

HYDROBIIDAE (GASTROPODA: HYDROBIOIDEA) FROM THE RIBEIRA VALLEY, S.E. BRAZIL, WITH DESCRIPTIONS OF TWO NEW CAVERNICOLOUS SPECIES

LUIZ RICARDO LOPES DE SIMONE¹ and NICOLETTA MORACCHIOLI²

¹ Seção de Moluscos, Museu de Zoologia da Universidade de São Paulo, Caixa Postal 7172; CEP 01064-970, São Paulo, SP, Brazil

² Departamento de Zoologia, Instituto de Biociências da Universidade de São Paulo, Caixa Postal 20520, CEP 01452-990, São Paulo, SP, Brazil

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ABSTRACT

Potamolithus karsticus n. sp. and *Potamolithus troglobius* n. sp., two Brazilian aquatic cavesnails (Gastropoda: Hydrobiidae), are described. *P. troglobius* is blind and depigmented, and is the first stygobiontic snail to be described from Brazil.

Additionally, specimens of *Potamolithus ribeirensis* Pilsbry, 1911 were collected near the type locality for comparison with the new cave species.

INTRODUCTION

Most cavernicolous freshwater molluscs are Hydrobioidea (Bole & Velkovrh, 1986). These include stygophilic (able to complete the life cycle in both epigeal and hypogean aquatic habitats) and stygobiontic (aquatic obligate subterranean forms) species. Groundwater hydrobiids occur in numerous areas, with a large fauna represented in karst regions of Europe, North America, Japan and New Zealand (Hershler & Holsinger, 1986). However, from South America only two known cavesnails have been reported: an undescribed Hydrobioidea from Ecuador (Bole & Velkovrh, 1986) and *Andesipyrgus sketi* Hershler & Velkovrh, 1993 from Colombia and Ecuador.

Several specimens of Hydrobiidae were collected during the study of cave fauna from the Ribeira Basin, SW São Paulo State, Brazil. The analysis of conchological and anatomical characters showed two new cavernicolous species: *Potamolithus troglobius* and *Potamolithus karsticus*. *Potamolithus troglobius* is the first stygobiontic mollusc species described for Brazil.

Specimens of *Potamolithus ribeirensis* Pilsbry, 1911 were collected near their type-locality for comparison of an epigeal form with the cavernicolous new species. Anatomical data for *P. ribeirensis* Pilsbry were compared with the

single *Potamolithus* species with known anatomy, *P. ribeirensis sensu* Davis & Pons da Silva, 1984.

MATERIAL AND METHODS

The specimens of *P. ribeirensis* Pilsbry, 1911 were found in the Iporanga River—24°35'S, 48°35'W, Iporanga/SP—near the species' type locality (Fig. 1 site A).

Cavernicolous specimens were collected in karstic hypogean water courses of the Ribeira Basin. A brief description of the caves, with their register numbers in the 'Sociedade Brasileira de Espeleologia' cadaster (1989), is given.

—SP-018/019—Areias Caves—24°35'20"S, 48°42'05"W, Lageado region, Iporanga/SP (Fig. 1, sites B and C). A set of two caves formed by the Areias Stream and separated by a 30 m epigeal course: the Areias I Cave (SP-018), 3260 m long, situated upstream, and the Areias II Cave (SP-019), 1760 m long, downstream. Collections were made at several points of the Areias Stream, in both caves and in the brief epigeal course.

—SP - 142 — Calcário Branco Cave — 24°30'20"S, 48°44'25"W, Apiai/SP (Fig. 1 site D). This cave is 250 m long. It is composed by two parallel, interconnected galleries, one crossed by a stream and the other a dry gallery. The entrance is the stream resurgence. Collections were made all along the stream inside the cave; snails were also observed outside the cave, near to the resurgence.

