



TAXONOMIC STUDY ON A COLLECTION OF TERRESTRIAL AND FRESHWATER GASTROPODS FROM CAVES IN BAHIA STATE, BRAZIL, WITH THE DESCRIPTION OF A NEW SPECIES

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ABSTRACT: Gastropod samples were collected during expeditions to caves in Bahia state, northeastern Brazil, and are studied herein. Collection took place over the past five years, and gastropods were found in 14 caves distributed across six different municipalities: Campo Formoso, Carinhanha, Coribe, Feira da Mata, Central, and Ituaçu. A total of 19 species-level taxa of terrestrial and freshwater gastropods (representing 10 families) were collected, including representatives of the taxa Neritimorpha, Caenogastropoda, Hygrophila, and Stylommatophora. A new species is described herein: *Helicina marfisae* sp. nov. (Neritimorpha, Helicinidae).

KEY WORDS: Caenogastropoda; endemic species; Neritimorpha; Stylommatophora; troglotauna

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INTRODUCTION

Brazil is one of the most megadiverse countries in the world for many – if not most – animal taxa (LEWINSOHN et al. 2005). Nevertheless, multiple historical causes (e.g., colonialism, vast territory, inaccessible areas, lack of funding, and the current wrecking of science) have kept the knowledge of this biodiversity mostly in its infancy. That is especially true for invertebrates and, in particular, for terrestrial and freshwater gastropods (SALVADOR 2019, ROSA et al. 2022).

One particular region of interest in Brazil is Bahia, a large state in the east-northeastern part of the country. Despite being among the best-studied states in the country for land snails (SALVADOR 2019), it still hides a myriad of discoveries. For instance, that state contains the contact zones of three of Brazil's main

biomes (Atlantic Forest, Cerrado, and Caatinga) and thus, has been identified as a potential biodiversity hotspot for land and freshwater snails (CAVALLARI et al. 2016, SILVA et al. 2021). Bahia also has numerous limestone and siliciclastic caves that have been tagged as hotspots for both terrestrial and freshwater invertebrates (TRAJANO & BICHUETTE 2009). The caves in Bahia are still largely unexplored regarding their molluscan fauna, but they should likewise harbor a wide range of potentially endemic snail species (SALVADOR et al. 2022b). Indeed, a few previous works have reported some gastropod species from caves in Bahia, including new species (e.g., SIMONE 2015, SALVADOR & SIMONE 2016, SALVADOR et al. 2022a), but the only more thorough molluscan survey of caves in Bahia state to date is that of SALVADOR et al. (2017).



Herein we examine material collected from caves in Bahia during several expeditions in the past five years. We describe a new species of Helicinidae and present new occurrences of previously known spe-

cies that extend their known geographic distributions to Bahia state, including cave facultative species (i.e., troglophiles) and cave-restricted species (troglobites).

MATERIAL AND METHODS

Multiple expeditions have been conducted by the team from the LES (Laboratório de Estudos Subterrâneos, Universidade Federal de São Carlos; São Carlos, SP, Brazil) to caves in Bahia during the years 2017–2022. The collection efforts focused on a variety of animal taxa, of which the gastropods were a part. The collections were made by visual inspection of several microhabitats in the caves, using small brushes.

Specimens were collected in 14 of the sampled caves, which are located across the following municipalities: Campo Formoso, Carinhanha, Coribe, Feira

da Mata, Central, and Ituaçu (Figs 1–4). A brief description of the municipalities’ areas and the caves can be found below.

The names of the caves (in Portuguese) are (Fig. 1): Toca da Barriguda (Campo Formoso municipality); Gruna Bem Bom (Carinhanha municipality); Gruta da Machadinha, Gruta do Leão, Toca Bonita, Toca da Mulher, Toca de Candeias, Toca do Cirilo, Toca do Waldemar (Central municipality); Gruna Serra Verde (Coribe municipality); Gruna da Pingueira II, Gruna do Engrunado (Feira da Mata municipality); Lapa da Mangabeira, Lapa Pé de Morro (Ituaçu municipality).

