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; troglofauna


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 species that extend their known geographic distributions to Bahia state, including cave facultative species (i.e., troglobilophiles) 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
Campo Formoso municipality: Toca da Barriguda cave. This is the second largest cave in Brazil, with circa 35 km of mapped passageways (RUBBIOLE 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 (RUBBIOLE 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).

Ituacu 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; RUBBIOLE 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 Espelaeologia – 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).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Locality</th>
<th>Voucher material</th>
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<tbody>
<tr>
<td><strong>NERITIMORPHA</strong></td>
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<td>Helicinidae</td>
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<tr>
<td>Helicina marfisae sp. nov.</td>
<td>Gruta do Leão</td>
<td>MZSP 158915 (hol)</td>
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<td><strong>CAENOGASTROPODA</strong></td>
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<td>Cochliopidae</td>
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<tr>
<td>Heleobia sp.</td>
<td>Toca do Waldemar</td>
<td>LES 0028016 (3 sh)</td>
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<td>Tomichiidae</td>
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<tr>
<td>Idiopyrgus adamanteus Salvador, Silva et Bichuette, 2022</td>
<td>Toca Bonita, Toca da Mulher, Toca de Candeias, Gruta da Machadinha</td>
<td>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)</td>
</tr>
<tr>
<td>Idiopyrgus minor Salvador, Silva et Bichuette, 2022</td>
<td>Gruna da Pingeirea II, Gruna do Engrunado</td>
<td>MZSP 158238 (hol), LES 027980 (2 par)</td>
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<tr>
<td>Idiopyrgus cf. walkeri Pilsbry, 1924</td>
<td>Gruna Bem Bom</td>
<td>LES 0027981 (3 sh)</td>
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<tr>
<td><strong>HYGROPHILA</strong></td>
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<td>Bulinidae</td>
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<tr>
<td>Plesiophysa sp.</td>
<td>Gruta da Machadinha, Toca de Candeias</td>
<td>MZSP 158916 (1 sh), LES 0028029 (1 sh)</td>
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<td>Planorbidae</td>
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<tr>
<td>Biomphalaria sp.</td>
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<tr>
<td>Biomphalaria straminea (Dunker, 1848)</td>
<td>Toca do Cirilo</td>
<td>LES 0028019 (2 sh)</td>
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<tr>
<td>Drepanostoma sp.</td>
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<tr>
<td><strong>STYLOMMATOPHORA</strong></td>
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<td>Achatinidae</td>
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<tr>
<td>Allopeas micra (d’Orbigny, 1835)</td>
<td>Toca da Barriguda</td>
<td>LES 0028021 (3 sh)</td>
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<tr>
<td>Subulina octona (Brugiére, 1789)</td>
<td>Lapa da Mangabeira</td>
<td>LES 0028022 (1 sh)</td>
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<td>Stenogyra octogyra (L. Pfeiffer, 1856)</td>
<td>Gruna Bem Bom, Gruta da Machadinha</td>
<td>LES 0028023 (1 sh), LES 0028024 (1 sh)</td>
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<tr>
<td>Bulimulidae</td>
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<tr>
<td>Anctus sp.</td>
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<tr>
<td>Gastrocoptidae</td>
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<tr>
<td>Gastrocopta oblonga (L. Pfeiffer, 1854)</td>
<td>Toca do Waldemar</td>
<td>LES 0028026 (2 sh)</td>
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<tr>
<td>Scolodontidae</td>
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<tr>
<td>Entodina derbyi (Ihering, 1912)</td>
<td>Toca Bonita</td>
<td>LES 0028034 (2 sh)</td>
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<tr>
<td>Happia sp.</td>
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<tr>
<td>Tamayaoa banghaasi (Thiele, 1927)</td>
<td>Gruta do Leão, Gruta da Serra Verde</td>
<td>LES 0028035 (1 sh), LES 0028036 (1 sh)</td>
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<tr>
<td>Streptaxidae</td>
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<tr>
<td>Streptartemon cf. cookeanus (F. Baker, 1914)</td>
<td>Toca Bonita, Toca de Candeias, Toca do Cirilo, Lapa Pé de Morro</td>
<td>LES 0028030 (1 sh), LES 0028031 (2 sh), LES 0028032 (1 sh), LES 0028033 (2 spm)</td>
</tr>
<tr>
<td>Streptaxis luetzelburgi Weber, 1925</td>
<td>Gruna da Serra Verde</td>
<td>LES 0028028 (1 sh)</td>
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</table>
96%. Their registration numbers are given in Table 1. Due to conservation concerns, the precise coordinates of each cave will not be presented here; geolocation 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 systematic 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

urn:lsid:zoobank.org:act:E4877EB4-7579-4506-930E-5F00FE7DDD13

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. Zepón 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. 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 helicinaform (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 Fadyemia...
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