Specimens and types examined during this study were deposited in the following museum collections, which will be designated as indicated in parenthesis:

- Museu de Zoologia da Universidade de São Paulo (MZUSP);
- Museu Nacional do Rio de Janeiro (MNRI).
- Fundação Zoobotânica do Rio Grande do Sul, Museu de Ciências Naturais (MCN).

Anatomical descriptions and illustrations are based upon a lot of 40 specimens of each species. Some

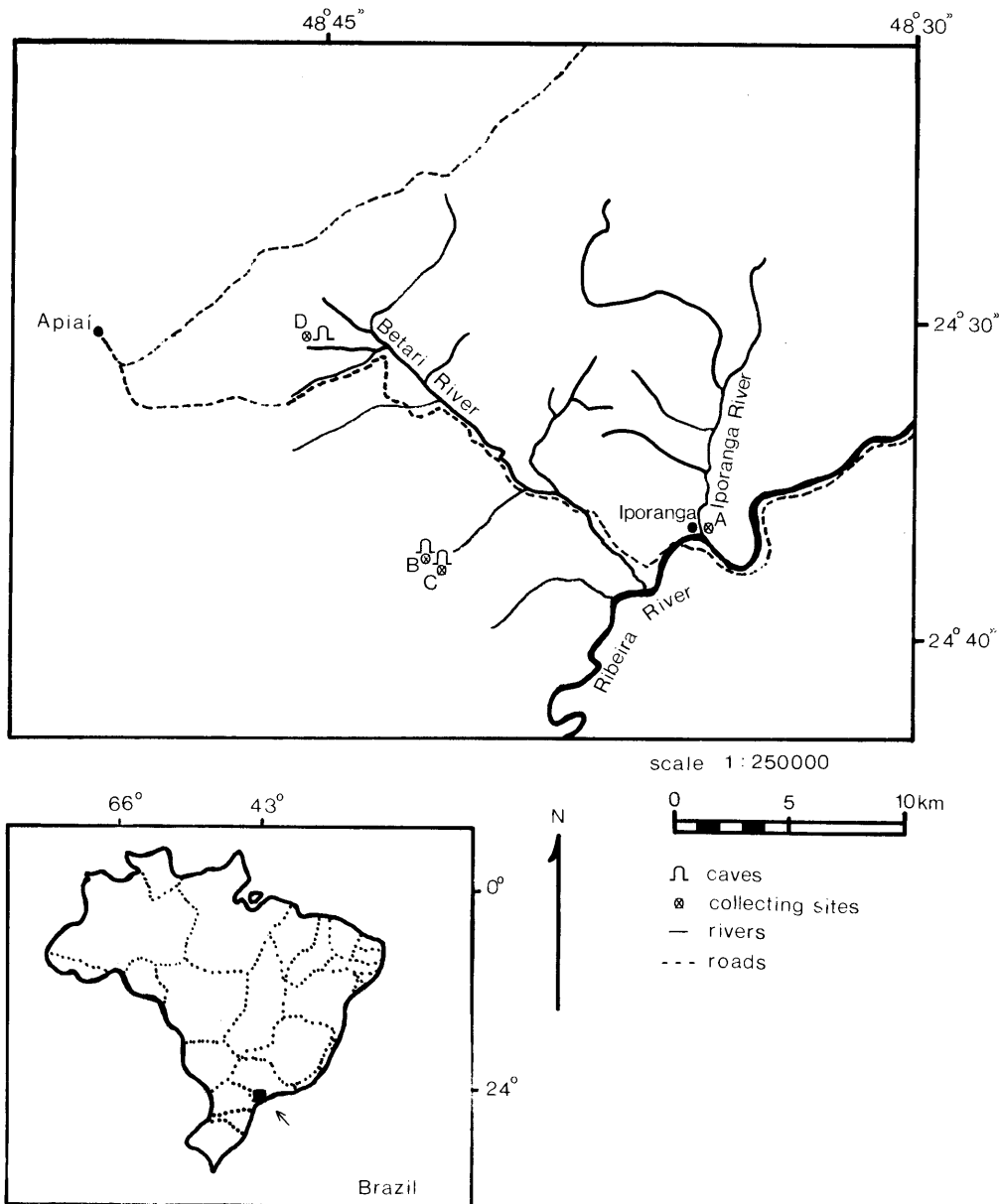


Figure 1 Map of collecting sites, South eastern part of São Paulo State, Brazil. **A:** Iporanga River. **B:** Areias I Cave. **C:** Areias II Cave. **D:** Calcario Branco Cave.

