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A new species of *Spiripockia* from eastern Brazil and reassignment to Cochliopidae (Gastropoda: Truncatelloidea)

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ABSTRACT

A new species belonging to the hitherto monotypic genus *Spiripockia* Simone, 2012 of cave-dwelling freshwater gastropods is described. *Spiripockia umbraticola* sp. nov. is diagnosable by its more turritiform beige to dark brown shell, less expanded body whorl and peristome, the teleoconch sculpture consisting of thorn-like triangular structures, the presence of eyes and some pigmentation on the head-foot, as well as a series of internal anatomical features. The species is known only from a single cavern in Bahia state, eastern Brazil. Furthermore, the genus *Spiripockia* is here transferred to the family Cochliopidae (Truncatelloidea).

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nov; troglobiont

Introduction

A series of surveys led by Dr Maria E. Bichuette (Universidade Federal de São Carlos, Brazil) aims to study the hitherto poorly known cavernicolous fauna of Brazil (Fernandes et al. 2019). The molluscan samples are being donated to the collection of Museu de Zoologia da Universidade de São Paulo (MZSP, São Paulo, Brazil) and have been studied by the authors (e.g. Simone 2012, 2013; Salvador et al. 2016, 2017). In a previous study, the genus *Spiripockia* Simone, 2012 was erected to accommodate a single troglobiont freshwater snail with a very distinct shell morphology: *S. punctata* Simone, 2012. That species is known only from a cavern in eastern Brazil (Lapa dos Peixes cave) belonging to the Serra do Ramalho karst region in Bahia state. Based on the anatomical study conducted at that time, the species was attributed to the caenogastropod family Pomatiopsidae.

A new sample from a different cave of Serra do Ramalho (Gruna do Domingão, or Domingão cave) was recently donated by Prof. Bichuette's team, and is deemed to represent a new species of *Spiripockia*. Herein, we present the description of this new species, accompanied by a full anatomical study that allows the reassignment of the genus *Spiripockia* to the family Cochliopidae (Caenogastropoda: Truncatelloidea).

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Material and methods

The Serra do Ramalho carbonate massif extends itself along a portion of the São Francisco River basin, encompassing several municipalities from south-western Bahia state to northern Minas Gerais state, in eastern Brazil (Bitencourt and Rodet 2001). The region is mainly composed of dolomite and limestone formations and contains numerous cave systems (Bitencourt and Rodet 2001). The present specimens were collected in a single cave (Grana do Domingão; Figure 1) in Carinhanha municipality, Bahia state, which represents a transitional area between two Brazilian biomes, the Cerrado and the Caatinga (Fernandes et al. 2019).

The studied material consists of one empty shell and a complete female specimen preserved in 70% EtOH. The shell was coated with a gold-palladium alloy for scanning electron microscope (SEM) examination in the Staatliches Museum für Naturkunde Stuttgart (SMNS, Stuttgart, Germany). The soft parts of the other specimen were extracted from the shell with the aid of a small hole punctured in the penultimate whorl. It was dissected using standard techniques (Simone 2011). Both specimens are now part of the malacological collection of the MZSP (151099 and 151100).

The following anatomical abbreviations are used in the figures: **aa**, anterior aorta; **ag**, albumen gland; **an**, anus; **bg**, buccal ganglion; **bm**, buccal mass; **ce**, cerebral ganglion; **cg**, capsule gland; **cm**, columellar muscle; **cv**, ctenidial vein; **dg**, digestive gland; **es**, oesophagus; **ey**, eye; **fe**, faecal pellets; **fp**, female pores; **fs**, foot sole; **ft**, foot; **gi**, gill; **in**, intestine; **ki**, kidney; **mb**, mantle border; **mo**, mouth; **ne**, nephrostome; **od**, odontophore; **of**, spermathecal oviduct; **op**, operculum; **os**, osphradium; **oy**, ovary; **pc**, pericardium; **pg**, anterior furrow of pedal glands; **pl**, pleural ganglion; **pn**, pedal ganglion; **rm**, snout ventral retractor muscle; **rn**, radular nucleus; **rs**, radular sac; **rt**, rectum; **sd**, salivary duct; **sg**, salivary gland; **sn**, snout; **sr**, seminal receptacle; **ss**, style sac; **st**, stomach; **su**, suboesophageal ganglion; **sy**, statocyst; **te**, cephalic tentacle; **vo**, visceral oviduct.