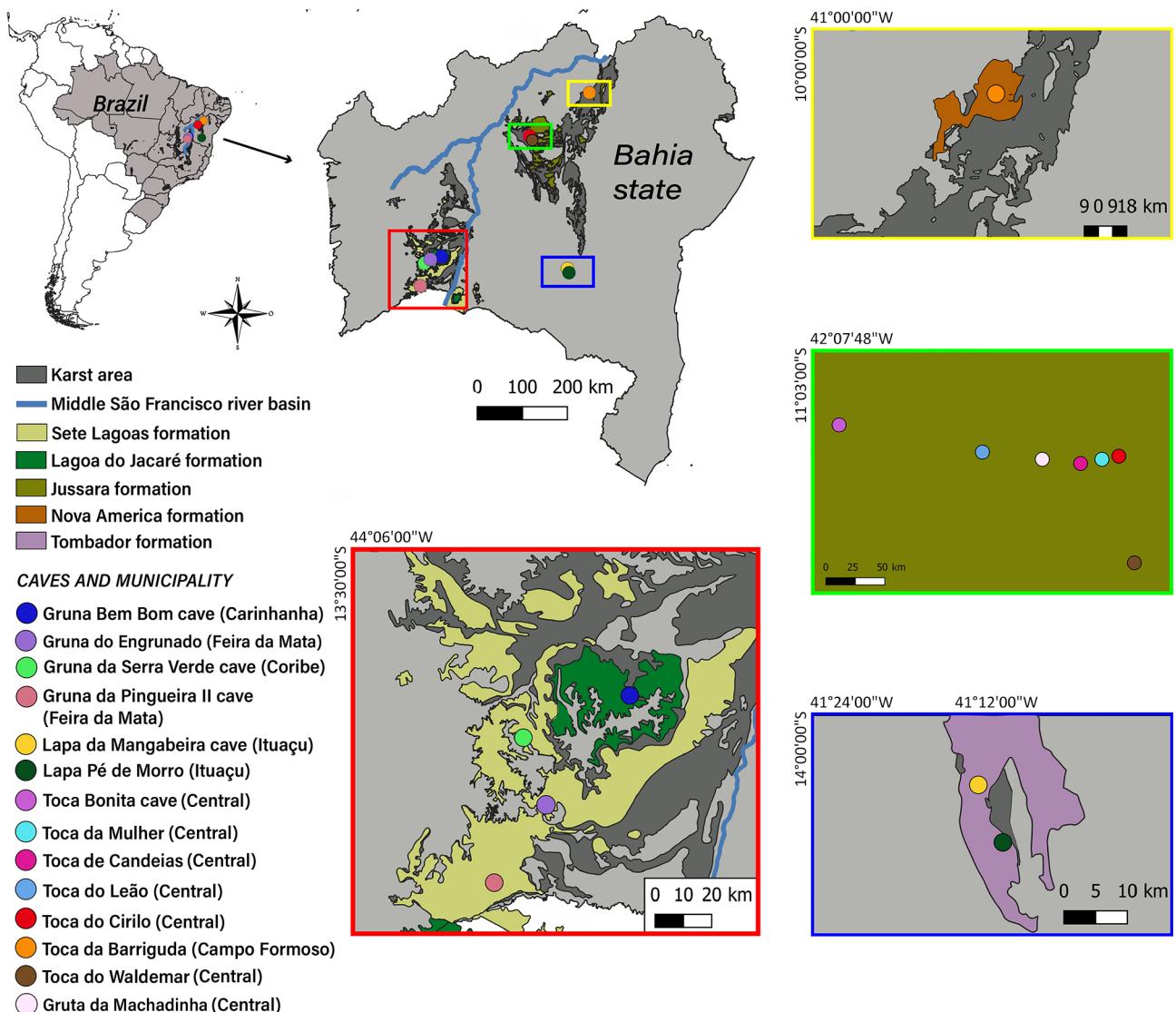


Fig. 1. Map of Bahia state showing the location of the studied caves



Figs 2–4. Examples of surface and cave environments from the present study: 2 – entrance of Gruna do Engrunado cave; 3 – Gallery of Gruna do Engrunado cave; 4 – Gallery of Toca Bonita cave. Photos: MARIA ELINA BICHUETTE

Campo Formoso municipality: Toca da Barriguda cave. This is the second largest cave in Brazil, with circa 35 km of mapped passageways (RUBBIOLI *et al.* 2019). It is a dolomitic cave of the Salitre Formation (Una geomorphological group) located in the Caatinga domain, with a tropical dry climate. The region is part of the Middle São Francisco River basin.

Serra do Ramalho karst area: Gruna Bem Bom, Gruna da Pingueira II, and Gruna Serra Verde caves. Serra do Ramalho is located in the southwestern Bahia state, on the left bank of the Middle São Francisco River basin, being dominated by a plateau formed by carbonates belonging to the Sete Lagoas Formation (Bambuí geomorphological group), with a high number of caves largely lacking legal protection (RUBBIOLI *et al.* 2019). The climate is tropical dry and the region's main biome is the Caatinga, composed of mesophytic and xeromorphic forests interspersed with Cerrado (savannah-like vegetation) (BICHUETTE & RIZZATO 2012).

Ituaçu municipality: Lapa da Mangabeira and Lapa Pé de Morro caves. These caves are located in the southern part of Chapada Diamantina, Upper

Paraguaçu River basin. Both caves are composed of the carbonates of the Salitre Formation (Una geomorphological group; RUBBIOLI *et al.* 2019). Lapa da Mangabeira is a large cave, with more than 3 km of mapped passageways, while Lapa Pé de Morro cave reaches 1.5 km of mapped area (Grupo Araras de Espeleologia – GAE, pers. com.). The region is situated in the Caatinga domain, interspersed by rupestrian fields, with a hot semi-arid climate. The main threats to these caves come from mining activities (limestone extraction) and land use for agriculture and livestock.

Central municipality: Gruta da Machadinha, Gruta do Leão, Toca Bonita, Toca da Mulher, Toca de Candeias, Toca do Cirilo, and Toca do Waldemar caves. This region is part of the Una geomorphological group, and the caves are formed by carbonates, most of them with a few to dozens of meters of development. The climate is hot semi-arid and the region belongs to the Caatinga domain, in the Middle São Francisco River basin. The main threats to these caves are related to the installation of wind parks, altering the limestone landscapes and, consequently, impacting the caves.



TAXONOMY

All the molluscan specimens collected in the expeditions and studied herein were deposited in the malacological collections of the Laboratório de Estudos Subterrâneos, Universidade Federal de São Carlos (LES; São Carlos, SP, Brazil) and the Museu de Zoologia da Universidade de São Paulo (MZSP; São Paulo, SP, Brazil). Empty shells were preserved dry, while complete specimens were preserved in ethanol

Table 1. List of taxa from the present study, with the names of the caves in which they were found, and the registration number of the voucher specimens in the LES or MZSP collections. Abbreviations: hol – holotype; par – paratype(s); sh – empty shell(s); spm – specimen with soft parts (preserved in ethanol).

Taxon	Locality	Voucher material
NERITIMORPHA		
Helicinidae		
<i>Helicina marfisae</i> sp. nov.	Gruta do Leão	MZSP 158915 (hol)
CAENOGASTROPODA		
Cochliopidae		
<i>Heleobia</i> sp.	Toca do Waldemar	LES 0028016 (3 sh)
Tomichiidae		
<i>Idiopyrgus adamanteus</i> Salvador, Silva et Bichuette, 2022	Toca Bonita, Toca da Mulher, Toca de Candeias, Gruta da Machadinha	MZSP 158237 (hol), LES 0027974 (14 par), LES 0027975 (3 par), LES 0027976 (2 sh), LES 0027977 (3 sh), LES 0027978 (4 sh), LES 0027979 (13 sh)
<i>Idiopyrgus minor</i> Salvador, Silva et Bichuette, 2022	Gruna da Pingueira II, Gruna do Engrunado	MZSP 158238 (hol), LES 027980 (2 par)
<i>Idiopyrgus</i> cf. <i>walkeri</i> Pilsbry, 1924	Gruna Bem Bom	LES 0027981 (3 sh)
HYGROPHILA		
Bulinidae		
<i>Plesiophysa</i> sp.	Gruta da Machadinha, Toca de Candeias	MZSP 158916 (1 sh), LES 0028029 (1 sh)
Planorbidae		
<i>Biomphalaria</i> sp.	Gruna Bem Bom, Toca de Candeias	LES 0028017 (1 sh), LES 0028018 (1 sh)
<i>Biomphalaria straminea</i> (Dunker, 1848)	Toca do Cirilo	LES 0028019 (2 sh)
<i>Drepanostoma</i> sp.	Gruta do Leão	LES 0028020 (3 sh)
STYLOMMATOPHORA		
Achatinidae		
<i>Allopeas micra</i> (d'Orbigny, 1835)	Toca da Barriguda	LES 0028021 (3 sh)
<i>Subulina octona</i> (Bruguière, 1789)	Lapa da Mangabeira	LES 0028022 (1 sh)
<i>Stenogyra octogyra</i> (L. Pfeiffer, 1856)	Gruna Bem Bom, Gruta da Machadinha	LES 0028023 (1 sh), LES 0028024 (1 sh)
Bulimulidae		
<i>Anctus</i> sp.	Gruta da Machadinha	LES 0028025 (1 sh)
Gastrocoptidae		
<i>Gastrocopta oblonga</i> (L. Pfeiffer, 1854)	Toca do Waldemar	LES 0028026 (2 sh)
Scolodontidae		
<i>Entodina derbyi</i> (Ihering, 1912)	Toca Bonita	LES 0028034 (2 sh)
<i>Happia</i> sp.	Gruna do Engrunado	LES 0028027 (1 sh)
<i>Tamayoa bangaasi</i> (Thiele, 1927)	Gruta do Leão, Gruta da Serra Verde	LES 0028035 (1 sh), LES 0028036 (1 sh)
Streptaxidae		
<i>Streptartemon</i> cf. <i>cookeanus</i> (F. Baker, 1914)	Toca Bonita, Toca de Candeias, Toca do Cirilo, Lapa Pé de Morro	LES 0028030 (1 sh), LES 0028031 (2 sh), LES 0028032 (1 sh), LES 0028033 (2 spm)
<i>Streptaxis luetzelburgi</i> Weber, 1925	Gruna da Serra Verde	LES 0028028 (1 sh)

96%. Their registration numbers are given in Table 1. Due to conservation concerns, the precise coordinates of each cave will not be presented here; geo-location data is available in the LES and MZSP collections' databases and can be shared upon request with the present authors or with the curatorial staff of those collections.