specimens were examined when alive, their shell being broken. Other specimens were fixed unrelaxed and preserved in 70% ethanol. Their shells were decalcified in Railliet-Henry fluid, then dehydrated in alcohol series, dyed in Carmine, cleared and fixed in creosote.

Serial sections of two individuals of each sex, per

species, were made at 7 μ m and stained in haematoxylin and eosin. For each species, three radulae prepared on a slide with Hoyer fluid were examined. One hundred specimens of each species were studied for shell characters. Conchological and anatomical terminology are based on Davis & Pons da Silva (1984).

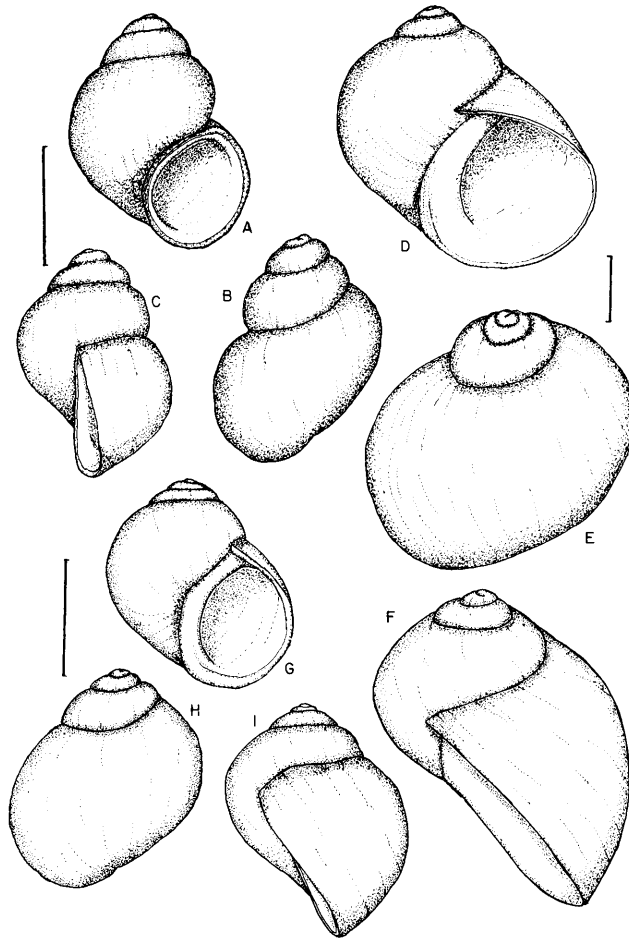


Figure 2 Shells: **A,B,C**, frontal, dorsal and lateral view of holotype of *Potamolithus karsticus*. **D,E,F**: frontal, dorsal and lateral view of a specimen of *P. ribeirensis*; **G,H,I**: frontal, dorsal and lateral view of holotype of *P. troglobius*. Scales = 1.0 mm.

Many specimens of cavernicolous hydrobiids collected in other caves of the Ribeira Valley region are deposited in MZUSP. They were not included here because their anatomy was not in good enough condition to be examined.

SYSTEMATIC DESCRIPTIONS

Genus *Potamolithus* Pilsbry, 1896

Potamolithus ribeirensis Pilsbry, 1911

(Figs: 2D, 2E, 2F, 4A, 5A, 6A, 7A, 8A, 9A, 10A, 11A)

Potamolithus ribeirensis Pilsbry, 1911:584 (pl.41B, f.6-7); Morretes, 1949:71; non Davis & Pons da Silva, 1984.