Figure 1. Left: Caatinga environment surrounding Domingão cave. Right: Domingão cave entrance. Photographs are courtesy of M.E. Bichuette.

Systematics

Genus *Spiripockia* Simone, 2012

Spiripockia umbraticola sp. nov.

(Figures 2, 3)

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Type material. Holotype MZSP 151099, spur-coated shell (Figure 2(a,b,f)). Paratype ♀, MZSP 151100, shell with a hole in penultimate whorl and dissected specimen, from type locality (Figure 2(c–e,g,h)).

Type locality. BRAZIL, Bahia state, Carinhanha municipality, Serra do Ramalho, Grana do Domingão (Domingão cave), 13°44'40.7"S 43°49'59.7"W [M.E. Bichuette, J.E. Gallão & P.P. Rizatto col. 27 July 2012].

Diagnosis. Shell turritiform, taller and slenderer than congener; beige to dark brown; whorls with uniform growth; body whorl not expanded towards aperture. Peristome

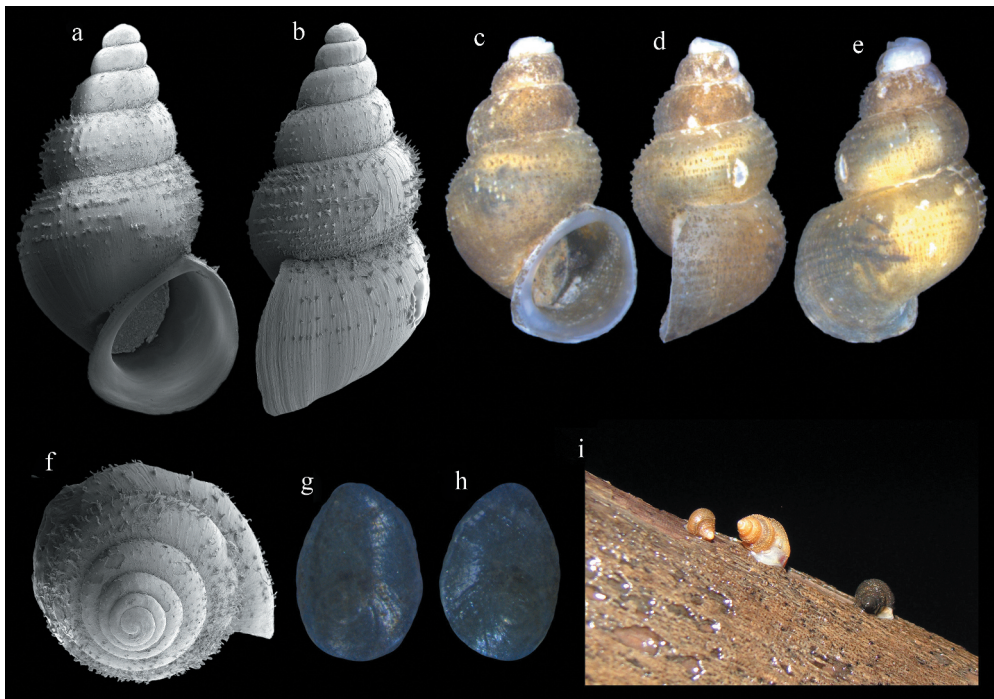


Figure 2. *Spiripockia umbraticola* sp. nov. (a,b,f) scanning electron microscope images of the holotype MZSP 151099; shell height = 5.2 mm. (c–e) Light microscopy of the paratype MZSP 151100; shell height = 4.8 mm. (f,g) Operculum of the paratype, light microscopy. (i) Live animals attached to wooden log (momentarily removed from the water for photographing); note the dark-pigmented specimen to the right. Photograph is courtesy of P.P. Rizatto.

not as flared as in congener. Teleoconch sculpture larger and displaying more pronounced triangular structures than congener; sculpture absent in abapical area of whorl. Aperture (and hence operculum) oval, more elongated than congener. Umbilicus rimate to closed. Presence of well-developed eyes and pigmented areas on head-foot. More conical snout than congener, with wide bifid anterior region; rectum narrower than congener, zigzagging; posterior region of pallial oviduct simpler than congener; visceral oviduct and seminal receptacle inserted directly in posterior region of albumen gland; nerve ring with longer cerebral and pedal commissures than congener.