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

*Helicina marfisae* sp. nov. can be immediately distinguished from all other helicinids 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* Hering, 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 helicinids. 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. leucoxonalis* 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 troglomorphs (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 troophilic 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


**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, Carinhanga, Gruna 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 inquiringum, 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 Lymnaeoidae**

**Family Bulinidae** P. Fischer et Crosse, 1880

**Genus Plesiophya** P. Fischer, 1883

**Plesiophya sp.**

Figs 14–15

**Material analyzed.** MZSP 158916 (1 sh; Bahia, Central, Gruta da Machadinha 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 *Plesiophya* 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, Paraiba, 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 (Paraena 2002a, b, 2003). However, the present shells are easily diagnosable from them, displaying a much more raised spired whorl 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 Açú municipality) (Baker 1914).  
**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, Itaúçu, 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 Scoldemontioidea**  
**Family Scoldemontidae**  
**Genus Entodina Ancey, 1887**

*Entodina derbyi* (Ihering, 1912)  
Figs 22–24

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

**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;

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 – Entoxina derbyi (Ihering, 1912), LES 0028034 (scale bar – 1 mm); 25–26 – Tamayoa banghaasi (Thiele, 1927), LES 0028035 (scale bar – 1 mm)
Snails from caves in Bahia, Brazil


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. Tamaya 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 Hygrophiina (basommatophorans”), while the remainder are terrestrial helicinids 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 troglomorphisms (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 troglobiotic, troglophilic, or just accidental.

Among the freshwater snails, there are more cave endemics and potentially troglobiotic 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).

ACKNOWLEDGEMENTS

We are very grateful to JEAN-CLAUDE STAHL (NMNZ) for the photos of the specimens used here; to LEONARDO DE ASSIS for the help in making Fig. 1; to SIMONE L. DA CRUZ (MZSP) and JONAS E. GALLÃO (LES) for collection support; to the LES team (TAMIRES ZEPON, JESSICA S. GALLO, DYANA F. TORRES and JONAS E. GALLÃO), and F. P. DE JESUS for help in the collections; to the GBPE group for all support to MEB’s subterranean biology projects in Serra do Ramalho karst area; to GPME (Grupo Pierre Martin de Espeleologia) for the support in the studies at Central and Itaguaçu da Bahia regions; to Espeleonordeste and GAE (Grupo Araras de Espeleologia) for support in the project “Subterranean biodiversity of Ituacu region, Bahia state” coordinated by MEB; and to the three anonymous reviewers and the editor ANDRZEJ LESICKI for their helpful suggestions. MEB received financial support from the CNPq (Conselho Nacional de Desenvolvimento
Etudes sur les Mollusques


FéruSSac a. e. j. P. d’audeBar de lezio ruBBioli. Planorbis xlvii[i] (Quarto) (13-IV-1822); livr. 16: 40–43. https://biodiversitylibrary.org/page/11057234


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Científico e Tecnológico), productivity fellowships 457413/2014-0 and 310378/2017-6; the ICMBio/CECAV (Instituto Chico Mendes para Conservação da Biodiversidade/Centro Nacional de Pesquisa e Conservação de Cavernas); the Instituto Brasileiro de Desenvolvimento e Sustentabilidade (IABS), project “Estudos para definição de áreas prioritárias para a Conservação de Proteção Espeleológico na Serra do Ramalho – BA”, under execution by the GBPE (Grupo Bambuí de Pesquisas Espeleológicas), coordinated by EZIO RUBBIOLI and integrated by MEB. Collection permits were granted to MEB by SISBIO (Sistema de Autorização Informação em Biodiversidade), permits #28992 and #20165.
Snails from caves in Bahia, Brazil


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Received: October 2nd, 2022
Revised: December 16th, 2022 / January 18th & 23rd, 2023
Accepted: January 31st, 2023
Published online: February 28th, 2023