Types: Lectotype ANSP 103076; Paralectotypes ANSP 353441 (5 specimens) (Designated by Davis & Pons da Silva, 1984: 106).

Type locality: Brazil, São Paulo State, Ribeira River, Iporanga [Yporanga].

Diagnosis: Shell naticoid, head without nuchal node, gill with about 19 long filaments, long osphradium. Stomach with one nodose chamber, intestine slender, radula cusps 21/6, 12, 18, 25. Pallial oviduct without divisions, penis with papilla and preputial ring.

Anatomical description: Shell (Figs: 2D, E and F): naticoid, very similar to those described by

Pilsbry, 1911 and also by David & Pons da Silva, 1984. The largest specimens (4.5 whorls) usually present a heavy and calloused columella, with a small umbilicus (Fig. 2D).

Head-Foot: head broad with thick stubby tentacles; snout relatively short, with about the same width as the neck (Fig. 4A); foot wide and powerful, mucus groove present, without folds. No nuchal node observed in females. Eyes well developed, not situated in prominences of the tentacles as described for *P. ribeirensis* sensu Davis & Pons da Silva (1984).

Operculum: corneous, transparent, beige, paucispiral, elliptical outline, slender, semi-circular scar. Occupies all aperture.

Mantle cavity: standard hydrobioid type (Fig. 5A). Wide and thickened mantle border; osphradium elliptical and long, parallel to mantle border. Common genital opening of females located on the floor of mantle cavity, next to the right side of the neck. Gill parallel to mantle border, with about 19 long filaments, that decrease towards the right side.

Digestive system: stomach shown in ventral-lateral view in Fig. 6A; insertion of oesophagus in a large, single chamber with very crumpled and nodose wall. Posterior part of stomach covered by digestive gland. Intestine slender, with tight U-shaped loop ventral to the style sac; long axis of loop dorsal to reproductive

glands, until anterior region of mantle cavity (Fig. 8A). Anus opening between columellar muscle and ctenidium (Fig. 10A).

Radula: typically taenioglossate (Fig. 7A); central tooth with 21 upper and 6 basal cusps in each side; lateral tooth with 12 cusps; inner marginal tooth with about 18 cusps and outer marginal tooth with about 25 cusps.

Female reproductive system: uncoiled female shown in Fig. 8A, head and kidney tissue re-

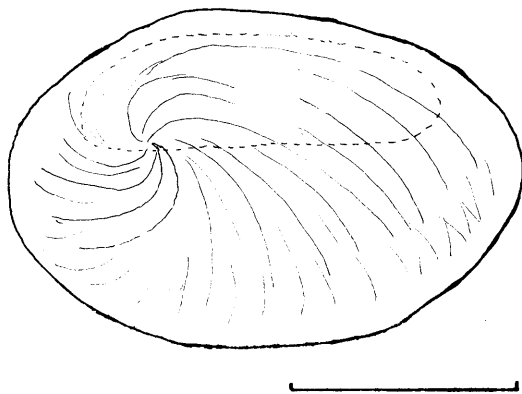


Figure 3 Operculum of *P. troglobius*, outer view. Scale: 0.5 mm.