Species identification was based on the catalogues of SIMONE (2006) and BIRCKOLZ et al. (2016), more specialized taxonomic works (listed in each species' entry below, as appropriate), and comparisons with further voucher material (including types) housed in the following collections: MZSP; CMRP, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (Ribeirão Preto, SP, Brazil); NMNZ, Museum of New Zealand Te Papa Tongarewa (Wellington, New Zealand).

Species of interest (new species and new records for Bahia state) are presented below, arranged in sys-

tematic order (BOUCHET et al. 2017). A complete list of species identified in the present material (but which were already known from Bahia) is compiled in Table 1. Some specimens were juveniles or fragmentary and thus, could not be identified at species level; for those specimens, identification is possible only at the genus level. Most of the species herein are widely distributed in Brazil and consequently are not restricted to caves.

Measurements of the shells were taken with a digital caliper (0.01 mm precision, rounded to the nearest 0.1 mm) or, for minute specimens, via the software ImageJ (v.1.8.0; SCHNEIDER et al. 2012). The following abbreviations are used throughout: col. – collector(s); D – greatest shell width (perpendicular to H); H – shell height (parallel to the columellar axis); sh – dry shell(s); spm – ethanol-preserved specimen(s).

SYSTEMATICS

Subclass Neritimorpha

Superfamily Helicinoidea

Family Helicinidae Férussac, 1822

Genus *Helicina* Lamarck, 1799

Helicina marfisae sp. nov.

Figs 5–7

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Type material. Holotype: MZSP 158915 (1 sh; Bahia, Central, Boqueirão do Maxixe, Gruta do Leão cave, twilight zone; M. E. BICHUETTE, J. E. GALLÃO & T. ZEPON col. 15/III/2017).

Type locality. Brazil, Bahia state, Central municipality, Gruta do Leão cave, 11°03'09.0"S, 42°07'32.4"W.

Distribution. Known only from type locality. The specimens occur in the twilight and aphotic zone, in silty and rocky substrate.

Etymology. After Marfisa, a fictional character in the epics *Orlando Innamorato* and *Orlando Furioso*. Marfisa was the Queen of India and one of the fiercest warriors on the land, often compared to a lioness. The name is an allusion to the name of the type locality, which translates to Cave of the Lion.

Diagnosis. Shell minute, conical. Spire prominent in comparison to neotropical helicinids; step-like. Body whorl marked by two angulations: one on its mid-section and one on the middle of the apical area of the whorl. Aperture small, abapically positioned in relation to previous whorl.

Description. Shell minute, conical, of c. 4¼ whorls. Colour yellowish-brown, translucent; spire top and peristome white. Protoconch bulbous, of c. ¾ whorl,

seemingly marked by faint malleations; transition to teleoconch marled by a sudden constriction in whorl width. Teleoconch sculpture by numerous unevenly-spaced parallel radial cordlets; cordlets absent from abapical area of whorl. Spire prominent, step-like. Suture shallow. Whorl profile convex; body whorl marked by two angulations: one on mid-section and another on the middle of apical area of the whorl. Aperture small, trapezoid, abapically positioned in relation to previous whorl; transition of columellar region to basal region of aperture marked by strong angulation; a faint angulation is present on transition of basal to palatal region. Peristome very lightly thickened, reflexed on basal and columellar regions. Shell imperforate.

Measurements. ~4¼ whorls; H – 4.4 mm; D – 4.9 mm.

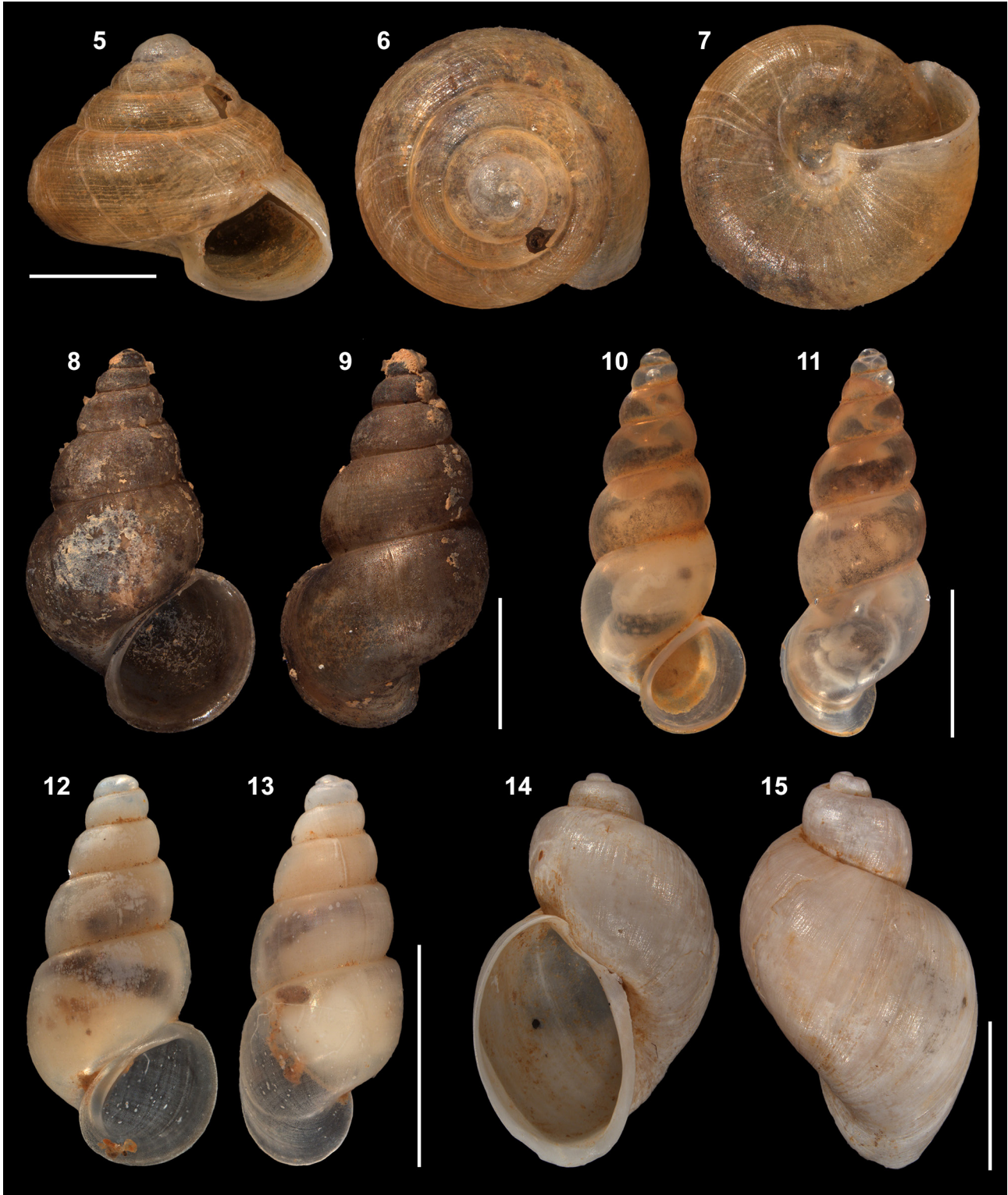
Discussion. The present specimen, an empty shell, is a minute Helicinidae. Even though it is a singleton, the shell is so strikingly different from all other helicinids in the country (and in South America), that we are confident in assigning it to a new species.