Description. Shell (Figure 2(a–f,i)). Turriform, circa 5 mm high; ~1.5 times longer than wide; spire angle 45–50°. Colour typically pale beige, translucent (single dark brown specimen was observed in the field – see Figure 2(c–e,i)). Protoconch of 1¼ whorl, rounded, smooth (Figure 2(f)). Teleoconch up to 4¼ convex whorls; suture deep; whorls increasing uniformly in height and width, ending in slightly opisthoclinal and lightly expanded peristome (Figure 2(a–e)). Teleoconch sculptured with minute pustules arranged in equidistantly spaced spiral rows (Figure 2(a–b)); initial whorls with 4 rows, increasing to up to 10 rows on body whorl; sculpture absent in abapical area of whorl. Each row composed of ~80 pustules in penultimate whorl. Pustules bearing periostracum hairs, being small on earlier whorls, increasing in size on later whorls, becoming triangular and thorn-like in shape. Peristome white, complete, not covering penultimate whorl; expanded, wider in anterior region, narrower in columellar region (Figure 1(c)); edges fragile. Aperture oval, adapically and abapically angulate, but with smooth rounded contour. Umbilicus extremely narrow to closed.

Measurements (in mm). Holotype: shell height = 5.2, width = 2.6; paratype: height = 4.8, width = 3.0.

Operculum (Figure 2(g,h)). Corneous, flexible, thin; paucispiral; translucent, with faint yellow-beige pigmentation. Outline oval, width ~80% of length. Edges thin. Nucleus located in middle region of inner-interior quadrant; ~3 whorls uniformly growing from nucleus; outer surface sculptured with weak growth lines. Inner surface glossy; scar elliptical, occupying circa half of inner surface, located towards (but not touching) internal edge. Occupies almost entire shell aperture.

Head-foot (Figure 3(b)). Relatively small, stubby. Pale beige, with dark brown spots on exposed areas, mainly on sides of snout. Foot thick, as wide as shell aperture. Mesopodium thick, flanked dorsally by shallow lateral furrows (Figure 3(b, ft)). Anterior furrow of pedal glands (pg) deep, restricted to anterior edge. Opercular pad simple, elliptical, terminal, occupying most of posterior dorsal surface of foot. Head bulbous, ~90% of foot's width; pair of cephalic tentacles positioned laterally (te), each tentacle simple, stubby, about half foot's length. Eyes well developed, located on outer region of tentacles' base. Snout (sn) about twice as wide as tentacles and same length; anterior end bilobed, preceded by narrower region; mouth subterminal, ventral. Columellar muscle (cm) thick, ~¾ whorl in length. Haemocoel elliptical, on central region of head-foot.