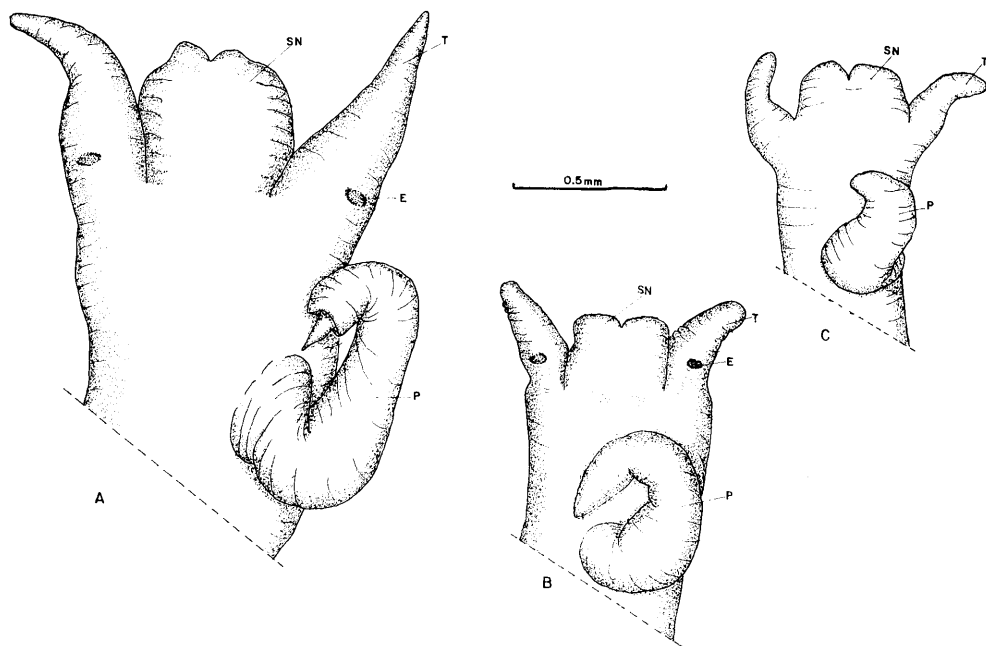


Figure 4 Dorsal view of a male head: A: *Potamolithus ribeirensis*; B: *P. karsticus*; C: *P. troglobius*.

moved. Distinctive features are: 1) pallial oviduct of homogeneous aspect, not clearly divided into anterior and posterior parts (Fig. 9A); 2) anterior end of pallial oviduct far removed from mantle collar. Gonad and posterior oviduct of generalized type. Bursa copulatrix, seminal receptacle, pallial oviduct and common genital opening shown in Fig. 9A, being very similar to those described by Davis & Pons da Silva (1984) for the *Potamolithus* species from Feitoria River, Rio Grande do Sul State, Brazil. These organs are orientated as shown in Fig. 8A, with bursa and receptacle posteriorly and respective ducts just over the columellar muscle, at the right side of oesophagus. Common genital opening just after the posterior half of mantle cavity.

Male reproductive system: prominent penis, coiled in typical hydrobiid fashion, in the head-neck region (Fig. 4A). Tip of penis with an extended and relatively long papilla, surrounded by an U-shaped preputial ring; many glands beneath the surface of epithelium (Fig. 11A). Base of penis rooted, as in other hydrobiids, without horseshoe-shaped muscle. Vas deferens positioned near convex edge of penis, non-undulating. Uncoiled male shown in Fig. 10A, head and kidney removed. Prostate squeezed between columellar muscle and intestine. Distinctive features are: 1) massive gonadal lobes, without slender, delicate branching system; 2) gonadal lobe just anterior to style sac of stomach; 3) gonad/vas deferens configuration of the general type described by Davis & Pons da Silva (1984); 4) seminal vesicle hardly developed, convolute, with a nodose wall (Fig. 10A); 5) prostate not clearly divided into anterior and posterior regions; 6) prostate overlies posterior end of mantle cavity, between columellar muscle and intestine; 7) anterior and posterior vas deferens nearly connected in prostate; 8) a portion of digestive gland over the stomach touches prostate (Fig. 10A).

Measurements: MZUSP 27940 (figured specimen) = length: 4.5 mm, width: 4.5 mm.

Range: Davis & Pons da Silva (1984) mention the co-ordinates of the type-locality (24°35'S, 48°35'W), that correspond to Iporanga Village, where the Ribeira River is about 50 metres wide and has muddy waters. No snails were found at its margins.

