference to place of discovery: Itaboraí Basin.

*Diagnosis:* Shell fusiform. Spire apex sharply acuminate, with concave outline. Aperture prosocline. Peristome reflected, incomplete (absent in parietal region). Columellar fold in the uppermost part of the columellar region (next to parietal region). Umbilicus imperforated.

*Re-Description:* Shell dexterous, fusiform. Greatest width on body whorl. Profile of whorls slightly convex. Spire apex sharply acuminate, with concave outline. Suture well-marked, linear, slightly oblique (diagonal) to columellar axis. Protoconch apparently smooth; transition to teleoconch unclear. Shell smooth, except for growth lines. Aperture large, sub-oval, prosocline. Peristome reflected, incomplete (absent in parietal

region). Columellar fold in the uppermost part of the columellar region (next to parietal region), extending itself towards interior. Umbilicus imperforated.

*Discussion:* Maury (1935) has created the genus *Itaborahia*, classifying it in Bulimulinae, in order to house one of the new species found in Itaboraí Basin, *I. lamegoi*. Maury (1935) pointed the similarity between the new species and the genera *Rhinus* Martens in Albers, 1860 and *Neopetraeus* Martens, 1885, but has decided to create a new genus due to the presence of a “prominent fold in the columella”.

The genus was maintained until Zilch (1959-60) has put it in doubt, presenting *Itaborahia* as a possible subgenus of *Bulimulus*. Brito (1967) followed Zilch (1959-60), but did not maintain *Itaborahia* as a subgenus; instead, treated it as a synonym of *Bulimulus* and referred to the type species as *Bulimulus lamegoi*. Additionally, Brito (1967) also described the new species *B. carvalhoi*. A couple of years later, Parodiz (1969) maintained *Itaborahia* as a valid genus due to the columellar fold, but including only *I. lamegoi* in the genus; showing that he possibly did not know the work of Brito (1967). Ferreira & Coelho (1971) maintained the synonymy with *Bulimulus* and described one more species, *B. trindadeae*. Later, Palma & Brito (1974) described the new species *B. coelhoi*, also maintaining the synonymy, but citing the columellar fold for *B. lamegoi*, *B. carvalhoi*, *B. trindadeae* and *B. coelhoi*.

Ribeiro (2003) has revalidated the genus *Itaborahia*, but has done so in a congress' abstract, which has no validity according to Article 9.9 of the ICZN (1999). Moreover, Ribeiro (2003) transferred the four species cited above to the genus *Itaborahia*; however, she did not explain the reason of the revalidation and the reallocation. In any case, the work of Ribeiro (2003) is cited and accepted by Bergqvist *et al.* (2006), thus validating these nomenclatural acts, resulting in the combinations *I. lamegoi*, *I. carvalhoi*, *I. trindadeae* and *I. coelhoi*. Bergqvist *et al.* (2006) indicate the columellar fold as the character responsible for the genus revalidation. Still, the only later work dealing with these mollusks is a short note, and it maintained the synonymy of *Itaborahia* with *Bulimulus* (Rodrigues & Fonseca, 2007). The revalidation of *Itaborahia* is accepted here, by the reasons explained below, but containing only the type species, *I. lamegoi*. Moreover, the genus description and diagnosis are complemented.

*Shell shape:* In a general way, *Itaborahia*'s shell has typical orthalicid shape and, more specifically that of Bulimulinae. Maury (1935) commented about the similarity between *Itaborahia* and *Rhinus*, but such

similarity is treated with caution here. *Rhinus* has a more oval and broader shell, its aperture is not prosocline and it does not have a columellar fold. Besides, *Rhinus* has a pilose periostracum, a character that unfortunately is not preserved in the fossil record. Moreover, the apex of the shell of *Itaborahia* is very characteristic, sharply acuminate and with a somewhat concave outline. Some species of the genus *Corona* Albers, 1850 have an acuminate apex, but have a straighter outline, never concave.

*Sculpture:* Protoconch sculpture is an important character in orthalicid taxonomy, especially for the Bulimulinae (Breure, 1979; Schileyko, 1999a). All known specimens of *Itaborahia* display smooth shell, including the protoconch. This can be a diagnostic feature of the genus but, despite the apparently good preservation state of the fossils, it could also be a preservation artifact, since this kind of sculpture is very delicate and can be easily erased during fossil diagenesis.

*Aperture, peristome and lamellae:* The closest genus to *Itaborahia* is perhaps *Bulimulus*, since so many authors have treated them as synonyms. However, such similarity is not as deep as it seems, especially when the aperture is taken into account. *Itaborahia*'s aperture is completely distinct: (1) it is sub-oval, with an expanded and reflected peristome, two features uncommon but not unheard of in the family; (2) the most striking feature however is its prosocline aperture, a rare character in orthalicids. Moreover, *Itaborahia* has a columellar fold, the very character used by all authors who maintained it as a distinct genus from *Bulimulus* (Maury, 1935; Parodiz, 1969; Ribeiro, 2003; Bergqvist *et al.*, 2006). However, similar folds have been found in other orthalicids as, for example, in the genus *Drymaeus* Albers, 1850. Therefore, it is regarded that only the columellar fold is not enough for the definition of *Itaborahia* as a distinct genus. As stated before, beside the columellar fold, other diagnostic features of *Itaborahia* are the sharply acuminate spire apex with a concave outline and the prosocline aperture.

### ***Itaborahia lamegoi* Maury, 1935 (Figs. 43-50)**

*Itaborahia lamegoi* Maury, 1935: 10 (figs. 6, 7); Oliveira, 1936: 5; Paula Couto, 1949: 11; Trindade, 1956: 13 (pl. 2, figs. 1b, 2b); Magalhães & Mezzalira, 1953: 220 (pl. 64, fig. 258); Parodiz, 1969: 183 (pl. 19, fig. 13); Breure, 1979: 137; Bergqvist *et al.*, 2006: 58 (fig. 68).

*Itaborahya lamegoi* (error): Mezzalira, 1946: 18.

*Bulimulus* ? (*Itaborahia*) *lamegoi*: Zilch in Wenz, 1959-60: 485, (fig. 1706).

*Bulimulus lamegoi*: Brito, 1967: 17 (pl. 2, fig. 3); Palma & Brito, 1974: 394 (pl. 1, fig. 1); Simone & Mezzalira, 1994: 51 (pl. 15, fig. 422); Rodrigues & Fonseca, 2007: 253.

*Bulimulus sommeri* Palma & Brito, 1974: 396 (pl. 2, fig. 3, 5); Breure, 1979: 137; Simone & Mezzalira, 1994: 50 (pl. 15, fig. 423); Bergqvist *et al.*, 2006: 57 (fig. 65).

*Holotype*: AMNH 24240 (examined; Figs. 48-49).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequences S1 and S2 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: Species dedicated to its collector, Dr. Alberto R. Lamego (*Serviço Geológico e Mineralógico do Brasil*).

*Diagnosis*: Shell fusiform. Spire apex sharply acuminated, with somewhat concave outline. Aperture prosocline. Peristome reflected, incomplete (absent in parietal region). Columellar fold in the uppermost part of the columellar region (next to parietal region). Umbilicus imperforated.

*Re-Description*: Shell large, fusiform. Greatest width on body whorl; width  $\sim 1/2$  shell length. Spire angle  $\sim 50^\circ$ . Profile of whorls slightly convex. Spire apex sharply acuminated, with somewhat concave outline. Suture well-marked, linear, slightly oblique (diagonal) to columellar axis. Protoconch apparently smooth; transition to teleoconch unclear. Shell smooth, except for growth lines. Aperture large, sub-oval, prosocline;  $\sim 1/2$  shell length. Peristome reflected, incomplete (absent in parietal region). Columellar fold in uppermost part of columellar region (next to parietal region), extending itself towards shell interior. Body whorl  $\sim 2/3$  shell length. Umbilicus imperforated.

*Measures (in mm)*: **Holotype**: 6 or 7 whorls (shell apex broken); H = 31.4; D = 15.1; S = 16.7; h = 15.9; d = 9.9. **Mean (n = 7)**: 7 whorls; H = 30.6  $\pm$  4.5 (max 34.6; min 25.7); D = 13.3  $\pm$  1.8 (max 16.5;

min 11.8); S = 16.0  $\pm$  2.3 (max 18.6; min 13.6); h = 14.1  $\pm$  2.5 (max 16.5; min 11.6); d = 9.1  $\pm$  1.4 (max 10.7; min 7.1).

*Examined material*: Holotype. DGM 3001-I (10 specimens), 4223-I (2 specimens), 5001-I (3 specimens); MNRJ 3350-I (1 specimen), 4341-I (1 specimen); MZSP 94822 (1 specimen), 98180 (1 specimen). Type material of *Bulimulus sommeri*: DGM 5411-I (holotype).

*Discussion*: Among all the species previously classified as *Itaborahia*, only the type species, *I. lamegoi*, is here maintained in the genus. All the other species show different shell shapes and lack a concave outline, a prosocline aperture and a columellar fold. The other species previously classified in *Itaborahia* by Bergqvist *et al.* (2006) are here classified as *Bulimulus trindadeae*, *Cyclodontina coelhoi* and *Cortana carvalhoi*.

The holotype of *Bulimulus sommeri* Palma & Brito, 1974 (DGM 5411-I; Figs. 50) is considered here as indistinguishable from *Itaborahia lamegoi* and, therefore, these species are synonyms. The paratype of *B. sommeri* (MNRJ 5188-I) is a new species of the genus *Eoborus* Klappenbach & Olazarri, 1970, and is described further in this work as *E. fusiforme* sp. nov.

### Genus *Leiostracus* Albers, 1850

#### *Leiostracus ferreirai* (Palma & Brito, 1974) comb. nov.

(Figs. 51-58)

*Bulimulus ferreirai* Palma & Brito, 1974: 393 (pl. 2, fig. 1, 6); Breure, 1979: 137; Simone & Mezzalira, 1994: 50 (pl. 15, fig. 421); Rodrigues & Fonseca, 2007: 253.

*Itaborahia ferreirai*: Breure, 1978: 238.

*Bulimulus fazendicus*: Bergqvist *et al.*, 2006: 57. (in synonymy, *non* Maury, 1935).

*Holotype*: DGM 5409-I (examined; Fig. 56).

*Paratype*: MNRJ 5186-I (1 specimen, examined; Figs. 57-58).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequences S1 and S2 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).



*Age:* Tertiary, Middle Paleocene.

*Etymology:* Species dedicated to Prof. Cândido S. Ferreira (*Museu Nacional*, Rio de Janeiro, Brazil).

*Diagnosis:* Shell small. Protoconch with fine axial ribs. Aperture rounded and diagonally elongated.

*Re-Description:* Shell small, conical-oval, with an acuminate apex; 7 whorls. Greatest width on last whorl; width  $\approx \frac{2}{3}$  shell length. Spire angle  $\approx 55^\circ$ . Protoconch with  $1\frac{1}{2}$  whorl, pointed, sculptured by fine axial ribs; transition to teleoconch clear. Teleoconch smooth, except for growth lines. Profile of whorls convex. Suture well-marked, slightly oblique (diagonal) to columellar axis; less oblique (approximately horizontal) on first whorl. Aperture medium-sized, orthocone, rounded, diagonally elongated; aperture  $\approx \frac{3}{5}$  shell width. Lamellae and teeth absent. Peristome complete, reflected; more strongly reflected in columellar region. Body whorl with bottom slightly flattened;  $\approx \frac{1}{2}$  shell length. Umbilicus narrow, partially covered by peristome.

*Measures (in mm):* **Holotype:** 6 whorls (shell apex and aperture broken); H = 9.7; S = 6.2. **Paratype:** 7 whorls; H = 10.8; D = 6.7; S = 7.2. **Figured specimen (DGM 4993-I):** 7 whorls; H = 12.2; D = 7.2; S = 7.7; h = 4.5; d = 4.2.

*Examined material:* Types. DGM 4993-I (4 specimens).

*Discussion:* This species was originally described as *Bulimulus ferreirai* by Palma & Brito (1974). These authors offered a diagnosis to differentiate the species from *Bulimulus fazendicus*: more convex whorls and a well-marked suture. Ribeiro (2003) proposed the synonymy between these two species, but has done it in a congress abstract, which is not valid according to Article 9.9 of the ICZN (1999). However, the work of Ribeiro (2003) is cited by Bergqvist *et al.* (2006), making the synonymy valid. In any case, no one has explained the decision in favor of the synonymy. Besides, the only later work dealing with this species is a short note, and it maintained the two species as distinct (Rodrigues & Fonseca, 2007). Therefore, as the species present significant differences between them, such synonymy is not accepted here. Additionally, after analyzing a greater number of well-preserved specimens, we decided for the reallocation of the species in the genus *Leiostracus* Albers, 1850. This is an additional indication of the differences between this species and *B. fazendicus*. *Leiostracus* is a recent genus and

its distribution reaches from Guyana and Suriname to the states of Minas Gerais and Espírito Santo, in Brazil (Breure, 1979; Schileyko, 1999a; Simone, 2006).