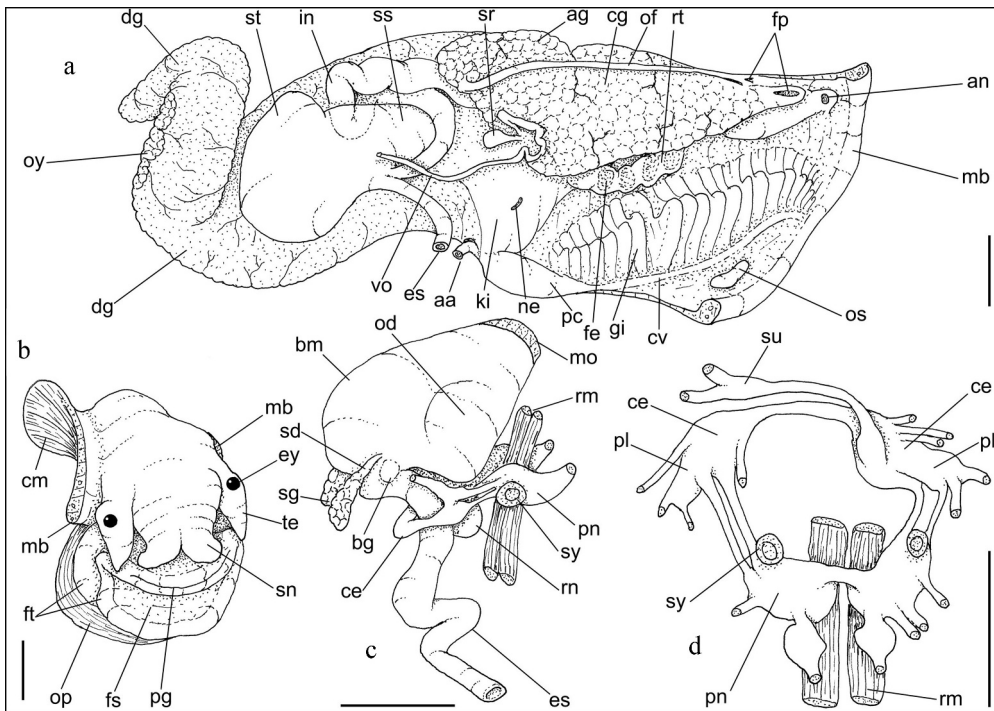


Figure 3. *Spiripockia umbraticola* sp. nov. Anatomical features of a female specimen (paratype MZSP 151100); scale bars = 0.5 mm. (a) Inner ventral view of pallial cavity roof, partially uncoiled visceral mass, stomach and adjacent structures seen as *in situ*; gill filament of middle region removed to show filament profile. (b) Frontal view of head-foot. (c) lateral view (right) of foregut and adjacent nerve ring. (d) Antero-ventral view of central nervous system.

Mantle organs (Figure 3(a)). Broad, $\sim 3/4$ whorl in length. Mantle edge simple, slightly thickened; unpigmented. Osphradium (os) short, almost straight, simple; length $\sim 10\%$ of pallial cavity's length; located in anterior-left corner of cavity, close and parallel to mantle edge. Gill (gi) elongated-elliptical, broad, $\sim 95\%$ of pallial cavity's length and $\sim 45\%$ of cavity's width; anterior end pointed, close to mantle border, slightly bent to left; posterior region rounded, filaments ending on pericardium. Gill filaments approximately triangular, with distal tip rounded; right edge strongly concave. Space between gill and rectum narrow. Hypobranchial gland inconspicuous. Rectum (rt) narrow, zigzagging on right half of cavity; bearing aligned series of elliptical faecal pellets (fe) arranged longitudinally, easily seen due to translucence. Anus (an) simple, shortly siphoned, close to mantle edge. Genital ducts running along right edge, relatively massive, described below.

Visceral mass (Figure 3(a)). Length ~ 2.5 whorls, thus not occupying first whorls of shell. Colour of most structures pale beige to white. Kidney (ki) positioned anteriorly; pericardium (pc) located in left-posterior corner of pallial cavity, and partially in visceral mass. Stomach (st) ~ 0.5 whorls long, occupying $\sim 60\%$ of adjacent whorl width. Digestive gland (dg) ~ 1.5 whorls long, mostly posterior to stomach, surrounding it. Ovary (oy) small, running along columellar surface of first 2 whorls.

Circulatory and excretory systems (Figure 3(a)). Pericardium narrow, located longitudinally between stomach and left corner of pallial cavity (pc); volume ~5% that of visceral mass. Kidney large, solid, occupying most of visceral area facing pallial cavity. Nephrostome (ne) small, transverse, located in middle region of kidney.