Iporanga River is a tributary of the Ribeira River, flowing into it at Iporanga City. Iporanga River is much smaller—about 10 metres wide—and has clear waters.

Habitat: *P. ribeirensis* were common on undersides of submerged rocks and boulders of Iporanga River, where there was continuous current. Snails were absent in depositional quiet water areas. The collection site of the examined material was Iporanga River, about 500 m before its junction with Ribeira River (Fig. 1 site A).

Material examined: MZUSP 27940, 1 specimen; MZUSP 27941, about 80 shells; MZUSP 27942, 35 preserved specimens, all from Iporanga River, and 45 specimens dissected, including cleared specimens, microslides of serial sections and of radulae; MZUSP 7424, 19 shells from Rio Ribeira, Yporanga [Iporanga], SP, Ihering col. and det. 1909 (labelled 'cotypes').

Potamolithus karsticus new species

(Figs: 2A, 2B, 2C, 4B, 5B, 6B, 7B, 8B, 9B, 10B, 11B)

Types: Holotype MZUSP 27943. Paratypes: MZUSP 27944 (1 specimen); MZUSP 27945 (1 specimen); MZUSP 27946 (18 specimens). MNRJ 6936 (2 specimens). MCN 33589 (2 specimens).

Type locality: Brazil, São Paulo State, Apiai city, stream inside Calcário Branco Cave, and outside near to its resurgence (Fig. 1 site D), (24°30'20"S 48°44'25"W).

Diagnosis: Shell elliptical, with dark periostracum, very minute. Head without nuchal node, gill with about 12 filaments, short osphradium. Stomach without chambers, intestine wide, weakly sigmoid in pallial cavity. Radula cusps 11/4, 10, 18, 16. Delicate branching gonad, female genital opening as a tube; penis simple, without glands or papilla, proportionally large, with pointed penis tip. Vas deferens runs alongside the prostate but does not enter it.

Description: Shell (Figs. 2A, B and C): minute (to 2.5 mm), elliptical, with small umbilicus; coloration dark brown. Protoconch with one whorl, flattened and smooth. Teleoconch with maximum of 4 convex whorls, suture shallow, spire high, rather obtuse, body whorl not outstandingly large. Periostracum heavy and opaque. Aperture slightly oblique, inclined at about 5 to 10° towards the axis of coiling; lips a little thickened. A slightly calloused columella, arched and concave (Fig. 2A).

Head-Foot: head broad and squat, with thick stubby tentacles; snout relatively short, with