Until now there were only two known specimens of *Leiostracus ferreirai*: the type material. The holotype (DGM 5409-I) has a broken aperture and approximately one third of the body whorl is broken (seen by the scar left in the previous whorl; Fig. 56). The paratype (MNRJ 5186-I) is not an adult, lacking a reflected lip (Fig. 57-58). This makes the shell smaller and does not allow the study of important characters for taxonomy such as the shell aperture. However, specimens in an excellent preservational state were found in the collections (DGM 4993-I; Figs. 51-55), erroneously identified as *B. fazendicus*. The analysis of these new specimens made the generic reallocation possible.

*Leiostracus ferreirai* has some of the typical characters of the genus: a conical shell with the sides of the spire straight, the protoconch sculptured by fine axial ribs, a strongly marked suture, the aperture diagonally elongated, and a thickened lip. Breure (1978) had already noticed that the protoconch of *L. ferreirai* (which he calls *Itaborahia ferreirai*) had axial ribs. *L. ferreirai* differs from the other species in the genus by its smaller size, greater number of whorls for its size, and more convex whorls. Besides, *L. ferreirai* can be easily differentiated of *B. fazendicus* by its smaller size, a larger, rounded and diagonally elongated aperture, a more strongly reflected lip and the two characters already pointed by Palma & Brito (1974): more convex whorls and a better-marked suture.

**Subfamily Odontostominae**  
**Genus *Cyclodontina* Beck, 1837**  
*Cyclodontina coelhoi* (Palma & Brito, 1974)  
**comb. nov.**  
**(Figs. 59-61)**

*Bulimulus coelhoi* Palma & Brito, 1974: 396 (pl. II, figs. 2, 4); Breure, 1979: 137; Simone & Mezzalira, 1994: 50 (pl. 15, fig. 419).

*Itaborahia coelhoi*: Bergqvist *et al.*, 2006: 58 (fig. 67).

*Holotype:* DGM 5410-I (examined; Fig. 61).

*Paratype:* MNRJ 5187-I (1 specimen, examined; Figs. 59-60).

*Type Locality:* Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence:* Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age:* Tertiary, Middle Paleocene.

*Etymology:* Species dedicated to Prof. Arnaldo C.S. Coelho (*Museu Nacional*, Rio de Janeiro, Brazil).

*Diagnosis:* Shell small, smooth. Whorls with a weakly raised fold on its central or upper portions. Aperture more laterally positioned. Single columellar lamella.

*Re-Description:* Shell small to medium-sized, conical, slightly fusiform. Greatest width on body whorl; width  $\sim 2/5$  shell length. Spire angle  $\sim 40^\circ$ . Protoconch dome-shaped, blunt, smooth; transition to teleoconch unclear. Teleoconch smooth, except for growth lines. Suture well-marked, oblique (diagonal) to columellar axis. Profile of whorls flat. Central portion of first whorls raised, forming a weakly raised fold; same pattern present on other whorls, but on upper portion only. Aperture medium-sized, slightly prosocline, oval and vertically elongated;  $\sim 3/5$  shell width and  $\sim 2/5$  shell length. Peristome thickened and reflected, more markedly on basal and columellar regions. Columellar spiral lamella strong and raised, extending itself towards interior; outer portion of lamella more prominent ("bilobate" *sensu* Palma & Brito, 1974). Body whorl  $\sim 1/2$  shell length. Umbilicus almost completely obstructed by peristome.

*Measures (in mm):* **Holotype:** 8 whorls; H = 15.3; D = 5.7; S = 9.1; h = 6.1; d = 3.4. **Paratype:** 7 whorls; H = 11.7; D = 4.7; S = 7.2; h = 4.3; d = 2.7.

*Examined material:* Types.

*Discussion:* This species was originally classified in the genus *Bulimulus* by Palma & Brito (1974) and posteriorly transferred to the genus *Itaborahia* due to its supposed columellar fold (Ribeiro, 2003; Bergqvist *et al.*, 2006). However, both generic attributions are mistaken. Besides its aperture and shell shape being completely different from *Bulimulus*, it also has a columellar lamella. The same holds true when comparing it to *Itaborahia* and, additionally, its strong columellar lamella is totally distinct from *Itaborahia*'s simple columellar fold (and it is also located in a distinct region).

This species shares many similarities with the genus *Cyclodontina* Beck, 1837 and thus we propose here the new combination *Cyclodontina coelhoi*.

*Cyclodontina* is a recent and diverse Odontostominae genus, occurring in tropical and subtropical regions of South America, including Brazil (Simone, 2006). The typical features of *Cyclodontina* displayed by *C. coelhoi* are: a conical and slightly fusiform shell shape, flat whorls, incomplete (absent in parietal region) and reflected peristome, aperture oval and vertically elongated, and the presence of a strong columellar lamella. *C. coelhoi* differs from the other species in the genus by its small size, smooth shell, whorls with a weakly raised fold, aperture positioned more laterally, and by having only the columellar lamella (without other teeth or lamellae).

Despite shell sculpture being commonplace in the genus, there are several species with smooth shell as, for example, *C. catharinae* (Pfeiffer, 1856) and *C. tudiculata* (Martens, 1868). Other *Cyclodontina* species show a strong columellar lamella, similar to what is found in *C. coelhoi*, but they have at least two more teeth/lamella in their apertures. As *C. coelhoi* has only the columellar lamella, it is plausible to suppose that, due to this fossil's old age, the lamella has been the first structure to appear in the genus' history; the other teeth and lamellae would have appeared later. The strong and raised lamella of *C. coelhoi* is a typical barrier to obstruct the aperture, protecting the animal against predators (Solem, 1972; Goodfriend, 1986; Stanley, 1988; Vermeij, 1993; Gittenberger, 1996; Barker & Efford, 2004).

**Genus *Plagiodontes* Doering, 1876**  
***Plagiodontes* aff. *dentatus* (Wood, 1828)**  
**(Figs. 62-65)**

*Plagiodontes* aff. *dentatus*: Salvador & Simone, 2012: 4 (figs. 9-10).

*Locality:* Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence:* With this record, the species is also known from the limestones of Itaboraí Basin. The precise stratigraphic occurrence can't be assessed; probably Sequence S1, the same sequence of occurrence of the other orthalicids (Medeiros & Bergqvist, 1999; Bergqvist *et al.* 2006).

*Age:* Tertiary, Middle Paleocene.

*Diagnostic features:* Shell multispiral, about 1.4 times longer than wide. Spire angle  $\sim 45^\circ$ . Fine ribs (about

77 on penultimate whorl), oblique to suture. Suture well-marked, oblique (diagonal) to columellar axis. First three to four whorls unsculptured (but may be an artifact of preservation). First whorls less convex; middle to last whorls more convex. Greatest width on (apparently) penultimate whorl.

*Measures (in mm)*: 7 whorls, H = 9.6, D = 7.1 (greatest diameter on penultimate whorl). The specimen is partially broken (lacking the aperture and protoconch), so the shell's real measures would be greater.

*Examined material*: MCT 6944-I.

*Discussion*: *Plagiodontes* is a Recent genus, occurring in tropical and subtropical regions of Brazil and southern South America, sometimes considered a subgenus of *Cyclodontina* (Pizá & Cazzaniga, 2003, 2009; Simone, 2006). *Plagiodontes dentatus* (Wood, 1828) is a Recent species found in the vicinities of La Plata River, Entre Ríos province, Argentina, and in Montevideo, Uruguay (Pizá & Cazzaniga, 2003, 2009; Morton & Herbst, 2007). However, there is a possible fossil record of this species: *Cyclodontina* cf. (*Plagiodontes*) *dentata* (Wood, 1828) from the Miocene of Uruguay and the Miocene and Pleistocene of Argentina (Caorsi & Goñi, 1958; Parodiz, 1969; Morton & Herbst, 2007).

The only specimen of Itaboraí was found among other orthalicids in the collection of the MCT and the presence of ribs on it has readily set it apart from the others. However, its preservation is far from good: the aperture and part of the protoconch are broken (*Plagiodontes* show striae on the protoconch; Pizá & Cazzaniga, 2003). Knowing only the middle portion of the shell, this specimen could fit in many Recent genera of Odontostominae; the rib pattern, however, narrows the possibilities to *Plagiodontes*, *Cyclodontina* and *Clessinia* Doering, 1875. The most marked difference between these genera is the apertural dentition: *Plagiodontes* and *Cyclodontina* have many teeth while *Clessinia* has none. Despite not knowing the aperture of the specimen, the placement in the genus *Plagiodontes* was preferred due to the shape of the whorls (middle to last whorls more convex and not much larger than the less convex preceding ones) and also for its known South American fossil record. Moreover, due to lack of information regarding the aperture, it was preferred to place the specimen provisionally under open classification, showing affinity to the recent species *Plagiodontes dentatus*. The fossils from this species also have a tentative classification, since not even a single well-preserved specimen was found.

Both geographical and temporal distances could indicate that the Itaborahian *Plagiodontes* belongs to a new species. However, rather than describing it as a new species, the present classification as *Plagiodontes* aff. *dentatus* was considered safer (as in Salvador & Simone, 2012), at least until more (and better preserved) material has been found.

## Family Strophocheilidae

### Subfamily Megalobuliminae

#### Genus *Eoborus* Klappenbach & Olazarri, 1970

#### *Eoborus rotundus* Salvador & Simone, 2012 (Figs. 66-74)

*Eoborus rotundus* Salvador & Simone, 2012: 4 (figs. 11-15).

*Holotype*: MCT 6941-I (examined; Figs. 70-74).

*Paratypes*: MCT 6942-I (1 specimen, examined; Figs. 66-67), MCT 6943-I (1 specimen, examined; Figs. 68-69).

*Type Locality*: Limestones of Parque Paleontológico de São José de Itaboraí, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality. The precise stratigraphic occurrence can't be assessed; probably Sequences S1 and S2, the same sequences of occurrence of *Eoborus sanctijosephi* (Medeiros & Bergqvist, 1999; Bergqvist *et al.* 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: The name refers to the rounded shell shape of the species.

*Diagnosis*: Size relatively small (~25 mm), shape ovoid, almost as large as high. Aperture rounded (instead of elliptical), with upper palatal region of outer lip meeting obliquely with preceding whorl. Peristome ample and highly reflexed. Large umbilicus.

*Description*: See Salvador & Simone (2012).

*Measures (in mm)*: **Holotype**: 5 whorls, H = 23.7, D = 16.8, S = 10.5, h = 12.4, d = 9.9. **Paratypes**: MCT 6942-I: 5 whorls, H = 25.5, D = 16.6, S = 10.5, h = 12.5. MCT 6943-I: 5 whorls, H = 25.5, D = 16.6; S = 10.4.

*Examined material*: Types.

*Discussion:* The genus *Eoborus* was created to house two species of Paleocene Strophocheilidae: *E. sanctijosephi* (Maury, 1935) from Itaboraí and *E. charruanus* (Frenguelli, 1930) from Uruguay. Both species were previously classified in the genus *Strophocheilus* Spix, 1827. Klappenbach & Olazarri (1970) decided to describe this new genus mainly due to a very striking feature of these two species: their wide umbilicus. Besides the type species, *E. charruanus*, and the now three Itaborahian species, there is only one more species described: *E. berroi* Klappenbach & Olazarri, 1986. There are still two other species that could also belong to *Eoborus*: *Strophocheilus chubutensis* Ihering, 1904 and *S. hauthali* (Ihering, 1904), but the preservation state of their fossils do not allow a precise diagnosis (Klappenbach & Olazarri, 1970; Martínez *et al.*, 1997). All the species are from the Tertiary of Brazil (the three species from Itaboraí), Uruguay (*E. charruanus* and *E. berroi*) and Argentina (*E. charruanus*) (Maury, 1935; Parodiz, 1969; Klappenbach & Olazarri, 1970, 1986; Martínez *et al.*, 1997; Simone & Mezzalira, 1994; Bergqvist *et al.*, 2006; Salvador & Simone, 2012).

*E. rotundus* shows many of the genus' characteristic features, such as the smooth protoconch, the teleoconch sculptured by well-marked growth lines and, obviously, the ample umbilicus (Klappenbach & Olazarri, 1970). It differs from *E. sanctijosephi* and *E. charruanus* in being smaller, having fewer whorls (the others have six), an ovoid shell, a more rounded aperture, a larger umbilicus, and a larger and slightly more reflexed peristome. It differs from *E. fusiforme* by its larger size, less acuminate spire, more convex whorls and orthocone aperture. Moreover, *E. rotundus* differs from all other species in the genus by the oblique way the upper palatal region of the lip meets the preceding whorl.

Strophocheilidae is a diverse South-American family and its species generally are very large. The fossils (*i.e.*, the genus *Eoborus*) are rather small when compared to their living relatives and it is likely that the first branches of the family were smaller and that the Strophocheilidae only achieved larger sizes more recently in their history. Moreover, the wide umbilicus was considered a primitive feature in the family (Klappenbach & Olazarri, 1970), since the recent species of the family show a tendency towards reducing and eliminating the umbilicus (Schileyko, 1999b). It should also be noted here that the wide umbilicus is indeed a diagnostic character of the genus *Eoborus*, as stated by Klappenbach & Olazarri (1970), and it is valid and practical in its utilization, despite Palma & Brito (1974) having defied its utility.