Digestive system (Figure 3(a,c)). Mouth on antero-ventral end of snout. Pair of strong ventral retractor muscles of snout and mouth (rm) originating from middle portion of haemocoelic ventral floor, running close to its median line towards anterior portion of body, flanking ventral surface of buccal mass, passing through nerve ring; inserting along ventral wall of snout close to ventral border of mouth. Buccal mass occupying entire inner surface of snout; ~30% of haemocoelic volume. Remaining characters of buccal mass, including jaws and odontophore muscles, similar to those described for *S. punctata* (Simone 2012, p. 519), except for buccal mass ~30% larger. Radular sac (rs) twice as long as odontophore and ~35% its width; radular nucleus (rn) slightly broader. Salivary gland (sg) small, white, with maximum length ~25% of length of buccal mass; about twice longer than wide; tip rounded. Remaining characters of foregut and midgut similar to those of *S. punctata* (Simone, 2012). Oesophageal insertion (es) and intestinal origin (in) close to one another, on left base of style sac. Intestine also similar to that of *S. punctata*, except for a narrower rectum with more zigzagging on pallial cavity roof.

Radula (Figure 4). Rachidian ~1/3 of ribbon width, trapezoid; lateral edges pointed; basal edge concave, with central small convexity; cutting edge bent inwards, with 5 terminal cusps; central cusp larger, lateral cusps succeedingly smaller; 3 pairs of basal cusps, with most central cusps larger, gradually diminishing laterally. Lateral teeth spoon-like, base relatively wide, distal width ~3/4 of rachidian width; 6 subterminal aligned cusps, second cusp larger, remaining cusps ~1/3 of larger cusp. Inner marginal teeth similar to lateral teeth, but ~30% narrower, with 5 aligned cusps, medial cusp slightly larger, cusps gradually diminishing laterally. Outer marginal teeth similar to inner marginal teeth, but ~20% narrower, 11–12 terminal small cusps aligned on cutting edge; medial cusp slightly larger, cusps gradually diminishing laterally.

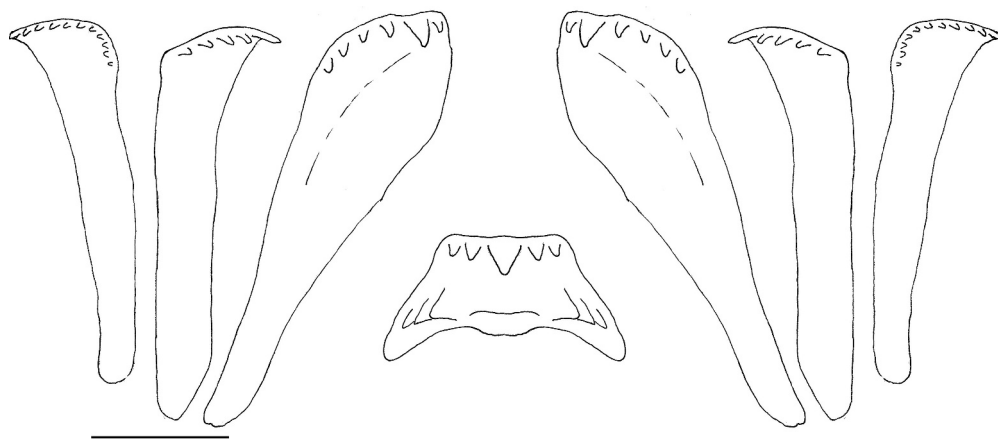


Figure 4. *Spiripockia umbraticola* sp. nov. Schematics of radular teeth. Scale bar = 0.1 mm.

Genital system, female (Figure 3(a)). Ovary (oy) restricted to columellar region of first whorls. Visceral oviduct (vo) very narrow, running along middle level of columellar surface of visceral mass, ~1/2 whorl in length. Visceral oviduct zigzagging anteriorly before inserting terminally into left-posterior side of albumen gland (ag). Seminal receptacle balloon-like, small, inserted close to visceral oviduct insertion. Spermathecal oviduct (of) very narrow, originating from posterior-right corner of albumen gland, running straight along ventral-right surface of pallial oviduct towards anterior portion; oviduct aperture very small, located slightly posteriorly from pallial oviduct's aperture. Capsule gland (cg) occupying ~60% of pallial oviduct's length; walls thick, glandular, white; lumen flattened; atrium short, terminal, with walls slightly thickened, tapering up to female pore. Female pore shortly siphoned, papilla-like, tilted anteriorly, located close to and posterior to anus.