All helicinids in Brazil present typical heliciniform (lenticular) shells (SIMONE 2006), as it would be expected; that also includes the more minute animals of similar size to the present specimen. As such, the present specimen's minute and relatively-high spired and conical shell, with a step-like profile and abapically positioned aperture, is immediately distinct from all other known helicinids in South America. Some of its conchological traits can be observed in Central American helicinids, particularly in the Caribbean: the step-like spire is seen in *Fadyenia*



Chitty, 1857, and the abapically-positioned aperture is seen in *Lucidella* Swainson, 1840. Nevertheless, the occurrence of all these traits together on a single shell is unique to the present specimen; this set of

traits are thus a strong suite of morphological diagnostic characters. Thus, we consider that the present specimen belongs to a new species: *Helicina marfisae* sp. nov. Considering the uniqueness of its shell, it is



Figs 5–15. Terrestrial and freshwater gastropods found in caves in Bahia state (scale bars – 2 mm): 5–7 – *Helicina marfisae* sp. nov., holotype MZSP 158915; 8–9 – *Idiopyrgus* cf. *walkeri* Pilsbry, 1924, LES 0027981; 10–11 – *Idiopyrgus adamanteus* Salvador, Silva et Bichuette, 2022(a), holotype MZSP 158237; 12–13 – *Idiopyrgus minor* Salvador, Silva et Bichuette, 2022(a), holotype MZSP 158238; 14–15 – *Plesiophysa* sp., MZSP 158916

possible that it could even represent a new genus; however, given that there is currently no phylogenetic background on Brazilian heliciniids to sustain such a proposal, we provisionally classify it in *Helicina*.

Helicina marfisae sp. nov. can be immediately distinguished from all other heliciniids in Brazil (in particular those of similar size) by its prominent step-like spire and its abapically positioned aperture. A few of the larger snails (e.g., *H. concentrica* L. Pfeiffer, 1849 and *H. juruana* Ihering, 1905, both from the Amazon) can display shells with a step-like spire profile, though their profile is much less marked than that of *H. marfisae* sp. nov. Furthermore, the shells of those larger *Helicina* spp. are at least twice the size of the shell of *H. marfisae* sp. nov.

The two angulations on the body whorl of *Helicina marfisae* sp. nov. are likewise diagnostic in comparison to other Brazilian heliciniids. Many of the larger-sized species of *Helicina* have a mid-whorl angulation, but the presence of the more apically positioned angulation is rare, being only present on a similar scale in *H. leucozonalis* Ancey, 1892 from western Brazil (which is a much larger snail).

Even though the single known specimen of *Helicina marfisae* sp. nov. was found inside Toca do Leão cave, we cannot ascertain whether this species is troglobiotic or not, as it could also be present in unsampled areas outside the cave. The lack of obvious shell troglomorphisms (the minute size notwithstanding, as it is within the size range of the genus in Brazil; SIMONE 2006) could be an indication that this species is either troglophilic or even accidental, also considering it was collected in the cave's twilight zone. Its shell, however, is rather fragile and it can be expected that it would not resist long transport into a cave, so it must be at least parautochthonous.

Subclass Caenogastropoda

Superfamily Truncatelloidea

Family Tomichiidae Wenz, 1938

Genus *Idiopyrgus* Pilsbry, 1911

Idiopyrgus cf. *walkeri* Pilsbry, 1924

Figs 8–9

Idiopyrgus cf. *walkeri* – SALVADOR et al. 2022a: p. 366.

Type locality. Brazil, Minas Gerais state, Rio das Velhas. Type material missing (see SALVADOR et al. 2022a).

Distribution. Known with certainty only from type locality (SALVADOR et al. 2022a).

Material analyzed. LES 0027981 (3 sh; Bahia, Carinhanha, Grana Bem Bom cave; M. E. BICHUETTE; J. S. GALLO; J. E. GALLÃO col. 07/VII/2021).

Discussion. Even though the genus *Idiopyrgus* has been typically classified in Pomatiopsidae, a recent molecular phylogenetic study demonstrated

that it belongs instead to the Gondwanan family Tomichiidae (SALVADOR et al. 2022a). Those authors also revised the status of all species in the genus and *I. walkeri* was considered a taxon inquirendum, given that its type specimens could not be located, no topotypes are known, and the simple line drawings of the species' shell (PILSBRY 1924) are not enough to allow its identification with certainty.

Nevertheless, the wider shells of the present specimens (in comparison to other *Idiopyrgus* spp.) are a good match to the description of *I. walkeri* and its illustrations (PILSBRY 1924). As such, the specimens are here tentatively identified as *Idiopyrgus* cf. *walkeri*. Their occurrence in Carinhanha municipality is circa 450 km to the north of the river which is the type locality of the species. The specimens were in a humid substrate composed of silt and rock, in the twilight and aphotic zones of the cave.

Remarks. Two new species of *Idiopyrgus* were identified in the material from the present expeditions and were described by SALVADOR et al. (2022a) in their revision of that genus. They are *I. adamanteus* (Figs 10–11) and *I. minor* (Figs 12–13).

Subclass Heterobranchia

Superorder Hygrophila

Superfamily Lymnaeoidea

Family Bulinidae P. Fischer et Crosse, 1880

Genus *Plesiophysa* P. Fischer, 1883

Plesiophysa sp.

Figs 14–15

Material analyzed. MZSP 158916 (1 sh; Bahia, Central, Gruta da Machadilha cave, twilight and aphotic zones; M. E. BICHUETTE, J. E. GALLÃO & T. ZEPON col. 15/III/2017); LES 0028029 (1 sh, juvenile; Bahia, Central, Toca de Candeias cave, twilight and aphotic zones; M. E. BICHUETTE col. 03/VII/2018).