### *Eoborus sanctijosephi* (Maury, 1935) (Figs. 75-83)

*Strophocheilus sancti-josephi* Maury, 1935: 7 (figs. 8, 9); Oliveira, 1936: 4; Mezzalira, 1946: 18; Trindade, 1956: 11 (pl. 2, figs. 1a, 2a); Magalhães & Mezzalira, 1953: 220 (pl. 64, fig. 259); Brito, 1967: 15 (pl. 2, fig. 2).

*Strophocheilus (Microborus) sancti-josephi*: Bequaert, 1948: 175.

*Megalobulimus sancti-josephi*: Paula Couto, 1949: 11.

*Strophocheilus (Strophocheilus) charruanus* (in part): Klappenbach & Olazarri, 1966: 233.

*Strophocheilus sanctijosephi [sancti-josephi]*: Parodiz, 1969: 171 (pl. 19, figs. 1, 2).

*Eoborus sanctijosephi*: Klappenbach & Olazarri, 1970: 180; Palma & Brito, 1974: 391 (pl. 1, fig. 7); Simone & Mezzalira, 1994: 50 (pl. 15, fig. 416); Salvador & Simone, 2012: 6 (figs. 16-17).

*Eoborus sancti-josephi*: Bergqvist *et al.*, 2006: 60 (fig. 77).

*Carinifex fluminensis* Brito, 1967: 13 (pl. 3, figs. 1, 2).

*Vorticifex fluminensis*: Palma & Brito, 1974: 391 (pl. 1, fig. 4, 5); Simone & Mezzalira, 1994: 49 (pl. 14, fig. 411); Bergqvist *et al.*, 2006: 59 (fig. 73).

*Holotype*: AMNH 24241 (examined; Fig. 80).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequences S1 and S2 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: Reference to place of discovery, the then called *Fazenda São José*, of which Itaboraí Basin was a part.

*Diagnosis*: Shell large for genus (albeit small to medium-sized for family), slightly conoidal. Aperture elliptical, with upper palatal region of outer lip meeting continuously with preceding whorl, accompanying the whorl outline.

*Re-Description*: Shell large, slightly conic, approximately twice as tall as broad; shell small to medium-sized for family (larger specimens with ~45 mm of length), but large for genus. Spire angle ~65°. Greatest

width on body whorl. Usually 6 whorls (more rarely 5). First 2 to 2½ whorls (protoconch) smooth; teleoconch with fine growth lines, well-marked, oblique. Protoconch conspicuous; transition to teleoconch clear. Profile of whorls slightly convex. Suture well-marked. Aperture elliptical, orthocone, without teeth or lamellae; ~½ shell length and ~⅔ width; aperture height ~1.5 times the width. Parietal suture of aperture well-marked. Peristome smooth and reflected. Upper palatal region of outer lip meeting continuously with preceding whorl, accompanying whorl outline. Body whorl ~⅔ shell length. Umbilicus wide.

*Measures (in mm): Holotype:* 5 or 6 whorls (shell apex and aperture broken); H = 44.0; D = 26.9. **Mean (n = 24):** 5 or 6 whorls (usually 6); H = 38.2 ± 3.8 (max 44.6; min 29.8); D = 20.8 ± 2.3 (max 22.9; min 18.3); S = 18.6 ± 2.6; h = 17.8 ± 1.7 (max 21.4; min 15.3); d = 12.7 ± 2.0 (max 15.0; min 11.1); H/D = 1.84; h/d = 1.40.

*Examined material:* Holotype. DGM 3736-I (1 specimen), 4220-I (1 specimen), 4992-I (9 specimens), unnumbered (4 specimens); MNRJ 4337-I (6 specimens), 4349-I (2 specimens), 4536-I (1 specimen); MZSP 86327 (9 specimens), 98179 (3 specimens). Type material of *Vorticifex fluminensis*: DGM 5003-I (holotype).

*Discussion:* In the original description of *E. sanctijosephi*, the specific epithet had a hyphen, which has reappeared in some recent works, but must be omitted obeying the ICZN (1999) rules (Articles 11.2 and 32.5.2.4.1). *E. sanctijosephi* is certainly the largest pulmonate in Itaboraí Basin and the second species with the most numerous record (the first is *Brasilennea arethusa*). *E. sanctijosephi* differs from *E. rotundus* Salvador & Simone, 2012 by its larger size, conic shell, oval aperture, less reflected peristome and the way in which the upper palatal region of outer lip meets with the preceding whorl accompanying its outline. Also, it differs from *E. fusiforme* sp. nov. by its much larger size, conic shell, less acuminate spire, slightly convex whorls and orthocone aperture.

Brito (1967) described *Carinifex fluminensis* (Figs. 81-83) from Itaboraí. This species was subsequently transferred by Palma & Brito (1974) to the genus *Vorticifex* Meek in Dall, 1870, which has been previously a subgenus of *Carinifex*. Both genera are North-American: *Vorticifex* contains only fossil species dating as back as the Eocene, while *Carinifex* endured from the Pliocene to the Recent (Baker, 1945). The change in the generic allocation of the Itaborahian

species was due to the “body relatively high for the group” and the lack of the “typical carina of *Carinifex*” (Palma & Brito, 1974: 391).

However, *V. fluminensis* does not really share any feature with these genera or other planorbids. It can be clearly seen that the specimen is worn-out and had greater dimensions: the last whorl is almost completely broken, but in any case there is no indication that this missing whorl would be the body whorl of an adult specimen. This can be easily seen by the scar that the broken whorl has left on the median-lower portion of the specimen’s actual last whorl and also in the columellar region. Therefore, here we advance that the single *V. fluminensis* specimen known is actually the spire apex of an *Eoborus sanctijosephi*: the protoconch and spire apex of an *E. sanctijosephi* (Figs. 75-78) show a pattern very close to that of *V. fluminensis*, including the supposed keel. By its size, it is most likely that *V. fluminensis* would be the protoconch of *Eoborus sanctijosephi*, the largest species in the genus.

### ***Eoborus fusiforme* sp. nov.** (Figs. 84-87)

*Holotype:* MNRJ 5188-I (Figs. 84-87).

*Type Locality:* Limestones of Parque Paleontológico de São José de Itaboraí, Rio de Janeiro, Brazil. Park’s center coordinates: 22°50’20”S, 42°52’30”W.

*Geographic and stratigraphic occurrence:* Known only from the type locality. The precise stratigraphic occurrence can’t be assessed; probably Sequences S1 and S2, the same sequences of occurrence of *Eoborus sanctijosephi* (Medeiros & Bergqvist, 1999; Bergqvist et al. 2006).

*Age:* Tertiary, Middle Paleocene.

*Etymology:* The Latin word *fusiforme* (meaning “spindle-shaped”) refers to the species conspicuous shell shape.

*Diagnosis:* Shell small for genus, fusiform. Acuminate spire. Whorls flat. Aperture elliptical, with upper palatal region of outer lip meeting continuously with preceding whorl, accompanying the whorl outline.

*Description:* Shell medium-sized, fusiform; small for family, less than 2 cm. Spire angle ~55°. Greatest width on body whorl; width ~½ shell length. Spire acuminate. Protoconch smooth, conspicuous; transition to teleoconch clear. Teleoconch with fine, well-marked

and oblique growth lines. Profile of whorls flat. Suture well-marked. Aperture elliptical, prosocline, with upper palatal region of outer lip meeting continuously with preceding whorl, accompanying whorl outline; without lamellae or teeth; aperture  $\sim 2/5$  shell length and  $\sim 2/3$  shell width. Peristome ample, smooth, greatly reflected. Body whorl  $\sim 2/3$  shell length. Umbilicus wide.

*Measures (in mm):* **Holotype:** 6 whorls; H = 18.3; D = 9.3; S = 9.6; h = 8.3; d = 6.0; H/D = 1.96; h/d = 1.37.

*Examined material:* Holotype.

*Discussion:* The only known specimen of *E. fusiforme* has been previously misidentified as the paratype (MNRJ 5188-I) of *Bulimulus sommeri* Palma & Brito, 1974. However, it clearly belongs to a different species; especially when considering that *B. sommeri* is a junior synonym of *Itaborahia lamegoi*. *E. fusiforme* differs from *E. sanctijosephi* and *E. rotundus* by its much smaller size, fusiform shell, acuminate spire, flattened whorls and prosocline aperture. Moreover, it differs from *E. rotundus* by the way in which the upper palatal region of outer lip meets with the preceding whorl, which is continuous and accompanies the whorl outline; this character *E. fusiforme* shares with *E. sanctijosephi*.

### Family Urocoptidae

#### Genus *Brachypodella* Beck, 1837

#### *"Brachypodella" britoi* Ferreira & Coelho, 1971 (Figs. 88-90)

*Brachypodella britoi* Ferreira & Coelho, 1971: 470 (figs. 8-9); Palma & Brito, 1974: 397 (pl. 1, fig. 8); Simone & Mezzalira, 1994: 51 (pl. 15, fig. 426); Bergqvist *et al.*, 2006: 60 (fig. 78).

*Holotype:* MNRJ 5024-I (destroyed, examined).

*Paratype:* MNRJ 5025-I (1 specimen, examined; Fig. 88), MNRJ 5026-I (5 specimens, examined; Figs. 89-90).

*Type Locality:* Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence:* Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age:* Tertiary, Middle Paleocene.

*Etymology:* Species dedicated to Prof. Ignácio M. Brito (*Instituto de Geociências da Universidade Federal do Rio de Janeiro*, UFRJ, Rio de Janeiro, Brazil).

*Diagnosis:* Protoconch smooth. Teleoconch sculptured by strong and well-marked ribs. Body whorl slightly detached from previous whorl. Peristome reflected.

*Re-Description:* Shell conical-turritiform, multispiral, high. Spire angle  $\sim 20^\circ$ . Protoconch smooth. Teleoconch sculptured by strong, well-marked, regularly space ribs; on last whorls, the ribs from a whorl are coincident with the ones on previous whorl. Suture well-marked, oblique (diagonal) to columellar axis. Profile of whorls slightly convex. Aperture rounded, slightly oblique, forming angles in transition from palatal and columellar regions to parietal region, being straight. Body whorl slightly detached from previous whorl. Peristome lightly reflected.

*Examined material:* Types.

*Discussion:* *Brachypodella* is a recent genus that occurs in southern North America, Central America, Caribbean Islands and northern South America, approximately the same distribution of the family (Schileyko, 1999a). The typical character of the genus is the presence of a keel on the basal portion of the body whorl (Schileyko, 1999a).

Little information can be obtained about *Brachypodella britoi* since there is not a single well-preserved specimen; they consist only of fragments. Moreover, the holotype was completely destroyed. Still, there is some information to be extracted from these fragments, as for example, the supposed conical-turritiform shell shape, similar to other species in the genus and commonplace in the family (Schileyko, 1999a).

Important characters in the familiar allocation of *B. britoi* are: the conical-turritiform shell shape, sculpture pattern and the body whorl detached from previous whorl, very common in Urocoptidae (Schileyko, 1999a). The original illustration of Ferreira & Coelho (1971: p. 471, fig. 8) shows the body whorl greatly detached from the previous one. However, this degree of detachment is not seen in the specimens - the body whorl is only slightly detached (Fig. 88). *Brachypodella britoi*, as *Brasilennea arethusa*, has few ribs per whorl, but they are raised and strong. Quensen & Woodruff (1997) relates these ribs to a greater protection against shell-breaking predators in *Cerion* Röding, 1798. Unfortunately,

there is no known malacophagous predator in Itaboraí in Sequence S1.

The holotype was the only specimen with a protoconch (as indicated by the original illustration in Ferreira & Coelho, 1971). Ferreira & Coelho (1971) also stated that the first whorl of the protoconch is very prominent but this feature could not be checked, since the holotype is destroyed. The protoconch is an important character for classification; Ferreira & Coelho (1971) decided to allocate the species in the genus *Brachypodella* precisely because the prominent protoconch of *B. britoi* was similar to the protoconch of *B. erratica* Pilsbry, 1930. However, loss of the protoconch is a well-disseminated character in Urocoptidae, including the genus *Brachypodella* (Schileiko, 1999a).

The aperture can be seen in a single specimen (a paratype) and it is hard to tell if it is complete or not. In any case, the aperture seems to be rounded, slightly oblique, without lamella or teeth and with a slightly reflected peristome. Moreover there is no keel on the basal portion of the body whorl; its presence is also a typical feature of the genus (Schileiko, 1999a).

Therefore, *B. britoi* has a protoconch and lacks the keel on the body whorl, going against the common features of the genus (Schileiko, 1999a). This suggests that this species could be transferred to a more suitable genus or even that a new genus could be erected to receive it. Moreover, the distant temporal and spatial occurrences could also warrant the creation of a new genus. Nevertheless, here we choose a more conservative approach, simply leaving the genus in doubt as "*Brachypodella*" *britoi*, until more specimens are found.

### Family Gastrocoptidae

#### Genus *Gastrocopta* Wollatson, 1878

#### *Gastrocopta mezzalirai* (Ferreira & Coelho, 1971)

comb. nov.