Central nervous system (Figure 3(c,d)). Nerve ring essentially like that of *S. punctata* (Simone, 2012), differing by its slightly longer cerebral commissure, narrower and longer pedal commissure, and bulging ganglionic structure on origin of pedal nerves.

Distribution. Only known from type locality.

Habitat. Cave surrounded by Caatinga environment (Figure 1), semi-arid climate with a dry season spanning 6–8 months, from mid-autumn to mid-spring (Conti and Furlan 2003; Fernandes et al. 2019). Live specimens were observed attached to hard surfaces such as rocks and logs (Figure 2(i)), always in the water. All specimens were observed in the aphotic zone of the cavern.

Material examined. Types.

Etymology. Latin for 'shade-lover', a nominative singular noun, in allusion to the aphotic habitat of the species.

Discussion

The present specimens can be attributed to the genus *Spiripockia* based on conchological and anatomical characters. The shell has a relatively tall spire, strongly convex whorls with a deep suture, an expanded peristome separated from the penultimate whorl, and a teleoconch sculpture consisting of aligned rows of hairy structures (Figure 2). *Spiripockia umbraticola* sp. nov. can be distinguished from its sole congener by its taller, more slender and more turritiform shell, which is beige to dark brown in colour, with a much less expanded body whorl and peristome (Figure 2). The teleoconch sculpture consists of larger and more pronounced triangular structures (which are absent on the abapical area of whorls).

The anatomical similarities of the two species also support the generic attribution of the new species. Besides the similarities of the nervous and digestive systems mentioned above, further shared features include the spermathecal oviduct (Figure 3(a, of) as a separated duct parallel to the ordinary pallial oviduct, and the strong pair of ventral snout retractor muscles (Figure 3(c,d)) passing through the nerve ring. The most striking differences are the presence of eyes in *S. umbraticola* sp. nov. and the integument

pigmentation, which are absent in the likewise troglobiont *S. punctata*. *Spiripockia umbraticola* can be further diagnosed by a more conical snout, with a wide bifid anterior region (Figure 3(b)); a narrower rectum that zigzags across the roof of the pallial cavity (Figure 3(a, rt)); a simpler posterior region of the pallial oviduct, with the visceral oviduct and a seminal receptacle being inserted directly in the posterior region of the albumen gland (Figure 3(a)) (*S. punctata* has the spermoduct bypassing a bulged region of the oviduct directly into the receptacle); and longer commissures (cerebral and pedal) of the nerve ring.

The present anatomical description of *S. umbraticola* sp. nov. is based on a single individual. The previous experience of the leading author studying *S. punctata*, for which a larger number of samples was available (Simone 2012), showed that the conchological and anatomical characters were not very variable.

When *Spiripockia* was first described, it was assigned to Pomatiopsidae based mostly on the diallic arrangement of the oviduct, with the presence of a spermathecal oviduct (Simone 2012). This systematic position also reflected the then-current classification scheme of South American freshwater 'hydrobioid' gastropods (e.g. Simone 2006, 2011). However, much has changed in freshwater snail classification since then (see the recent compendium by Lydeard and Cummings 2019). For example, a diallic arrangement of the oviduct is also observed in Amnicolidae and Cochliopidae (Hershler and Thompson 1992; Liu et al. 2001; Wilke et al. 2013; R. Hershler, pers. comm.) and the anatomical features seen in *Spiripockia* are strikingly similar to those of the cochliopid genus *Littoridinops* Pilsbry, 1952 (Liu et al. 2001). For instance, like *Spiripockia*, *Littoridinops* also has a middle pallial oviduct arrangement, with a seminal receptacle located close to, but separated from, the insertion of the visceral oviduct (Liu et al. 2001: fig. 2(b)). However, in *Littoridinops* the receptacle drains to a sperm duct (Liu et al. 2001: fig. 2(b)), while in *Spiripockia* it drains directly into the capsule gland (Figure 3).