Discussion. Only two of the five species in the genus *Plesiophysa* occur in Brazil, *P. guadeloupensis* Mazé, 1883 and *P. dolichomastix* Paraense, 2002(a) (PARAENSE 2002a, b, 2003, SIMONE 2006). The latter is so far known only from its type locality in the Brazilian Midwest: a lake in Santa Rosa municipality, Goiás state (PARAENSE 2002a). The former, on the other hand, is widespread in Central and South America, being distributed from Guadeloupe and the Dominican Republic to southeastern Brazil (BIRCKOLZ et al. 2016). In Brazil, *P. guadeloupensis* has been reported from Rio Grande do Norte, Paraíba, Pernambuco, Sergipe, Bahia, Espírito Santo, Minas Gerais, and Rio de Janeiro states (BIRCKOLZ et al. 2016).



Species of *Plesiophysa* are considered nearly indistinguishable from one another based on shell characters alone (PARAENSE 2002a, b, 2003). However, the present shells are easily diagnosable from them, displaying a much more raised spired while in its congeners the spire is depressed into the later whorls. Furthermore, the shape and position of the body whorl is different in the present specimens, being shorter/smaller and much more diagonally positioned in relation to the columellar axis (i.e., at a greater angle) than in congeners. Finally, the shell aperture of the present specimens is almost perfectly oval, being more vertically positioned in relation to the shell axis.

Considering the conchological features described above, the present specimens could potentially represent a new species. However, the shells of freshwater snails are knowingly very plastic and variable in their morphology and a final verdict on the status of the present specimens will have to wait until more specimens become available, alongside anatomical and/or molecular data. For now, we identify the specimens simply as *Plesiophysa* sp.

Order Stylommatophora

Superfamily Streptaxoidea

Family Streptaxidae

Genus *Streptartemon* Kobelt, 1905

Streptartemon cf. *cookeanus* (F. Baker, 1914)

Figs 16–21

Type locality. Brazil, Rio Grande do Norte state, Ceará-Mirim and Estremoz municipalities and Baixa Verde (in Açu municipality) (BAKER 1914).

Distribution. Brazil: Ceará, Rio Grande do Norte and Paraíba states (SIMONE 2006). As SALVADOR & CUNHA (2020) argued, previous reports of *S. cookeanus* from southeastern Brazil belong to another species, *S. waukeen* Salvador et Cunha, 2020.

Material analyzed. LES 0028030 (1 sh; Bahia, Central, Toca de Candeias; M. E. BICHUETTE col. 03/VII/2018); LES 0028031 (2 sh; Bahia, Central, Toca Bonita; M. E. BICHUETTE, J. E. GALLÃO & T. ZEPON col. 13/III/2017); LES 0028032 (1 sh; Bahia, Central, Toca do Cirilo; M. E. BICHUETTE, J. E. GALLÃO & T. ZEPON col. 14/III/2017); LES 0028033 (2 sh; Bahia, Ituaçu, Lapa Pé do Morro; M. E. BICHUETTE, T. ZEPON & J. E. GALLÃO col. 30/VI/2018).

Discussion. Shells of this species can be identified by the sloping penultimate and body whorls, alongside a proportionately small aperture that lacks teeth. The present specimens generally fit within the conchological variation observed in *S. cookeanus*, but some factors make a definite identification uncertain: (1) small deviations in shell morphology, such as a lower

body whorl (Figs 16–18) or more laterally elongated shells (Figs 19–21); (2) the vast geographic distance to previous records (the present records would extend the species distribution around 700 km SW); and (3) the fact that the present specimens come from cave environments, which are known to foster speciation. All these could be an indication that we are potentially dealing with a new species, particularly when taking into account that specimens from southeast Brazil previously identified as *S. cookeanus* have been recently described as a distinct species (SALVADOR & CUNHA 2020). As such, we consider it preferable to leave the present specimens in open classification for the time being, until anatomical and/or molecular data become available.

Superfamily Scolodontoidea

Family Scolodontidae

Genus *Entodina* Ancey, 1887

Entodina derbyi (Ihering, 1912)

Figs 22–24

Streptaxis (*Polygyratia*) *derbyi* IHERING 1912: p. 488, pl. 42, fig. 19.

Entodina derbyi – MORRETES 1940: p. 258; MORRETES 1949: p. 138; SALGADO & COELHO 2003: p. 169; SIMONE 2006: p. 223, fig. 847.

Type locality. Brazil, Bahia state, Paraguaçu River.

Distribution. Brazil: Bahia state, São Francisco and Paraguaçu Rivers (SIMONE 2006).

Material analyzed. LES 0028034 (3 sh; Bahia, Central, Toca Bonita; M. E. BICHUETTE, J. E. GALLÃO & T. ZEPON col. 13/III/2017).

Discussion. *Entodina derbyi* can be easily identified by the marked angulation on the middle section of the whorl (IHERING 1912). This species is reported from only two localities in Bahia state. The present record is thus an interesting occurrence, given that it is an intermediate point (longitudinally) between them, being closer to the São Francisco River. Furthermore, considering that *E. derbyi* is rarely recorded or illustrated in the literature, we hope the photographs provided here will be of help to future studies.

Remarks. The genus *Entodina* is often considered a synonym of *Systrophia* L. Pfeiffer, 1855, although sometimes it is regarded as a separate taxon (e.g., SIMONE 2006). Molecular data has hinted that *Entodina* is possibly valid as a separate genus (SALVADOR 2021).

Genus *Tamayoa* H. B. Baker, 1925

Tamayoa banghaasi (Thiele, 1927)

Figs 25–27

Happia banghaasi THIELE 1927: p. 319, pl. 26, fig. 13a, b, text-fig. 4; HAAS 1935: p. 111;

Tamayoa (Tamayops) banghaasi – BAKER 1928: p. 124; HAAS 1939: p. 268; MONTEIRO & SANTOS 2001: p. 1049.

Tamayoa bankhaasi – MORRETES 1949: p. 139; SCHADE 1965: p. 218.

Tamayoa banghaasi – JAECKEL 1952: p. 7; QUINTANA 1982: p. 102; OLIVEIRA & OLIVEIRA 1984: p. 8;

SANTOS & MONTEIRO 2001: tab. 2, 3; SALGADO & COELHO 2003: p. 169; SIMONE 2006: p. 230, fig. 875; SANTOS et al. 2010: p. 514; ALEXANDRE et al. 2017: p. 34; SALVADOR et al. 2018: p. 119, fig. 11D–G; RANGEL et al. 2021: p. 4, fig. 7D.

Type locality. Brazil, Pernambuco state, Olinda municipality; and Espírito Santo state.



Figs 16–27. Stylommatophoran gastropods found in caves in Bahia state: 16–21 – *Streptartemon* cf. *cookeanus* (F. Baker, 1914) (scale bars – 2 mm; 16–18 – LES 0028031; 19–21 – LES 0028030); 22–24 – *Entodina derbyi* (Ihering, 1912), LES 0028034 (scale bar – 1 mm); 25–26 – *Tamayoa banghaasi* (Thiele, 1927), LES 0028035 (scale bar – 1 mm)



Distribution. Brazil: Paraíba, Pernambuco, Alagoas, Minas Gerais, Espírito Santo, and Rio de Janeiro states (SALVADOR *et al.* 2018).