(Figs. 91-93)

*Vertigo mezzalirai* Ferreira & Coelho, 1971: 468 (fig. 5); Palma & Brito, 1974: 397; Simone & Mezzalira, 1994: 49 (pl. 14, fig. 412); Bergqvist *et al.*, 2006: 60 (fig. 79).

*Holotype*: MNRJ 5018-I-A (examined; Figs. 91-93).

*Paratype*: MNRJ 5019-I (11 specimens, examined).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age*: Tertiary, Middle Paleocene.

*Etymology*: Species dedicated to Sergio Mezzalira (*Instituto Geográfico e Geológico*, São Paulo, Brazil).

*Diagnosis*: Shell smooth, oval with flattened base. Greatest width on body whorl. Aperture sub-rectangular, with two teeth: one large parietal and one small columellar.

*Re-Description*: Shell diminutive, oval with flattened base. Greatest width on body whorl; width  $\sim 3/4$  shell length. Spire angle  $\sim 60^\circ$ . Spire apex not protuberant. Protoconch flattened, blunt, smooth; transition to teleoconch not clear. Shell smooth, except for growth lines. Profile of whorls convex. Suture weakly marked, slightly oblique (diagonal) to columellar axis. Aperture medium-sized, orthocone, sub-rectangular; aperture  $\sim 1/3$  shell length and  $\sim 1/2$  width. Peristome reflected, incomplete (absent in parietal region). Aperture with two teeth, one large and strong parietal and one small columellar; none extending itself towards interior. Parietal tooth  $\sim 1/2$  aperture height. Body whorl  $\sim 1/3$  shell length.

*Measures (in mm)*: **Holotype**: 5 whorls; H = 1.7; D = 1.3; S = 1.1; h = 0.5; d = 0.4; H/D = 1.31; h/d = 1.25.

*Examined material*: Types. MNRJ 5042-I (44 specimens).

*Discussion*: *Vertigo* O.F. Müller, 1773 is a diverse genus with a Holarctic distribution (Schileiko, 1998b). *Gastrocopta* Wollatson, 1878 is a typical American genus, occurring on the whole continent (Schileiko, 1998b) and being the only gastrocoptid genus in Brazil (Simone, 2006). This was the main criterion used to transfer *V. mezzalirai* to *Gastrocopta*, since morphological diagnosis in the family is difficult (Schileiko, 1998b). Still, some morphological characters, like the aperture dentition, are useful and were also taken into account.

The diminutive size is common in Gastrocoptidae, but *G. mezzalirai* is a little smaller than the mean, not even reaching 2 mm. Its shell shape is also slightly different from the norm in the genus: it is not as cylindrical and has its greatest width on the body whorl. However, there are species in this genus with similar shape like, for instance, *G. contracta* (Say, 1822). The aperture of *G. mezzalirai* is very much like the norm

in the genus, yet it shows a characteristic of its own: the reflected lip gives the aperture an approximately rectangular shape. Again, regarding both the shape and position of the aperture, *G. mezzalirai* is very similar to *G. contracta*. In their original description of *G. mezzalirai*, Ferreira & Coelho (1971) stated the affinity of *G. mezzalirai* to *Vertigo ovata* Say, 1882; however, *V. ovata*'s shell is typical of the genus and here we could not find any similarity between these two species besides those expected for two members of the same family.

*G. mezzalirai* has some of the typical dentition in the family: a large parietal tooth and a small columellar tooth. Dentition is greatly variable in the family; gastropods may have from none to six teeth. The strong parietal tooth (actually a fusion of the parietal and angular lamellae) occluding half the aperture seen in *G. mezzalirai* is typical of the genus *Gastrocopta* (Schileyko, 1998b). These teeth do not extend themselves towards the shell interior, indicating that their function should have been protection against predators that attack through the aperture (Solem, 1972; Goodfriend, 1986; Stanley, 1988; Vermeij, 1993; Gittenberger, 1996; Barker & Efford, 2004).

***Gastrocopta itaboraiensis* sp. nov.**  
(Figs. 94-96)

*Holotype*: MNRJ 5018-I-B (Figs. 94-96).

*Type Locality*: Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence*: Known only from the type locality. The precise stratigraphic occurrence can't be assessed; probably Sequence S1, the same sequence of occurrence of *Gastrocopta mezzalirai* (Medeiros & Bergqvist, 1999; Bergqvist *et al.* 2006).

*Etymology*: Reference to Itaboraí Basin.

*Diagnosis*: Shell smooth, oval. Greatest width on penultimate whorl. Aperture rounded (except parietal region), with three small teeth: one parietal, one columellar and one palatal.

*Description*: Shell diminutive, oval. Greatest width on penultimate whorl; width  $\sim 2/3$  shell length. Spire angle  $\sim 65^\circ$ . Spire apex not protuberant. Protoconch flattened, blunt, smooth; transition to teleoconch not clear. Shell smooth, except for growth lines. Profile of whorls convex. Suture weakly marked, slightly oblique (diagonal)

to columellar axis. Aperture rounded (except parietal region), orthocone; aperture  $\sim 1/3$  shell length and  $\sim 1/2$  width. Peristome reflected, incomplete (absent in parietal region). Aperture with three small teeth: one parietal, one columellar and one palatal; none extending itself towards interior. Body whorl  $\sim 1/3$  shell length.

*Measures (in mm)*: **Holotype**: 5 whorls; H = 1.5; D = 1.0; S = 0.9; h = 0.6; d = 0.5; H/D = 1.5; h/d = 1.2.

*Examined material*: Holotype.

*Discussion*: *G. itaboraiensis* has approximately the same size of *G. mezzalirai*, but it can easily be differentiated by its more oval shell, with the greatest width on its penultimate whorl. *G. itaboraiensis* has a rounded aperture with, apparently, three small teeth: one parietal, one columellar and one palatal. However, the bad preservation state (mainly in the apertural region, which is filled by sediments of the same color as the shell) and the species' diminutive size make clear observation rather difficult, even under the stereomicroscope. Therefore, it is possible that a different number of teeth actually exist and that they are not visible in this condition.

Despite large teeth being commonplace in *Gastrocopta*, there are many species with smaller ones like, for instance, *G. oblonga* (Pfeiffer, 1852) and *G. pellucida* Pilsbry, 1980. The great differential of *G. itaboraiensis* is its globular shape, unknown in the genus, despite the North-American *G. tappaniana* (C.B. Adams, 1842) is near to this shape. Still, a rounded shell is common in some vertiginid genera like *Vertigo* and *Nesopupa* Pilsbry, 1900.

**Basommatophora**  
**Family Planorbidae**  
**Subfamily Planorbinae**

**Genus *Biomphalaria* Preston, 1910**  
***Biomphalaria itaboraiensis* (Mezzalira, 1946)**  
(Fig. 97)

*Australorbis itaboraiensis* Mezzalira, 1946: 159 (2 figs.); Paula Couto, 1949: 11; Brito, 1967: 13 (pl. 3, fig. 3).

*Biomphalaria itaboraiensis*: Ferreira & Coelho, 1971: 465; Palma & Brito, 1974: 391 (pl. 1, fig. 8); Simone & Mezzalira, 1994: 49 (pl. 14, fig. 409); Bergqvist *et al.*, 2006: 59 (fig. 72).

*Holotype*: DGM 3910-I.



*Type Locality:* Limestones of *Parque Paleontológico de São José de Itaboraí*, Rio de Janeiro, Brazil. Park's center coordinates: 22°50'20"S, 42°52'30"W.

*Geographic and stratigraphic occurrence:* Known only from the type locality: Sequence S1 (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

*Age:* Tertiary, Middle Paleocene.

*Etymology:* Reference to Itaboraí Basin.

*Diagnosis:* Shell with few whorls. Abrupt increase of width on outer whorls when compared to inner ones.

*Re-Description:* Shell smooth, planispiral, pseudodextral, with few whorls (from 3½ to 4). Inner whorls narrow, densely packed next to the protoconch; sudden increase of width on outer whorls. Transition to teleoconch unclear. Aperture sub-circular, at same plane as shell; aperture ~2/5 shell width. Umbilicus shallow.

*Examined material:* DGM 4994-I (1 specimen), unnumbered (2 specimens); MNRJ 5041-I (7 specimens).

*Discussion:* *Biomphalaria* Preston, 1910 is a Recent genus (with other known fossil record; Simone & Mezzalira, 1994), occurring in Africa and the Americas, much studied due to the medicinal importance of some species. The only *Biomphalaria* from Itaboraí was originally described by Mezzalira (1946) in the genus *Australorbis*, which was later considered synonym of *Biomphalaria* by the Opinion 735 of the ICZN (1965). Unfortunately, the holotype of *B. itaborahiensis* is lost; it could not be found in the museum's collection (previously DGM, now MCT) and also was not in the records of lent material. Luckily, there is more non-type material available.

*B. itaborahiensis* displays few whorls: the inner ones are densely packed next to the protoconch, while the outer whorls show an abrupt increase in width. Besides these characters, and the Paleocene age, that can help to differentiate *B. itaborahiensis* from the other species in the genus, there is not much information to be extract from the shell. The shells of *Biomphalaria* species are very similar among themselves, displaying few (or none) characters with appreciable interspecific differences; taxonomic studies in the genus are based mainly on anatomical characters (Baker, 1945; Hubendick, 1955; Paraense, 1975).

Interestingly, the occurrence of a planorbid (basommatophorans) in Itaboraí indicates the presence of a fresh water environment in the basin's vicinity during the Paleocene (all the other Itaborahian pulmonates are strictly terrestrial stylommatophorans), as already noted by Palma & Brito (1974).

## DISCUSSION

### The diversity of Itaboraí's fossil molluscan fauna

Simone (1999), dealing with the recent Brazilian and Neotropical pulmonate fauna, states that it is very rarefied and sparse, differing greatly from other regions of the world, where these animals are more abundant. Solem (1981, 1984) argues that the diversity of terrestrial mollusks in small areas (giving a mean 15 to 50 km diameter for the species' home range) around the world generally is something around 5 to 10 sympatric species (a fauna with 15 species is exceptional and one that reaches 20 species is very rare). In tropical regions of Africa and America, this number is much closer to the lower limit of five (Solem, 1984).

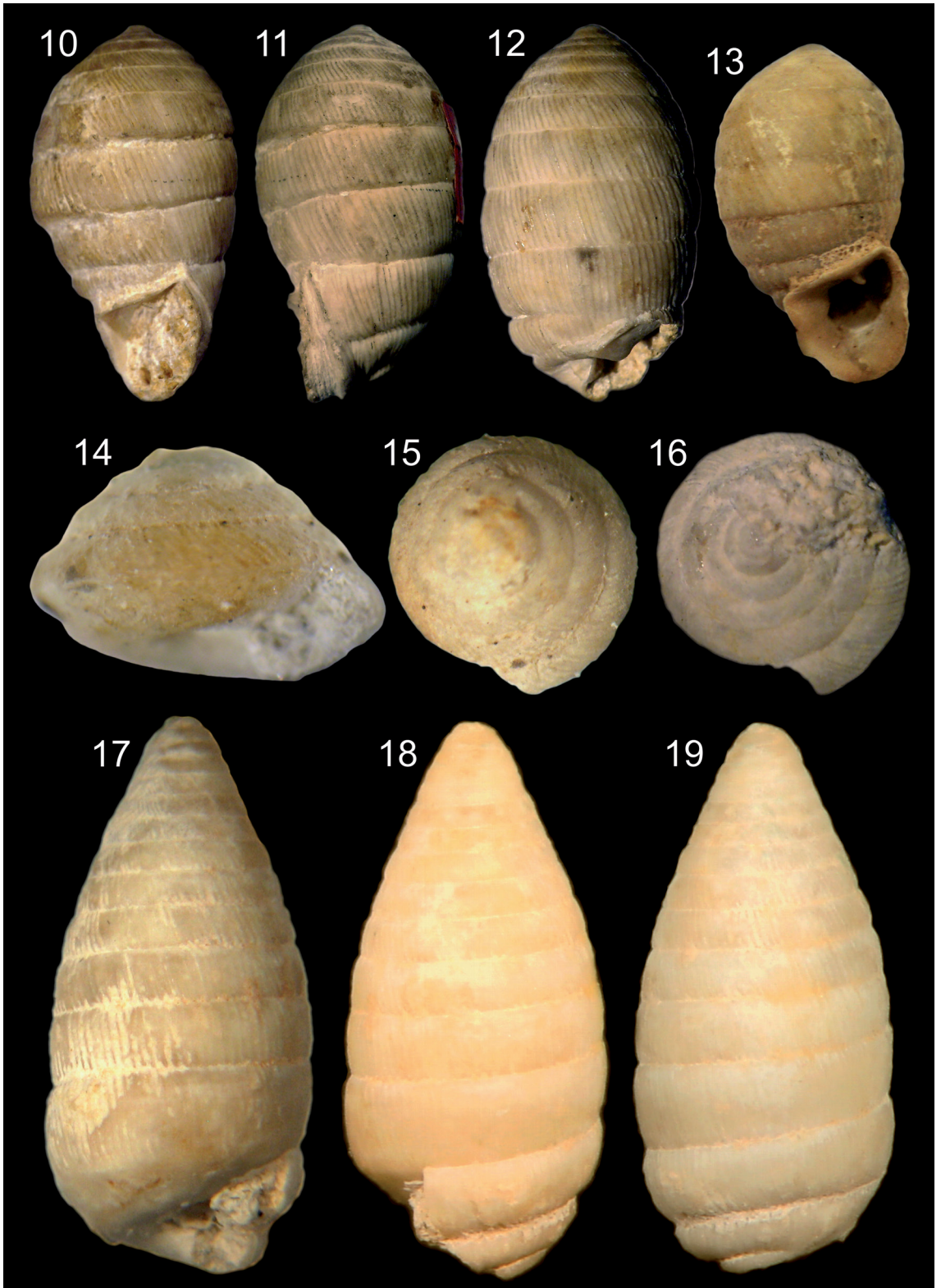
Surprisingly, what we see in the Paleocene of Itaboraí is something extraordinary for the Neotropic: 20 sympatric and contemporaneous species. We consider here that they are indeed contemporaneous since all species occur in Facies B of Sequence S1. Despite the lack of more precise stratigraphic data, the time interval in which the four facies of sequences S1 and S2 occur is very limited, 59 to 57 Ma (Medeiros & Bergqvist, 1999; Bergqvist *et al.*, 2006).