Further morphoanatomical features of *Spiripockia* (sculptured shell, paucispiral operculum and reduced albumen gland) are consistent with Cochliopidae as well (Thiele 1929; Hershler and Thompson 1992; Wilke et al. 2013; Clark 2019). As such, we reclassify *Spiripockia* in Cochliopidae, which is widely distributed in South America, including cave environments (Clark 2019). In fact, several 'hydrobioid' South American genera were recently transferred to Cochliopidae, such as the common *Heleobia* Stimpson, 1865 and *Littoridina* Souleyet, 1852 (Clark 2019, and references therein).

Both *Spiripockia* spp. are troglobionts, living in aphotic areas of caverns. However, the presence of eyes and the darker periostracum colouration of *S. umbraticola* (in comparison to the blind and translucent white *S. punctata*; Simone 2012) are character states typically interpreted in the literature as signs of a more recent colonisation of the aphotic environment. Nevertheless, not all troglobiont species evolve troglomorphisms (Christiansen 2012; Trontelj et al. 2012), so such character states might not be good indicators of time since colonisation of the aphotic environment.

As argued by Salvador (2019), caverns represent a major habitat type that remains scarcely explored and, in all likelihood, contain a wealth of species still unknown to science. In fact, several species of freshwater and land snails have been described from caves in the past decade (Birckolz et al. 2016; Salvador et al. 2017; Simone 2018, 2019; Simone et al. 2020). The caves in the Serra do Ramalho region

of Brazil, in particular, are considered a biodiversity hot spot for other animal taxa (Trajano et al. 2016). As such, it can be expected that this will also be the case for gastropods, especially considering that snails are typically abundant and diverse in carbonate-rich environments (e.g. Schilthuizen et al. 2003; Braby et al. 2011). Unfortunately, Serra do Ramalho is a mostly unprotected area, and mining and deforestation for charcoal production threaten the regional biota (Gallão and Bichuette 2018; Fernandes et al. 2019).

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Disclosure statement

No potential conflict of interest was reported by the authors.

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References

- Birckolcz CJ, Salvador RB, Cavallari DC, Simone LRL. 2016. Illustrated checklist of newly described (2006–2016) land and freshwater Gastropoda from Brazil. *Arch Molluskenkd.* 145(2):133–150. doi:10.1127/arch.moll/145/133-150
- Bitencourt ALV, Rodet J. 2001. Premiers éléments d'évolution karstique sous contrôle tectonique d'un massif calcaire: la Serra do Ramalho (Bahia, Brésil). *Geol Belg.* 4(3–4):251–261.
- Braby MF, Willan RC, Woinarski JCZ, Kessner V. 2011. Land snails associated with limestone outcrops in northern Australia – a potential bioindicator group. *North Territ Nat.* 23:2–17.
- Christiansen K. 2012. Morphological adaptations. In: Culver DC, White WB, editors. *Encyclopedia of Caves*. 2nd ed. Amsterdam: Elsevier Academic Press; p. 517–528.
- Clark SA. 2019. Cochliopidae Tryon, 1866. In: Lydeard C, Cummings KS, editors. *Freshwater Mollusks of the World: a Distribution Atlas*. Baltimore: Johns Hopkins University Press; p. 104–108.
- Conti JB, Furlan SA. 2003. Geoecologia: o clima, os solos e a biota. In: Ross JLS, editor. *Geografia do Brasil*. São Paulo: EDUSP; p. 64–207.
- Fernandes CS, Campos-Filho IS, Araujo PB, Bichuette ME. 2019. Synopsis of terrestrial isopods (Crustacea: Isopoda: Oniscidea) from Brazilian caves, with emphasis on new records from north, midwest, northeast and southeast regions. *J Nat Hist.* 53(17–18):1095–1129. doi:10.1080/00222933.2019.1634225
- Gallão JE, Bichuette ME. 2018. Brazilian obligatory subterranean fauna and threats to the hypogean environment. *ZooKeys.* 746:1–23. doi:10.3897/zookeys.746.15140
- Hershler R, Thompson FG. 1992. A review of the aquatic gastropod subfamily Cochliopinae (Prosobranchia: Hydrobiidae). *Malacol Rev Suppl.* 5:1–140.