Material analyzed. LES0028035 (1 sh; Bahia, Central, Gruta do Leão; M. E. BICHUETTE, J. E. GALLÃO & T. ZEPON col. 15/III/2017); LES 0028036 (1 sh; Bahia, Coribe, Gruta da Serra Verde; M. E. BICHUETTE, J.

E. GALLÃO, J. S. GALLO & V. F. SPERANDEI col. 05/VII/2021).

Remarks. *Tamayoa banghaasi* is widespread in eastern Brazil. The present records fill a gap in the species known distribution, linking the records from the northeast (Paraíba, Pernambuco and Alagoas states) to those in the southeast (Minas Gerais, Espírito Santo and Rio de Janeiro states).

DISCUSSION

A total of 19 species-level taxa (representing 10 families) was found in the present material, 8 of which are freshwater caenogastropods and Hygrophila (“basommatophorans”), while the remainder are terrestrial heliciniids and stylommatophorans (Table 1). As expected, there is reduced diversity in cave environments as compared to adjacent surface areas.

The previously reported trend of Achatinidae (Subulininae) and Scolodontidae being the most diverse terrestrial families in caves (e.g., SALVADOR *et al.* 2016, 2017, 2021) is further supported by our data (Table 1). Nevertheless, it is worth noting that most representatives of those families in caves belong to widespread species in the country (SALVADOR *et al.* 2022a).

By contrast, the family Helicinidae of operculated land snails is usually uncommon among cave snail checklists, with only a few species reported from subterranean environments (SALVADOR *et al.* 2016, 2017, 2021). Nevertheless, the only new species of terrestrial snail described here, *Helicina marfisae* sp. nov., belongs to this family. Despite its unique shell shape (Figs 5–7), there are no obvious conchological characters that could be considered troglomor-

phisms (the small size notwithstanding). As mentioned above, given that only a single empty shell was found, we cannot even ascertain whether this species is indeed troglotrophic, troglophilic, or just accidental.

Among the freshwater snails, there are more cave endemics and potentially troglotrophic species (e.g., *Idiopyrgus minor*), likely due to the populations becoming isolated. In those cases, it is also common to find morphoanatomical features that are probably troglomorphisms, such as translucent shells and lack of body pigmentation (Figs 10–13; SALVADOR *et al.* 2022a, b). Even though *Plesiophysa* sp. might represent a yet undescribed species, as mentioned above, no obvious troglomorphisms can be observed in the shell (Figs 14–15).

As recently suggested in the study of SALVADOR *et al.* (2022a), it is also notable that the caves in Bahia state could be a hotbed of speciation of *Idiopyrgus*, an otherwise low-diversity relict genus. Besides the three species reported herein (Table 1), *I. souleyetanus* Pilsbry, 1911 also occurs in Bahia, totaling four out of the seven currently-recognized species in the genus (SALVADOR *et al.* 2022a).

CONCLUSION

The present study improves the knowledge of the cave snail fauna in Bahia state and has brought a new species to light. Given that the region might be a hotspot for snails and other invertebrates (TRAJANO & BICHUETTE 2009, CAVALLARI *et al.* 2016, SILVA *et al.* 2021), the current lack of protection of the caves studied herein is worrying. The caves in the regions of Central municipality and Serra do Ramalho, for instance, are impacted by deforestation, agriculture, and mining, which increasingly shows the need for fauna studies in these places (GALLÃO & BICHUETTE 2018, SALVADOR *et al.* 2021, 2022a).

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REFERENCES

- ALEXANDRE G. L., DAMASCENO H. V., MIYAHIRA I. C., CAETANO C. H. S. 2017. Gastrópodes (Mollusca) presentes no campus Urca da Universidade Federal do Estado do Rio de Janeiro (UNIRIO). *Biotemas* 30(4): 31–40.
<https://doi.org/10.5007/2175-7925.2017v30n4p31>
- ANCEY C. F. 1892. On some shells from eastern Bolivia and western Brazil. *Journal of Conchology* 7: 90–97.
<https://www.biodiversitylibrary.org/page/31573584>
- BAKER F. 1914. The land and fresh-water mollusks of the Stanford Expedition to Brazil. *Proceedings of the Academy of Natural Sciences of Philadelphia* 65: 618–672.
<https://www.biodiversitylibrary.org/page/26307597>
- BAKER F. 1928. Thiele’s Brazilian land snails. *Nautilus* 41: 124–129.
- BAKER H. B. 1925. The Mollusca collected by the University of Michigan-Williamson Expedition in Venezuela, Part III: Pupillidae to Oleacinidae. *Occasional Papers of the Museum of Zoology, University of Michigan* 156: 1–56.
<https://deepblue.lib.umich.edu/bitstream/handle/2027.42/56595/OP156.pdf?sequence=1&isAllowed=y>
- BICHUETTE M. E., RIZZATO P. P. 2012. A new species of cave catfish from Brazil, *Trichomycterus rubbioli* sp. n., from Serra do Ramalho karstic area, São Francisco River basin, Bahia State (Siluriformes: Trichomycteridae). *Zootaxa* 3480: 48–66.
<https://doi.org/10.11646/zootaxa.3480.1.2>
- BIRCKOLZ C. J., SALVADOR R. B., CAVALLARI D. C., SIMONE L. R. L. 2016. Illustrated checklist of newly described (2006–2016) land and freshwater Gastropoda from Brazil. *Archiv für Molluskenkunde* 145: 133–150.
<https://doi.org/10.1127/arch.moll/145/133-150>
- BOUCHET P., ROCROI J. P., HAUSDORF B., KAIM A., KANO Y., NÜTZEL A., PARKHAEV P., SCHRÖDL M., STRONG E. E. 2017. Revised classification, nomenclator and typification of gastropod and monoplacophoran families. *Malacologia* 61: 1–527.
<https://doi.org/10.4002/040.061.0201>
- BRUGUIÈRE J. G. 1789. *Encyclopédie méthodique ou par ordre de matières. Histoire naturelle des vers*, volume 1. Pancoucke, Paris, pp. 1–344.
<https://biodiversitylibrary.org/page/8892006>
- CAVALLARI D. C., SALVADOR R. B., SIMONE L. R. L. 2016. A possible land snail diversity hotspot in Bahia state, Brazil. *Tentacle* 24: 14–16.
- CAVALLARI D. C., SILVA F. S., CUNHA C. M., BICHUETTE M. E., SALVADOR R. B. 2021. Brazilian troglobitic snails begin to emerge – and are already in danger. *Tentacle* 29: 32–34.
- CHITTY E. 1857. On Stoastomidae as a family and on seven proposed new genera, sixty-one new species, and two new varieties from Jamaica. *Proceedings of the Zoological Society of London* 25: 162–201.
<https://biodiversitylibrary.org/page/12861218>
- DUNKER W. 1848. Diagnoses specierum novarum generis *Planorbis* collectionis Cumingianae. *Proceedings of the Zoological Society of London* 16: 40–43.
<https://www.biodiversitylibrary.org/page/12861882>
- FÉRUSAC A. E. J. P. F. D’AUDEBARD DE 1822. *Tableaux systématiques des animaux mollusques classés en familles naturelles, dans lesquels on a établi la concordance de tous les systèmes; suivis d’un Prodrôme général pour tous les mollusques ou fluviatiles, vivantes ou fossiles. Livraison 14: i-xxiv (Quarto) (16-II-1822); livr. 15: xxv-xlvi[i] (Quarto) (13-IV-1822); livr. 16: 1–27 (Quarto) (16-VII-1822).* Arthus Bertrand/G.B. Sowerby, Paris/London.
<https://biodiversitylibrary.org/page/11057234>
- FISCHER P. 1883. *Manuel de conchyliologie et de paléontologie conchyliologique, ou histoire naturelle des mollusques vivants et fossiles suivi d’un Appendice sur les Brachiopodes par D. P. Oehlert. Avec 23 planches contenant 600 figures dessinées par S. P. Woodward.* F. Savy, Paris, vol. 5, pp. 417–512.
<https://www.biodiversitylibrary.org/item/47340>
- FISCHER P., CROSSE H. 1880. *Etudes sur les Mollusques terrestres et fluviatiles du Mexique et du Guatemala. Mission scientifique au Mexique et dans l’Amérique Centrale. Recherches zoologiques, Vol. 2, Part 8.* Imprimerie Nationale, Paris, pp. 1–80.
- GALLÃO J. E., BICHUETTE M. E. 2018. Brazilian obligatory subterranean fauna and threats to the hypogean environment. *ZooKeys* 746: 1–23.
<https://doi.org/10.3897/zookeys.746.15140>
- HAAS F. 1935. *Kurze bemerkungen V (3): binnenschnecken aus verschiedenen teilen Brasiliens.* *Archiv für Molluskenkunde* 67: 109–112.
- HAAS F. 1939. *Zur Kenntnis der Binnen-Mollusken NO-Brasiliens.* *Senckenbergiana* 21: 254–278.
- IHERING H. VON 1905. O rio Juruá. *Revista do Museu Paulista* 6: 385–460.
<https://www.biodiversitylibrary.org/page/11191899>