Pulmonates tend to be more abundant and diverse when their typical appropriate environmental conditions are present: high humidity, abundant vegetation, high calcium availability and finally, few or no predators (Solem, 1981, 1984; Cook, 2001; Pearce & Örstan, 2006). Clearly, Itaboraí was a calcareous basin, something that alone could attract many pulmonates (Barker, 2001; Cook, 2001; Pearce & Örstan, 2006). However, due to the great diversity of the Itaborahian pulmonate paleofauna, it is plausible to imagine that a fair amount of the other conditions should have also been present.

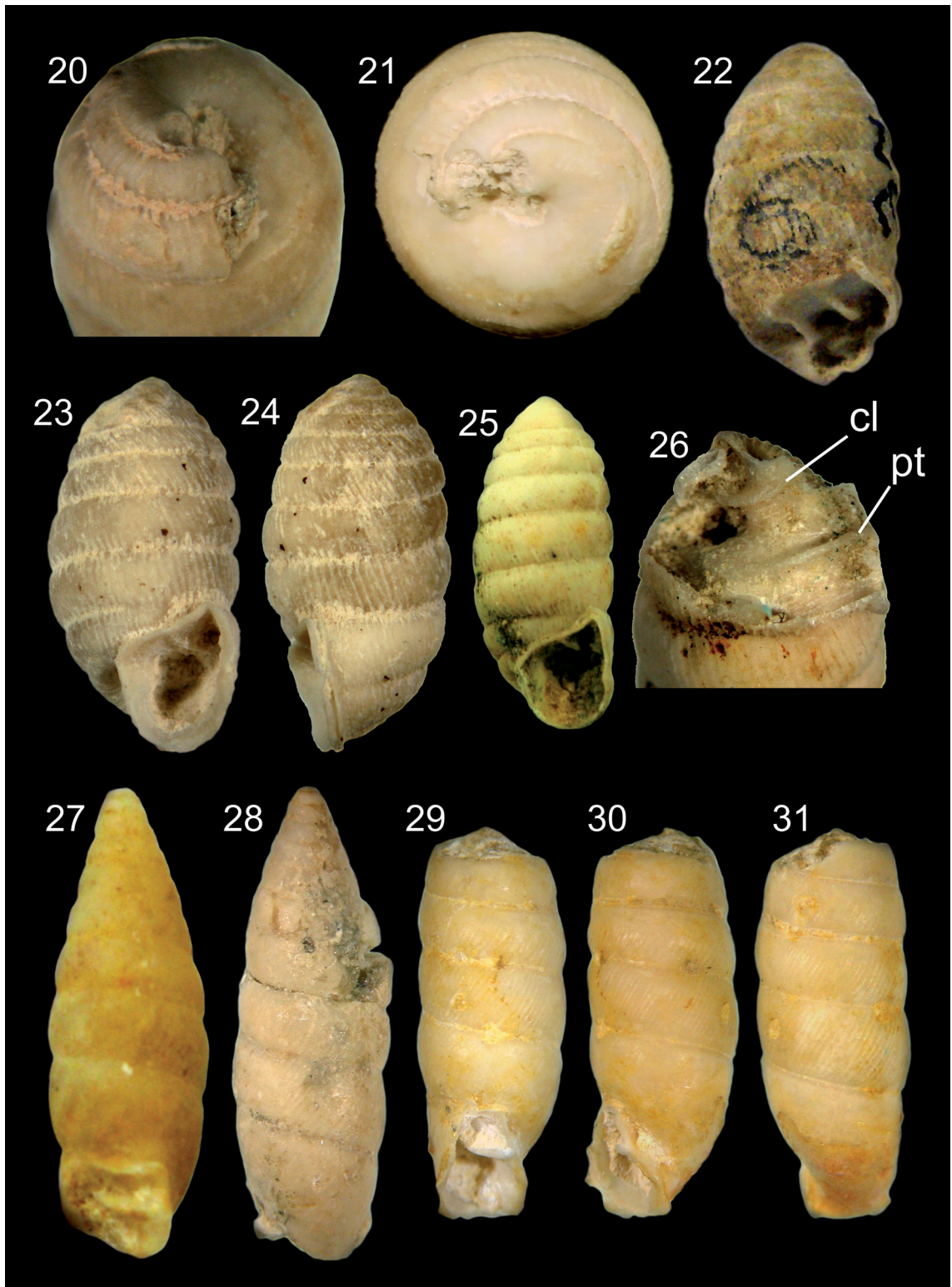
There is no record of typical malacophagous predators like arthropods, possibly due to non-preservation rather than their absence, and there is also not even a single representative of a malacophagous snail family such as Streptaxidae. Nevertheless, there are many other animal groups in Itaboraí for which malacophagous predators are known: mammals



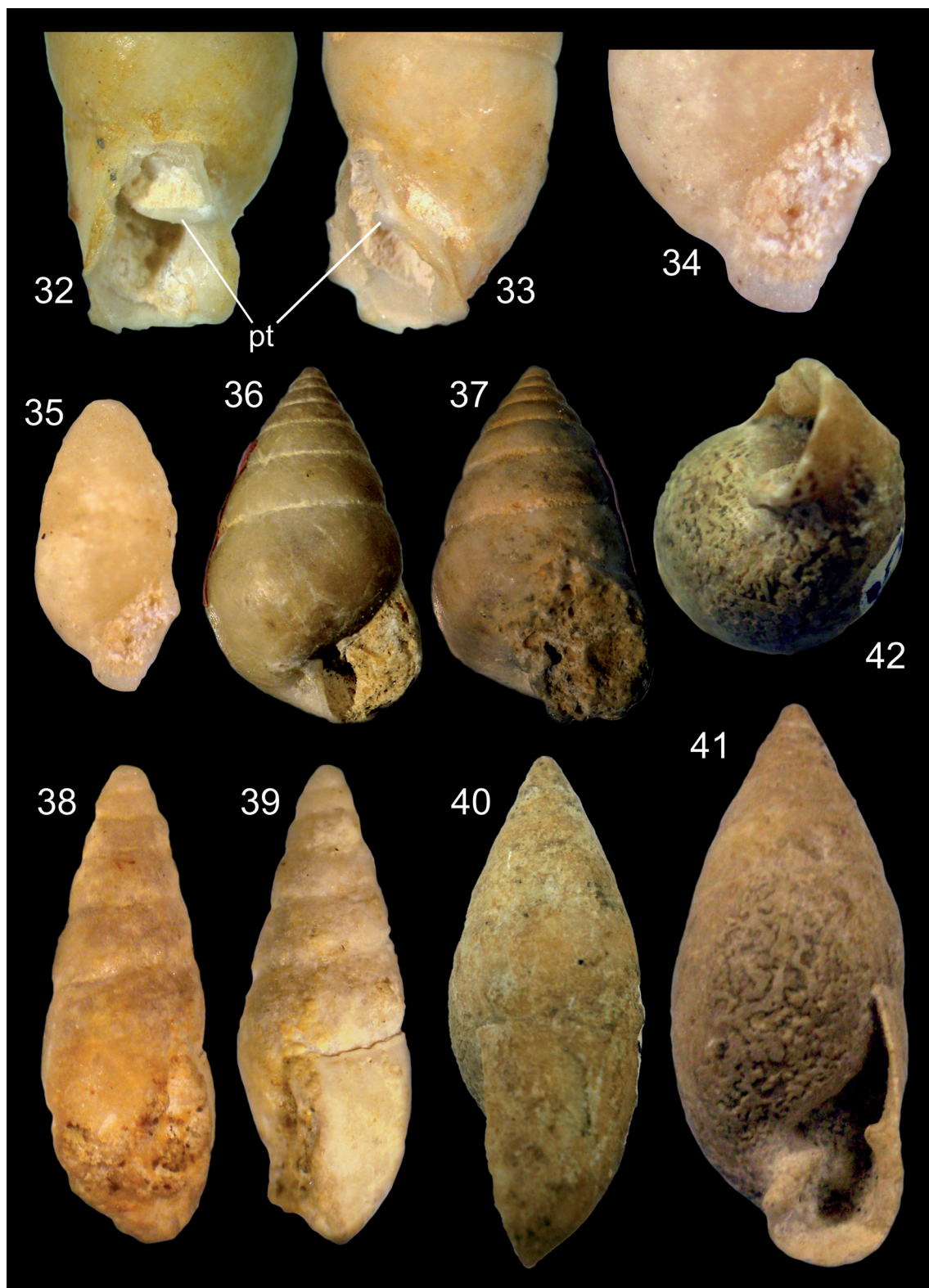
**FIGURES 3-9:** *Brasilennea arethusae* (MZSP 86322); shell length 21 mm. **3-5.** Overview. **6.** Body whorl, showing the two spiral furrows. **7.** Smooth protoconch. **8.** Aperture; peristome with duplicate aspect (parallel lamella *sensu* Maury, 1935). **9.** Broken aperture, showing the parietal (pt) and columellar (cl) lamellae.



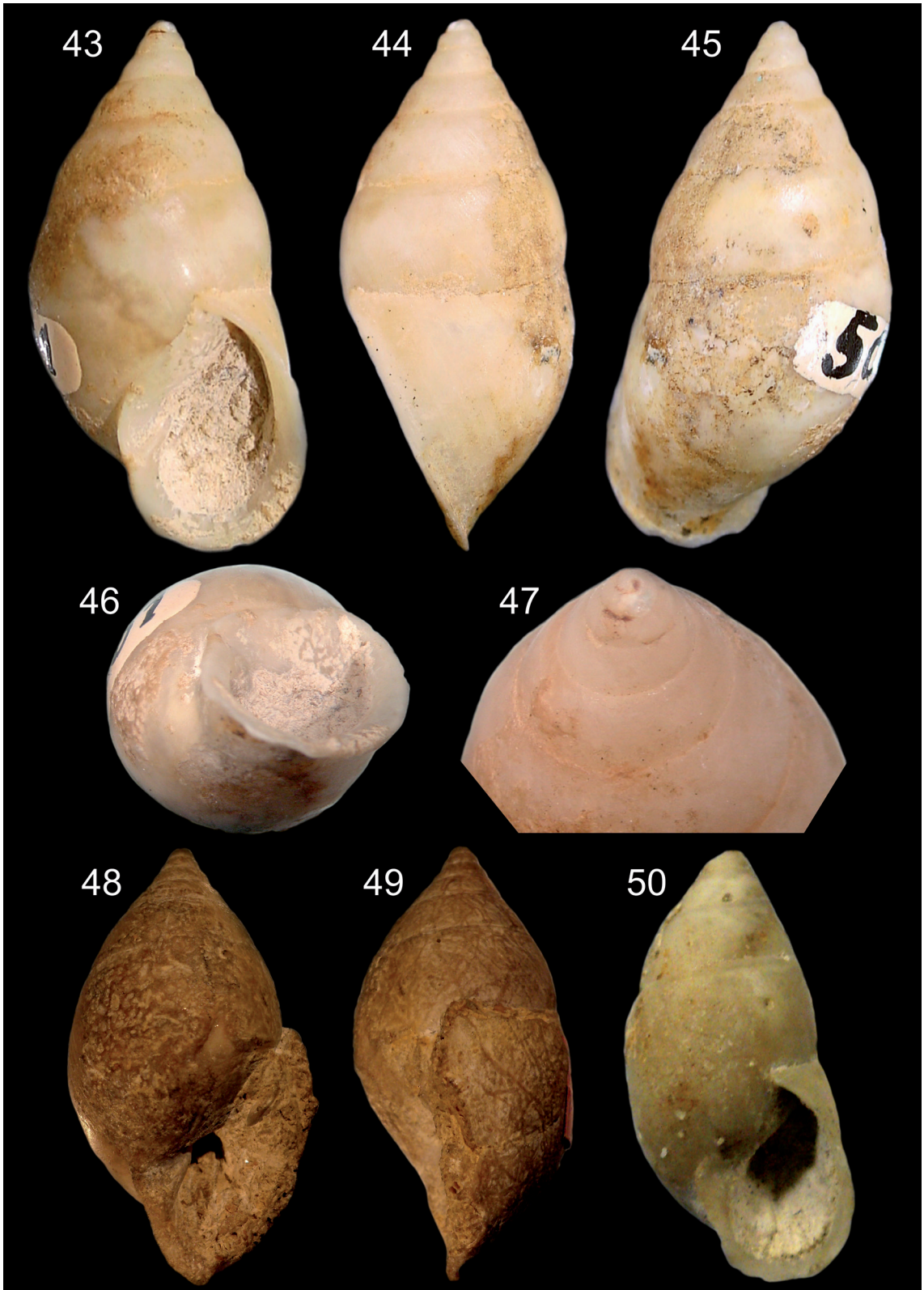
**FIGURES 10-19:** 10-11. *Brasilennea arethusae* (AMNH 24237; holotype); shell length 23.5 mm. 12. *B. arethusae* (AMNH 24238; paratype); shell length 24 mm. 13. Anomalous specimen of *B. arethusae* (DGM 4998-I); shell length 27 mm. 14-15. "*Strobilopsis maurryae*" (MNRJ 5020-I; holotype); greater width 4.5 mm. 16. *B. arethusae* (AMNH 24239; paratype); greater width 7.5 mm. 17-19. *Brasilennea guttula* (MCT 6940-I; holotype); shell length 13.5 mm.