- Liu H-P, Hershler R, Thompson FG. 2001. Phylogenetic relationships of the Cochliopinae (Rissooidea: Hydrobiidae): an enigmatic group of aquatic gastropods. *Mol Phylogenet Evol.* 21(1):17–25. doi:10.1006/mpev.2001.0988
- Lydeard C, Cummings KS. 2019. *Freshwater Mollusks of the World: a distribution Atlas*. Baltimore: Johns Hopkins University Press; p. 242.
- Salvador RB. 2019. Land snail diversity in Brazil. *Strombus*. 25:10–20.
- Salvador RB, Cavallari DC, Simone LRL. 2016. Taxonomical study on a sample of land snails from Alto Ribeira State Park (São Paulo, Brazil), with description of a new species. *Arch Molluskenkd.* 145(1):59–68. doi:10.1127/arch.moll/1869-0963/145/059-068
- Salvador RB, Cavallari DC, Simone LRL. 2017. Taxonomical study on a sample of land and freshwater snails from caves in central Brazil, with description of a new species. *Zoosyst Evol.* 93(1):135–141. doi:10.3897/zse.93.10995
- Schilthuizen M, Chai H-N, Kimsin TE, Vermeulen JJ. 2003. Abundance and diversity of land-snails (Mollusca: Gastropoda) on limestone hills in Borneo. *Raffles Bull Zool.* 51(1):35–42.
- Simone LRL. 2006. Accounts on the phylogeny of the Rissooidea (=Hydrobioidea) and Littorinoidea, based on some American representatives, as base for a future taxonomic reevaluation (Mollusca, Caenogastropoda). *Strombus*. 13(2):18–26.
- Simone LRL. 2011. Phylogeny of the Caenogastropoda (Mollusca), based on comparative morphology. *Arq Zool.* 42(4):161–323. doi:10.11606/2176-7793.v42i4p161-323
- Simone LRL. 2012. A new genus and species of cavernicolous Pomatiopsidae (Mollusca, Caenogastropoda) in Bahia, Brazil. *Pap Avulsos Zool.* 52(40):515–524. doi:10.1590/S0031-10492012022000001
- Simone LRL. 2013. *Habeas*, a new genus of Diplommatinidae from Central Bahia, Brazil (Caenogastropoda), with description of three new species. *J Conchol.* 41(4):519–525.
- Simone LRL. 2018. *Lavajatus moroi*, new cavernicolous Subulininae from Ceará, Brazil (Gastropoda, Eupulmonata, Achatinidae). *Spixiana*. 41(2):173–187.
- Simone LRL. 2019. The new genus *Habeastrum*, with two new species (Gastropoda, Diplommatinidae) in Mato Grosso do Sul caves, Brazil. *Zootaxa*. 4543(2):287–290. doi:10.11646/zootaxa.4543.2.7
- Simone LRL, Cavallari DC, Salvador RB. 2020. A new troglobite species of *Habeastrum* Simone, 2019 from Brazil, and support for classification in Diplommatinidae (Mollusca, Caenogastropoda). *Zoosyst Evol.* 96(2):639–647. doi:10.3897/zse.96.53880
- Thiele J. 1929. *Handbuch der systematischen Weichtierkunde*. Erster Band, Teil 1. Jena: Gustav Fischer; p. 376.
- Trajano E, Gallão JE, Bichuette ME. 2016. Spots of high diversity of troglobites in Brazil: the challenge of measuring subterranean diversity. *Biodivers Conserv.* 25(10):1805–1828. doi:10.1007/s10531-016-1151-5
- Trontelj P, Blejcek A, Fišer C. 2012. Ecomorphological convergence of cave communities. *Evolution*. 66(12):3852–3865. doi:10.1111/j.1558-5646.2012.01734.x
- Wilke T, Hasse M, Hershler R, Liu H-P, Misof B, Ponder WF. 2013. Pushing short DNA fragments to the limit: phylogenetic relationships of 'hydrobioid' gastropods (Caenogastropoda: Rissooidea). *Mol Phylogenet Evol.* 66:715–736. doi:10.1016/j.jmpev.2012.10.025