- IHERING H. VON 1912. Analyse der Süd-Amerikanischen Heliceen. *Journal of the Academy of Natural History of Philadelphia* 15: 475–500.
- JAECKEL S. 1952. Short review of the land and freshwater molluscs of the North-East States of Brazil. *Dusenica* 3(1): 1–10.
- LAMARCK J. B. M. 1799. Prodrôme d'une nouvelle classification des coquilles, comprenant une rédaction appropriée des caractères génériques, et l'établissement d'un grand nombre de genres nouveaux. *Mémoires de la Société d'Histoire Naturelle de Paris* 1: 63–91. <https://www.biodiversitylibrary.org/page/13585626>
- LEWINSOHN T. M., FREITAS A. V. L., PRADO P. I. 2005. Conservation of terrestrial invertebrates and their habitats in Brazil. *Conservation Biology* 19: 640–645. <https://doi.org/10.1111/j.1523-1739.2005.00682.x>
- MAZÉ H. 1883. Catalogue révisé des Mollusques terrestres et fluviatiles de la Guadeloupe et de ses dépendances. *Journal de Conchyliologie* 31: 5–54. <https://www.biodiversitylibrary.org/page/15857016>
- MONTEIRO D. P., SANTOS S. B. 2001. Conquiliomorfolgia de *Tamayoa (Tamayops) banghaasi* (Thiele) (Gastropoda, Systrophiiidae). *Revista Brasileira de Zoologia* 18: 1049–1055. <https://doi.org/10.1590/S0101-81752001000400002>
- MORRETES F. L. 1940. Um novo gasterópodo pulmonado do Brasil. *Arquivos de Zoologia* 2: 257–260.
- MORRETES F. L. 1949. Ensaio de catálogo dos moluscos do Brasil. *Arquivos do Museu Paranaense* 7: 5–216.
- OLIVEIRA M. P., OLIVEIRA M. H. R. 1984. Comunicações malacológicas nº 16. Listagem de tipos de gastropoda pulmonata brasileiros depositados em quatro museus europeus. *Boletim do Instituto de Ciências Biológicas e de Geociências* 38: 1–46.
- D'ORBIGNY A. 1835. Synopsis terrestrium et fluviatilium molluscorum, in suo per Americam meridionalem itinere collectorum. *Magasin de Zoologie* 5(62): 1–44. <https://www.biodiversitylibrary.org/page/2633132>
- PARAENSE W. L. 2002a. *Plesiophysa dolichomastix* sp. n. (Gastropoda: Planorbidae). *Memórias do Instituto Oswaldo Cruz, Rio de Janeiro* 97: 505–508. <https://doi.org/10.1590/S0074-02762002000400009>
- PARAENSE W. L. 2002b. The genus *Plesiophysa*, with a re-description of *P. ornata* (Haas, 1938) (Gastropoda: Planorbidae). *Brazilian Journal of Biology* 62: 333–338. <https://www.scielo.br/j/bjb/a/J4FdnPmXQpXst7Gg7mBQXyG/?lang=en&format=pdf>
- PARAENSE W. L. 2003. *Plesiophysa guadeloupensis* ("Fischer" Mazé, 1883). *Memórias do Instituto Oswaldo Cruz* 98: 519–521. <https://doi.org/10.1590/S0074-02762003000400017>
- PFEIFFER L. 1849. Description of twenty-nine new species of *Helicina*, from the collection of H. Cuming, Esq. *Proceedings of the Zoological Society of London* 16 (187–188) ["1848"]: 119–125. <https://www.biodiversitylibrary.org/page/12861983>
- PFEIFFER L. 1854. Descriptions of sixty-six new land shells, from the collection of H. Cuming, Esq. *Proceedings of the Zoological Society of London* 20 (242) ["1852"]: 65–70. <https://www.biodiversitylibrary.org/page/30680666>
- PFEIFFER L. 1855. Versuch einer Anordnung der Heliceen nach natürlichen Gruppen. *Malakozoologische Blätter* 2: 113–144. <https://www.biodiversitylibrary.org/page/15864853>
- PFEIFFER L. 1856. Diagnosen neuer Landschnecken. *Malakozoologische Blätter* 3(12): 43–48. <https://www.biodiversitylibrary.org/page/15865010>
- PILSBRY H. A. 1911. Non-marine Mollusca of Patagonia. In: SCOTT W. B. (ed.). *Reports of the Princeton University Expeditions to Patagonia, 1896–1899. Volume III, 2. Zoology*. Princeton University, Princeton, N.J.; Schweizerbart'sche Verlagshandlung, Stuttgart, pp. 513–633. <https://www.biodiversitylibrary.org/page/23493634>
- PILSBRY H. A. 1924. South American land and fresh-water mollusks: notes and descriptions. *Proceedings of the Academy of Natural Sciences of Philadelphia* 76: 49–66.
- QUINTANA M. G. 1982. Catálogo preliminar de la malacofauna del Paraguay. *Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (Zoología)* 11: 61–158.
- RANGEL F. C. S., GOMES S. R., CANUTO T., RODRIGUES O. S., THIENGO S. C. 2021. Diversity of non-marine gastropods of the Fiocruz Atlantic Forest Biological Station and adjacent urban areas, Rio de Janeiro, RJ, Brazil. *Annals of the Brazilian Academy of Sciences* 93: e20190691. <https://doi.org/10.1590/0001-3765202120190691>
- ROSA R. M., CAVALLARI D. C., SALVADOR R. B. 2022. iNaturalist as a tool in the study of tropical molluscs. *PLoS ONE* 17(5): e0268048. <https://doi.org/10.1371/journal.pone.0268048>
- RUBBIOLI E., AULER A. S., MENIN D., BRANDI R. 2019. *Cavernas. Atlas do Brasil Subterrâneo*. CECAV, Belo Horizonte.
- SALGADO N. C., COELHO A. C. S. 2003. Moluscos terrestres do Brasil (Gastropodes operculados ou não, exclusive Veronicellidae, Milacidae e Limacidae). *Revista de Biologia Tropical* 51(suppl. 3): 149–189. <https://www.redalyc.org/pdf/449/44911879010.pdf>
- SALVADOR R. B. 2019. Land snail diversity in Brazil. *Strombus* 25: 10–20.
- SALVADOR R. B. 2021. Phylogenetic position of the genus *Ridleyconcha* (Gastropoda, Stylommatophora). *American Malacological Bulletin* 38: 63–71. <https://doi.org/10.4003/006.038.0212>
- SALVADOR R. B., CAVALLARI D. C., SIMONE L. R. L. 2016. Taxonomical study on a sample of land snails from Alto Ribeira State Park (São Paulo, Brazil), with description of a new species. *Archiv für Molluskenkunde* 145: 59–68. <https://doi.org/10.1127/arch.moll/1869-0963/145/059-068>
- SALVADOR R. B., CAVALLARI D. C., SIMONE L. R. L. 2017. Taxonomical study on a sample of land and freshwater snails from caves in central Brazil, with description of