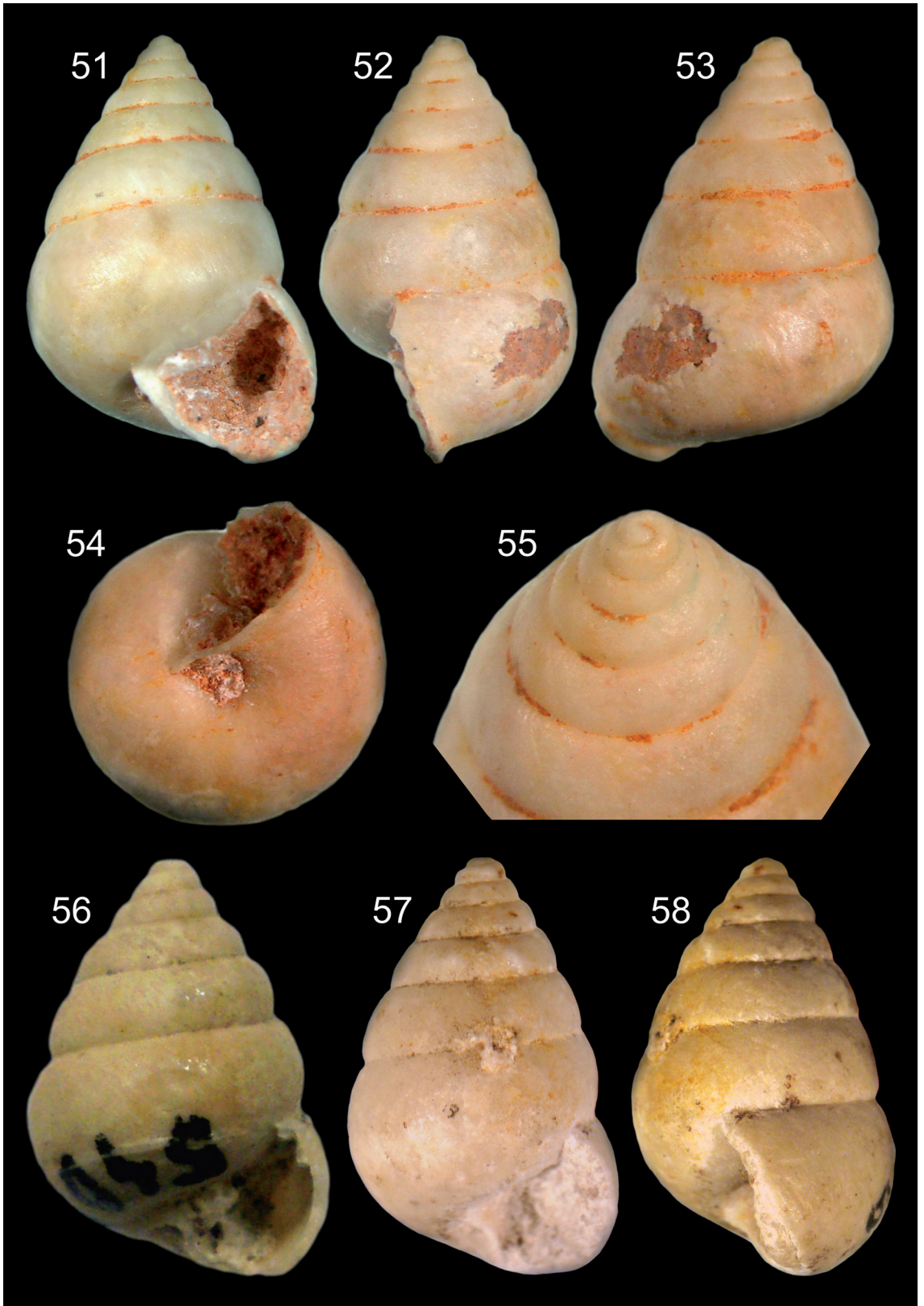
**FIGURES 20-31:** 20-21. *Brasilennea guttula* (MCT 6940-I; holotype), showing the two spiral furrows on the body whorl; shell length 13.5 mm. 22. *Brasilennea minor* (DGM 4221-I; holotype); shell length 9 mm. 23-24. *B. minor* (DGM 4999-I); shell length 11.5 mm. 25. Taller specimen of *B. minor* (DGM 4999-I); altura 15 mm. 26. *B. minor* (DGM 4999-I) with broken aperture, showing the parietal (pt) and columellar (cl) lamellae. 27. *Temesa magalhaesi* (DGM 4220-I; holotype); shell length 14.5 mm. 28-31. *T. magalhaesi* (DGM 4997-I); shell length 14 mm.



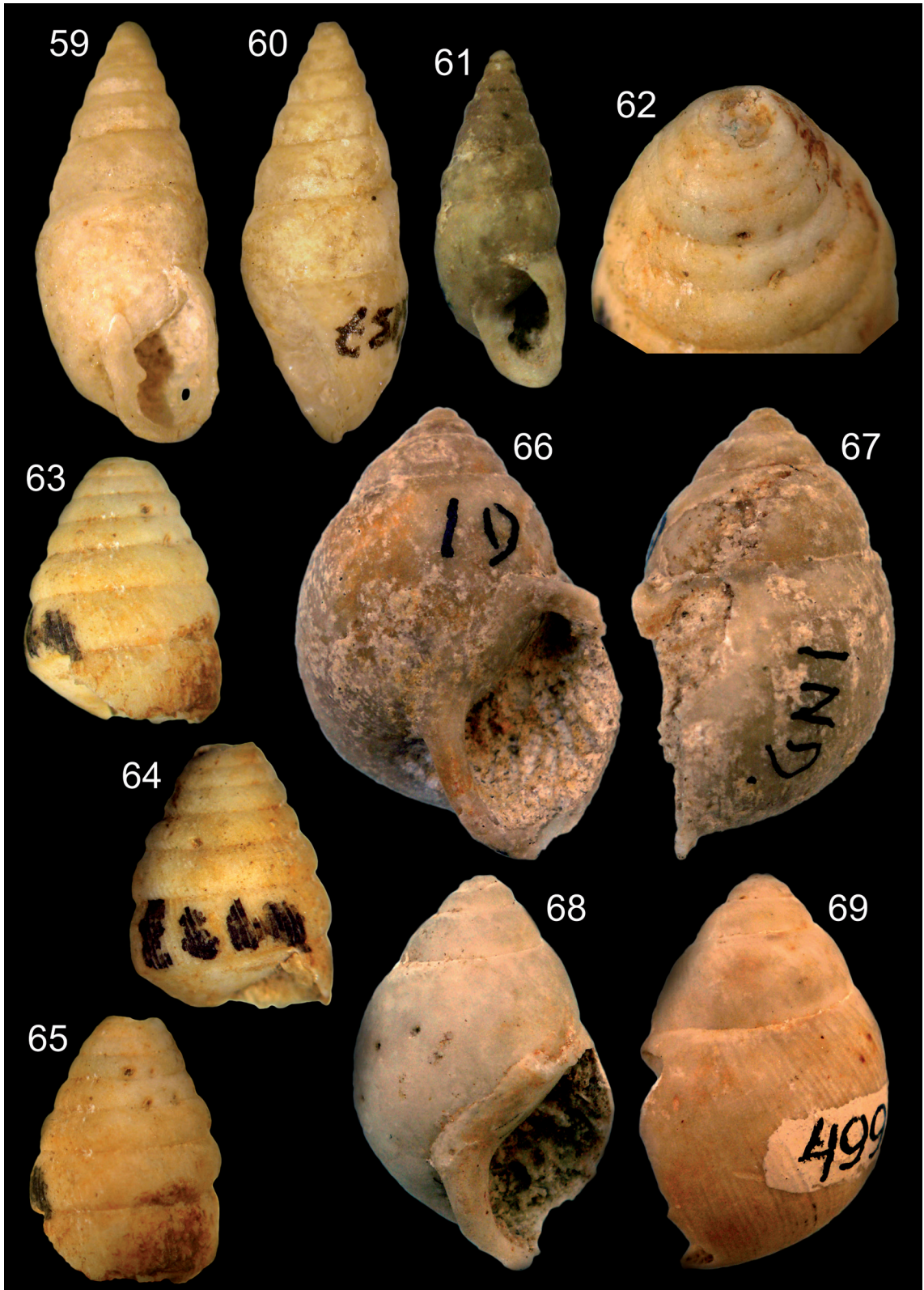
**FIGURES 32-42:** 32-33. *Temesa magalhaesi* (DGM 4997-I) with broken aperture, showing the parietal lamella (pt). 34-35. *Cecilioides sommeri* (MNRJ 5016-I; holotype); shell length 2.5 mm. 36. *Bulimulus fazendicus* (AMNH 24243; holotype); shell length 16.5 mm. 37. *B. fazendicus* (AMNH 24242; paratype); shell length 16.5 mm. 38-39. *Bulimulus trindadeae* (MNRJ 5022-I; holotype); shell length 9.5 mm. 40-42. *Cortana carvalhoi* (DGM 4995-I; holotype); shell length 30.5 mm.



**FIGURES 43-50:** 43-47. *Itaborahia lamegoi* (DGM 5001-I); shell length 30 mm. 43-45. Overview. 46. Imperforated umbilicus. 47. Smooth protoconch. 69-70. *I. lamegoi* (AMNH 24240; holotype); shell length 31.5 mm. 50. "*Bulimulus sommeri*" (DGM 5411-I; holotype); shell length 20.5 mm.

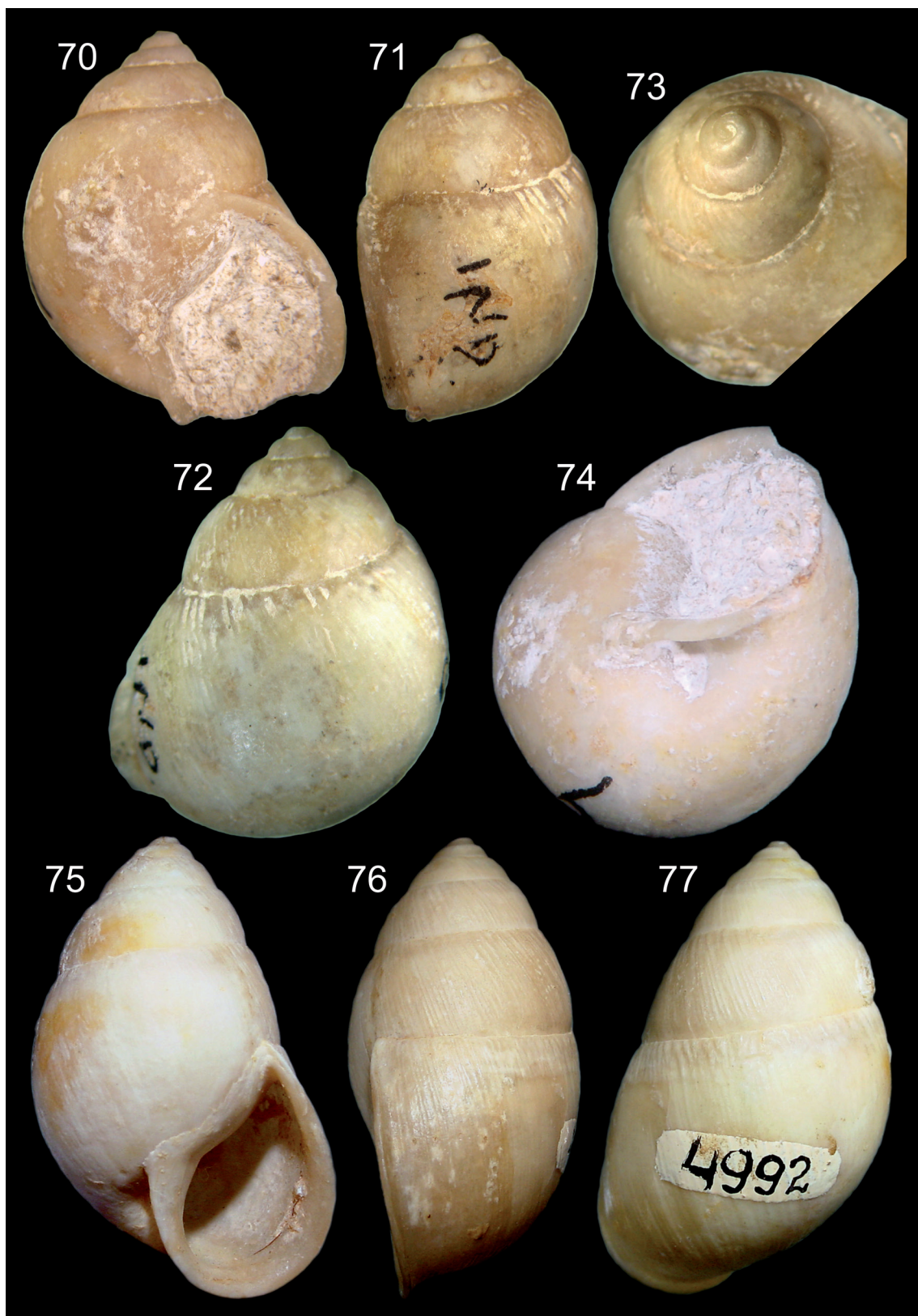


FIGURES 51-58: 51-55. *Leiostracus ferreirai* (DGM 4993-I); shell length 12 mm. 51-53. Overview. 54. Umbilicus. 55. Protoconch. 56. *L. ferreirai* (DGM 5409-I; holotype); shell length 9.5 mm. 57-58. *L. ferreirai* (MNRJ 5186-I; paratype); shell length 11 mm.