- a new species. *Zoosystematics and Evolution* 93: 135–141.
<https://doi.org/10.3897/zse.93.10995>
- SALVADOR R. B., CHARLES L., SIMONE L. R. L., MAESTRATI P. 2018. Terrestrial gastropods from Pedra Talhada Biological Reserve, Alagoas state, Brazil, with description of a new species of *Radiodiscus* (Gastropoda: Charopidae). *Archiv für Molluskenkunde* 147: 101–128.
<https://doi.org/10.1127/arch.moll/147/101-128>
- SALVADOR R. B., CUNHA C. M. 2020. A new species of *Streptartemon* from southeastern Brazil (Gastropoda: Streptaxidae). *Journal of Conchology* 43: 513–519.
- SALVADOR R. B., SIMONE L. R. L. 2016. A new species of *Kora* from Bahia, Brazil (Gastropoda: Pulmonata: Orthalicoidea), with an emended diagnosis of the genus. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* 9: 1–7.
- SALVADOR R. B., SILVA F. S., BICHUETTE M. E. 2022a. Phylogenetic position of the relict South American genus *Idiopyrgus* Pilsbry, 1911 (Gastropoda, Truncatelloidea), with the description of two new cave species. *Zoosystematics and Evolution* 98: 365–375.
<https://doi.org/10.3897/zse.98.90797>
- SALVADOR R. B., SILVA F. S., CAVALLARI D. C., CUNHA C. M., BICHUETTE M. E. 2022b. Cave-dwelling gastropods (Mollusca: Gastropoda) of Brazil: state of the art and conservation. *Zoologia (Curitiba)* 39: e21033.
<https://doi.org/10.1590/S1984-4689.v39.e21033>
- SALVADOR R. B., SILVA F. S., CAVALLARI D. C., SIMONE L. R. L. 2021. Terrestrial Gastropoda from the caves of Presidente Olegário, southeastern Brazil. *Biota Neotropica* 21: e20201169.
<https://doi.org/10.1590/1676-0611-BN-2020-1169>
- SANTOS S. B., MONTEIRO D. P. 2001. Composição de gastrópodes terrestres em duas áreas do Centro de Estudos Ambientais e Desenvolvimento Sustentado (CEADS), Vila Dois Rios, Ilha Grande, Rio de Janeiro, Brasil. Um estudo piloto. *Revista Brasileira de Zoologia* 18 (supl. 1): 181–190.
<https://doi.org/10.1590/S0101-81752001000500014>
- SANTOS S. B., RODRIGUES C. L., NUNES G. K. M., BARBOSA A. B., LACERDA L. E. M., MIYAHIRA I. C., VIANA T. A., OLIVEIRA J. L., FONSECA F. C., SILVA P. C. C. 2010. Estado do conhecimento da fauna de invertebrados não-marinhos da Ilha Grande (Angra dos Reis, RJ). *Oecologia Australis* 14: 504–549.
<https://doi.org/10.4257/oeco.2010.1402.11>
- SCHADE F. H. 1965. Lista de moluscos del Guaira (Villarrica-Paraguay) conocidos hasta el presente. *Comunicaciones de la Sociedad Malacológica del Uruguay* 1: 209–221.
- SCHNEIDER C. A., RASBAND W. S., ELICEIRI K. W. 2012. NIH Image to ImageJ: 25 years of image analysis. *Nature Methods* 9: 671–675.
<https://doi.org/10.1038/nmeth.2089>
- SILVA F. S., SIMONE L. R. L., SALVADOR R. B. 2021. Synopsis of the terrestrial and freshwater gastropod fauna of southern Bahia, Brazil. *Arquivos de Zoologia* 52: 41–61.
- SIMONE L. R. L. 2006. Land and Freshwater Molluscs from Brazil. EGB/Fapesp, São Paulo.
- SIMONE L. R. L. 2015. Three new species of *Kora* (Pulmonata, Orthalicidae) from Bahia and Minas Gerais, Brazil. *Journal of Conchology* 42: 51–56.
- SWAINSON W. 1840. A treatise on malacology or shells and shell-fish. Longman, London.
<https://www.biodiversitylibrary.org/item/33450>
- THIELE J. 1927. Über einige brasilianische Landschnecken. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft* 40: 307–330.
- TRAJANO E., BICHUETTE M. E. 2009. Diversity of Brazilian subterranean invertebrates, with a list of troglomorphic taxa. *Subterranean Biology* 7: 1–16.
- WEBER A. 1925. Konchyliologische Ergebnisse einer Forschungsreise Dr. v. Lützelburg's in Brasilien. *Zoologische Jahrbücher* 50: 273–282.
- WENZ W. 1938. Gastropoda. Teil 1: Allgemeiner Teil und Prosobranchia. In: SCHINDEWOLF O. H. (ed.). *Handbuch der Paläozoologie*, Band 6. Bornträger, pp. 1–240 [March 1938]; 241–480 [October 1938].

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