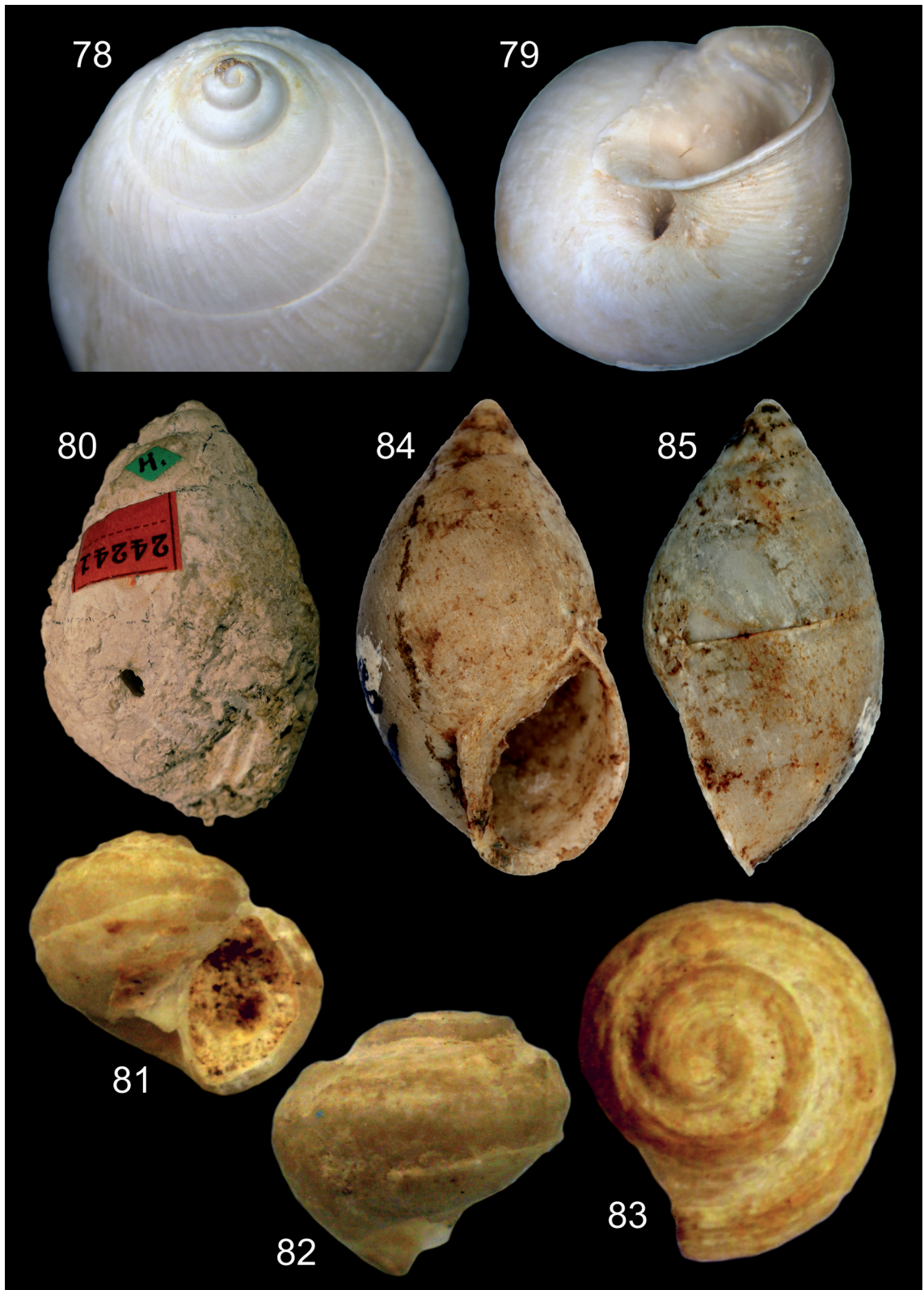


**FIGURES 59-69:** 59-60. *Cyclodontina coelhoi* (MN 5187-I; paratype); shell length 11.5 mm. 61. *C. coelhoi* (DGM 5410-I; holotype); shell length 15.5 mm. 62-65. *Plagiodontes* aff. *dentatus* (MCT 6944-I); shell length 9.5 mm. 66-67. *Eoborus rotundus* (MCT 6942-I; paratype); shell length 25.5 mm. 68-69. *Eoborus rotundus* (MCT 6943-I; paratype); shell length 25.5 mm.

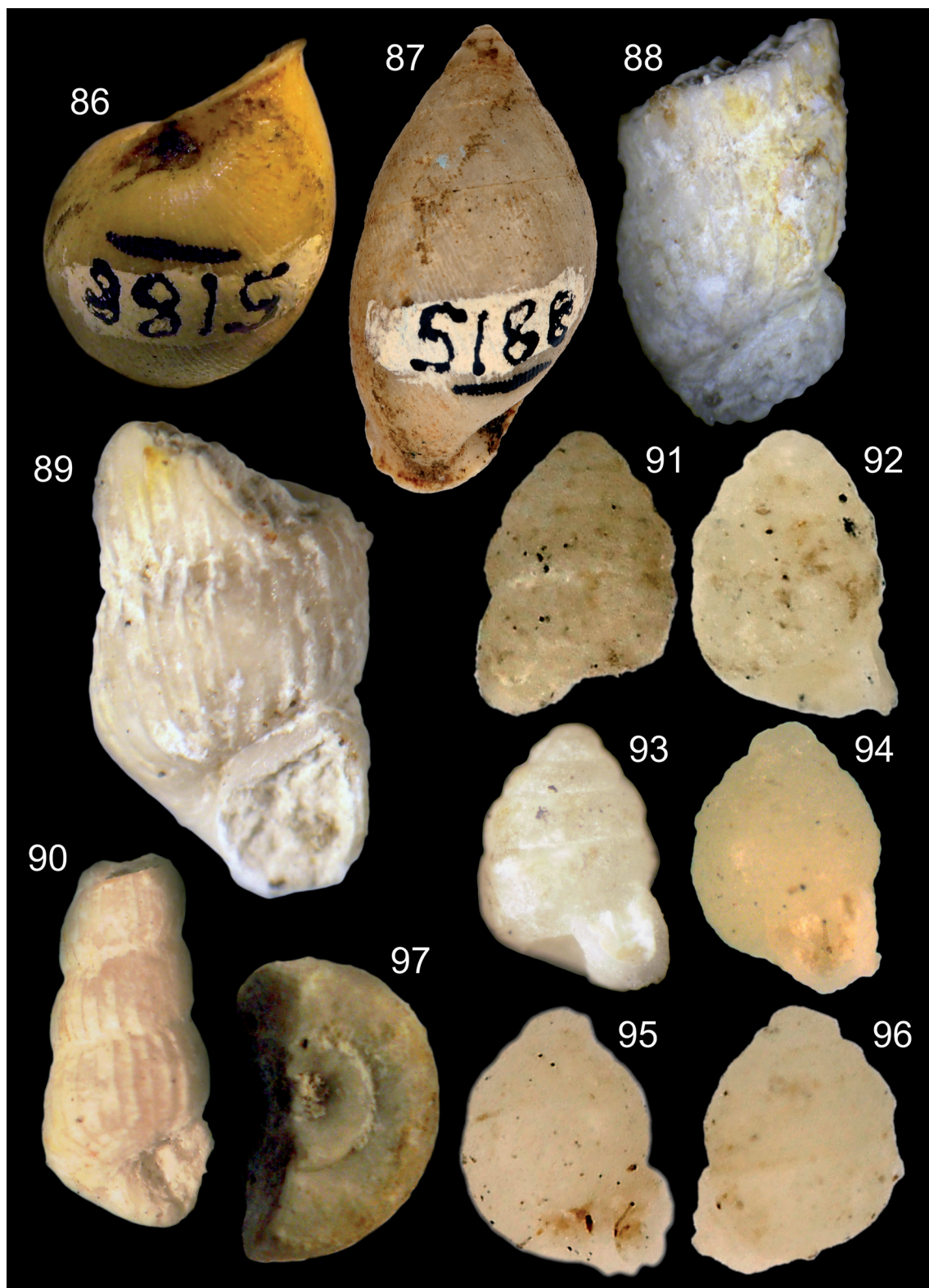




FIGURES 70-77: 70-74. *Eoborus rotundus* (MCT 6941-I; holotype); shell length 23.5 mm. 70-72. Overview. 73. Umbilicus. 74. Smooth protoconch. 75-77. *Eoborus sanctijosephi* (DGM 4992); shell length 44.5 mm.



**FIGURES 78-85:** 78-79. *Eoborus sanctijosephi* (DGM 4992). 78. Smooth protoconch. 79. Umbilicus. 80. *E. sanctijosephi* (AMNH 24241; holotype); shell length 44 mm. 81-83. *E. sanctijosephi*; specimen previously classified as *Vorticifex fluminensis* (DGM 5003-I; holotype); greater width 8.5 mm. 84-85. *Eoborus fusiforme* sp. nov. (MNRJ 5188-I; holotype); shell length 18.5 mm.



**FIGURES 86-97:** 86-87. *Eoborus fusiforme* sp. nov. (MNRJ 5188-I; holotype); shell length 18.5 mm. 88. *Brachypodella* "britoi" (MNRJ 5025-I; paratype); shell length 4 mm. 89-90. *Brachypodella* "britoi" (MNRJ 5026-I; paratype); shell length (both) 4 mm. 91-93. *Gastrocopta mezzalirai* (MN 5018-I-A; holotype); shell length 1.5 mm. 94-96. *Gastrocopta itaboraiensis* sp. nov. (MNRJ 5018-I-B; holotype); shell length 1.5 mm. 97. *Biomphalaria itaboraiensis* (DGM unnumbered); greater width 5 mm.

(especially the marsupials), birds and lizards. Still, few of these animals are present in Sequence S1; they occur almost exclusively in sequence S2 (Bergqvist *et al.*, 2006), where the mollusks are less diverse or even absent according to some authors (Ferreira & Coelho, 1971; Rodrigues Francisco & Cunha, 1978; Cunha *et al.*, 1984). The basin's flora was diverse and abundant (Paula Couto, 1970), dominated by angiosperms (Bergqvist *et al.*, 2006), but little is known about its paleoenvironment. In the literature, there are only scattered comments about the basin's paleoenvironment, but not even a single work deals specifically with this topic. In any case, most authors state only that the basin had a humid and hot climate (Rodrigues Francisco & Cunha, 1978; Lima & Cunha, 1986), perhaps similar to the present (Beurlen & Sommer, 1954). Still, Bergqvist *et al.* (2006) argue for a milder climate in the beginning of Sequence S1, becoming more arid towards the top of the sequence.

### Notes on paleobiogeography

Itaboraí's limestones house an astounding diversity of fossil pulmonates. Their early Cenozoic age (Middle Paleocene; Medeiros & Bergqvist, 1999) and geographical location in South America makes these fossils very important to understand the evolution and biogeographic history of New World pulmonates. Such interesting records are explored with greater detail for each family represented in Itaboraí's molluscan paleofauna:

**Cerionidae:** This family was not officially present in the basin until the recent revision of the genus *Brasilennea* by Salvador *et al.* (2011), as it was previously classified in Streptaxidae. There are three *Brasilennea* species in Itaboraí, which together consist on the second oldest record of Cerionidae. The oldest is a probable *Cerion*, named *C. acherontis*, from the Upper Cretaceous of Montana, USA (Roth & Hartman, 1998). Even if Itaboraí's record is not the oldest, its location is very interesting, for the basin is greatly removed from the family's recent distribution: the islands of Florida and the Caribbean Islands (Fig. 98). Despite the absence of recent cerionids in South America, it can be seen that the family's distribution included this area in the beginning of the Cenozoic. It is even possible that, at that time, Cerionidae had a more ample distribution, occurring from northwestern USA (*C. acherontis*) to Rio de Janeiro (*Brasilennea*).

**Charopidae:** The single charopid of Itaboraí, *Austro-discus lopesi*, is the second oldest record for the family; the oldest being from the Cretaceous of Argentina (Morton, 1999). Itaboraí rests well inside the family's recent distribution: the Americas, Island of Saint Helena, southern Africa, Islands of the Pacific and Oceania (Solem, 1981; Simone, 2006).

**Clausiliidae:** There is only one clausiliid in Itaboraí, *Temesa magalhaesi*, of the subfamily Neniinae. This is a record reasonably removed from the family's recent distribution (Fig. 98): the Central and South American species are restricted to some Caribbean Islands and to the Andes at the continent's west and northwest (Schileyko, 2000). The closest records are *Nenia orbigny*, in Mato Grosso state in Brazil (Simone, 2006), and a doubtful *Temesa argentina*, in Argentina (Loosjes & Loosjes-van Bemmelen, 1966; Schileyko, 2000). The family is known since the Cretaceous of Europe (Solem, 1976) and has a vast record in this continent (Nordsieck, 2000); however the Itaborahian



**FIGURE 98:** Map showing the Recent distribution of Cerionidae (full line), Neniinae (dashed lined) and Urocoptidae (dotted line). The oldest fossils known for Cerionidae and Urocoptidae are indicated by a "C" and a "U", respectively. Itaboraí Basin is indicated by an "X" (its record of Neniinae is the oldest for the subfamily). The circle indicates the possible new record of Urocoptidae discovered by Pena *et al.* (2011).

species is the oldest record in South America for the family and also the oldest record of Neniinae.

**Ferussaciidae:** The single ferussaciid from Itaboraí, *Ceciliooides sommeri*, is a record within the family's recent distribution: there are only three recent species occurring in Brazil, and one of them, *Geostilbia gundlachi*, occurs in Rio de Janeiro state (Simone, 2006). So far, the family's oldest fossil record would only be doubtful specimens (due to the simplicity and fragility of ferussaciid shells) from the European Eocene (Solem, 1976, 1979). Now the record from Itaboraí is the oldest for the family.

**Orthalicidae:** This family has a diverse record in Itaboraí, seven species distributed in six genera, composing a little more than one third of the basin's molluscan fauna. Orthalicidae is an extremely diverse family in the Recent (Breure, 1978, 1979; Schileyko, 1999a; Simone, 2006): in Brazil, it is responsible for roughly 45% of pulmonate diversity (Simone, 2006). It is interesting to note that even in Middle Paleocene the family was already very diverse, at least in Itaboraí. The Itaborahian species are within the family's recent distribution and are the oldest record for the family.

**Strophocheilidae:** The three *Eoborus* species from Itaboraí are the oldest record for the family, falling well within its recent distribution.

**Urocoptidae:** *Brachypodella britoi* is the single urocoptid in Itaboraí. The oldest record for the family comes from the Upper Cretaceous of Canada (Tozer, 1956) and Mexico (Perrilliat *et al.*, 2000). As such, *B. britoi* would be the third oldest Urocoptidae record (the oldest in South America). Still, *B. britoi* is of great biogeographic interest, for it is very distant from the family's recent distribution (Fig. 98): southern North America, Central America, the Caribbean Islands and northern South America (Schileyko, 1999a). Besides, the discovery of a possible Urocoptidae in a nature reserve in the Brazilian state of Minas Gerais (Pena *et al.*, 2011) would extend this distribution further south if confirmed. The presence of *B. britoi* in Itaboraí, together with the North-American records, shows that the family's distribution was much vaster in the past. It is interesting to note that the distribution of Cerionidae, a family closely related to Urocoptidae (Uit de Weerd, 2008), shows a similar pattern (Fig. 98).

**Gastrocoptidae:** The two *Gastrocopta* species from Itaboraí are the oldest record for the family.

Gastrocoptidae has a worldwide recent distribution, including many Brazilian species (Simone, 2006).

**Planorbidae:** There is only one confirmed species in Itaboraí, *Biomphalaria itaboraiensis*. In any case, this is a record within the family recent distribution. Planorbidae has a vast worldwide fossil record, the oldest being from the Jurassic of France (Zilch, 1959-60). However, Meier-Brook (1984) considers all planorbids older than the Cenozoic as doubtful, stating that they have to be treated carefully and be revised. If this author's doubts are to be confirmed, the importance of the planorbid record from Itaboraí may increase.

Summarizing, the oldest records for the families Orthalicidae, Gastrocoptidae, Ferussaciidae and Strophocheilidae stem from Itaboraí Basin. The records of Cerionidae, Charopidae, Clausiliidae, and Urocoptidae, despite not being the oldest, are very close to that. Additionally, the records of Cerionidae, Clausiliidae and Urocoptidae are also of great biogeographic importance, for they are far removed from their families' recent distribution (Fig. 98).

Moreover, Itaboraí Basin's records are the oldest for most genera, only *Biomphalaria* has a known older record: *Biomphalaria monserratisensis* (Hartt, 1870) from the Lower Cretaceous of the state of Bahia, in Brazil (Derby, 1878; Simone & Mezzalira, 1994). Additionally, the Itaborahian records are the only fossils known for the genera *Austrodiscus*, *Ceciliooides*, *Leiostracus* and *Temesa* (considering only completely fossil species, not recent species with Quaternary records).

Moreover, as happens for some families, the Itaboraí locality is outside the recent distribution of the following genera: *Austrodiscus* (Chile; Schileyko, 2001); *Brachypodella* (southern North America, Central America, the Caribbean Islands and northern South America; Schileyko, 1999a); *Ceciliooides* (Caribbean Islands, Colombia, Venezuela, the Amazonas state in Brazil; Paraguay and northwestern Argentina; Richards & Hummelinck, 1940; Scott, 1948; Quintana, 1982; Simone, 2006; Norma C. Salgado, *pers. comm.*); *Leiostracus* (from Guyana and Suriname to the Brazilian states of Minas Gerais and Espírito Santo; Breure, 1979; Schileyko, 1999a; Simone, 2006); *Temesa* (Colombia, Peru, Bolivia and perhaps Argentina; Loosjes & Loosjes-van Bemmelen, 1966; Schileyko, 2000; Nordsieck, 2005). For all the other genera, the records from Itaboraí fall within the current distribution (Schileyko, 1998b, 1999a; Simone, 2006; Jørgensen *et al.*, 2007; Pizá & Cazzaniga, 2009).

## CONCLUSION

For the 18 or 17 species formerly present in Itaboraí Basin according, respectively, to Simone & Mezzalira (1994) and Bergqvist *et al.* (2006), many changes are here proposed, including the description of new species. There are currently 20 valid molluscan species in Itaboraí. Summarizing the taxonomic revision, we have the following:

- The genus *Itaborahia* is revalidated, containing only its type-specimen, *I. lamegoi*;
- *Bulimulus sommeri* is considered a junior synonym of *Itaborahia lamegoi*;
- *Strobilops mauryae* is considered a junior synonym of *Brasilennea arethusae*, considered a misidentification of young specimens;
- *Vorticifex fluminensis* is considered a junior synonym of *Eoborus sanctijosephi*, considered a misidentification of a worn-out spire apex;
- A new genus, *Cortana*, is proposed to house the species previously described as *Bulimulus carvalhoi*, resulting in the new combination *Cortana carvalhoi*;
- *Austrodiscus lopesi* was transferred from Endodontidae to Charopidae, following the reallocation of the genus *Austrodiscus* in the latter by Fonseca & Thomé (1993);
- *Clausilia magalhaesi* was transferred to the genus *Temesa*, resulting in the new combination *Temesa magalhaesi*;
- *Vertigo mezzalirai* was transferred to the genus *Gastrocopta*, resulting in the new combination *Gastrocopta mezzalirai*;
- *Bulimulus coelhoi* was transferred to the genus *Cyclodontina*, resulting in the new combination *Cyclodontina coelhoi*;
- *Carychium sommeri* was transferred to the genus *Cecilioides*, of another family, Ferussaciidae, resulting in the new combination *Cecilioides sommeri*;
- *Bulimulus ferreirai* is not considered a junior synonym of *Bulimulus fazendicus* (*contra* Ribeiro, 2003, and Bergqvist *et al.*, 2006); moreover, it was transferred to the genus *Leiostracus*, resulting in the new combination *Leiostracus ferreirai*;
- *Bulimulus trindadeae* was allocated once more in the genus *Bulimulus* (*contra* its allocation in *Itaborahia* by Ribeiro, 2003, and Bergqvist *et al.*, 2006);
- Current classification remains unchanged for the following species: *Austrodiscus lopesi*, *Biomphalaria itaboraiensis*, *Brasilennea arethusae*,

*Brasilennea guttula*, *Brasilennea minor*, *Bulimulus fazendicus*, *Eoborus sanctijosephi*, *Eoborus rotundus*, and *Itaborahia lamegoi*;

- “*Brachypodella*” *britoi* is also maintained, at least until new specimens (and in better conditions) are found. This species clearly belongs to another genus, but the bad preservational state of the material does not allow a generic reallocation or the description of new genus;
- Two new species are described here, *Eoborus fusiforme* (Strophocheilidae) and *Gastrocopta itaboraiensis* (Gastrocoptidae);
- Following Salvador *et al.* (2011), the genus *Brasilennea* is considered a Cerionidae, not a Streptaxidae;
- The possibility is raised here that *Plagiodontes* aff. *dentatus* presented by Salvador & Simone (2012) is actually a new Odontostominae species, but its precarious preservation do not allow such decision to be taken satisfactorily;
- The records of Itaboraí are the oldest for the genera *Austrodiscus*, *Brachypodella*, *Bulimulus*, *Cecilioides*, *Cyclodontina*, *Eoborus*, *Gastrocopta*, *Leiostracus*, *Plagiodontes* and *Temesa*. Also, the basin harbors the oldest record for the families Orthalicidae, Gastrocoptidae, Ferussaciidae and Strophocheilidae.

## RESUMO

*Os calcários da Bacia de Itaboraí (Paleoceno Médio), Rio de Janeiro, Brasil, abrigam uma rica fauna de gastrópodes pulmonados do Paleoceno Médio, tanto terrestres quanto dulciaquícolas. No presente trabalho realiza-se uma extensiva revisão taxonômica dessa paleofauna. Duas novas espécies, Eoborus fusiforme e Gastrocopta itaboraiensis, são descritas, assim como um novo gênero, Cortana. A classificação revisada encontra-se do seguinte modo: Austrodiscus lopesi (Charopidae); Biomphalaria itaboraiensis (Planorbidae); “Brachypodella” britoi (Urocoptidae); Brasilennea arethusae, Brasilennea guttula, Brasilennea minor (Cerionidae); Bulimulus fazendicus, Bulimulus trindadeae, Cortana carvalhoi, Cyclodontina coelhoi, Itaborahia lamegoi, Leiostracus ferreirai, Plagiodontes aff. dentatus (Orthalicidae); Cecilioides sommeri (Ferussaciidae); Eoborus rotundus, Eoborus sanctijosephi, Eoborus fusiforme (Strophocheilidae); Gastrocopta mezzalirai, Gastrocopta itaboraiensis (Gastrocoptidae); Temesa magalhaesi (Clausiliidae). A espécie Strobilopsis mauryae foi considerada sinônimo de Brasilennea arethusae; Bulimulus sommeri sinônimo de Itaborahia lamegoi;*

e *Vorticifex fluminensis* sinônimo de *Eoborus sancti-josephi*. A bacia conta com os registros fósseis mais antigos das famílias *Orthalicidae*, *Gastrocoptidae*, *Ferussaciidae* e *Strophocheilidae*. Além disso, os registros de Itaboraí das famílias *Charopidae*, *Clausiliidae*, *Cerionidae*, e *Urocoptidae* estão entre os mais antigos do mundo e, dentre esses, os de *Cerionidae*, *Clausiliidae* e *Urocoptidae* merecem destaque por estarem bem afastados das distribuições atuais das famílias. Ademais, os registros de Itaboraí são os mais antigos para os gêneros *Austrodiscus*, *Brachypodella*, *Bulimulus*, *Cecilioides*, *Cyclodontina*, *Eoborus*, *Gastrocopta*, *Leiostracus*, *Plagiodontes* e *Temesa*. Há três gêneros endêmicos na bacia: *Brasilennea*, *Cortana* e *Itaborahia*. Discussões adicionais sobre paleobiogeografia e evolução dessa paleofauna são oferecidas.

PALAVRAS-CHAVE: Itaboraí; Mollusca; Paleoceno Médio; Pulmonata; Rio de Janeiro.

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