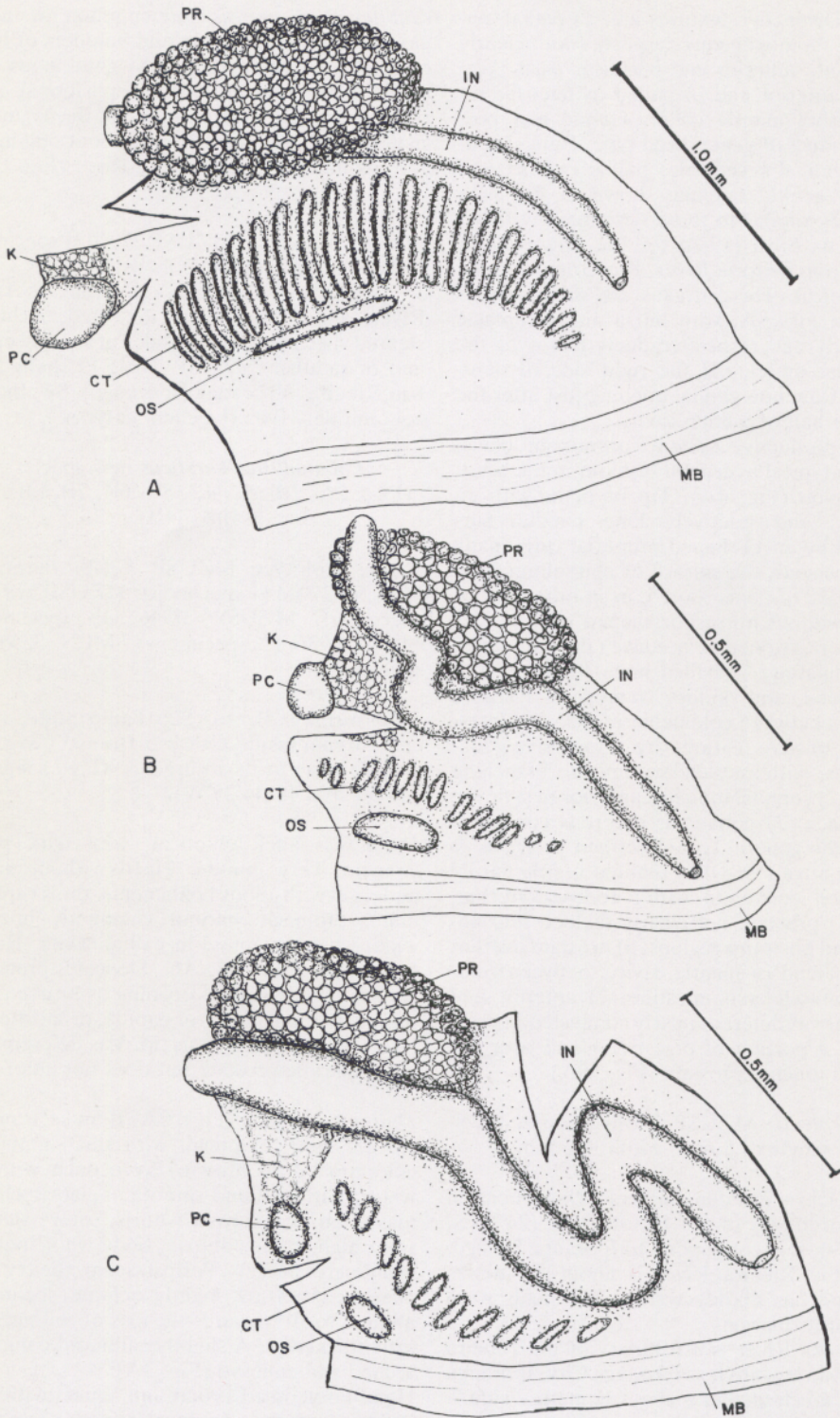


Figure 5 Inner view of pallial cavity of a male: A: *Potamolithus ribeirensis*; B: *P. karsticus*; C: *P. troglobius*.

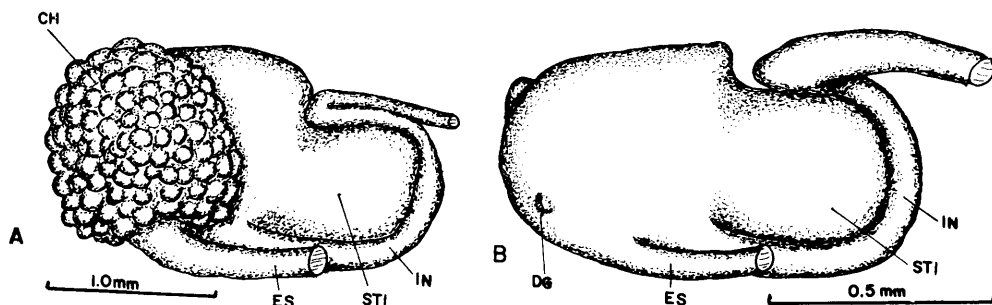


Figure 6 Ventral-lateral view of stomach: A: *Potamolithus ribeirensis*. B: *P. karsticus*.

about the same width as the neck (Fig. 4B); foot wide and powerful, with the usual anterior mucous groove, without any other groove or fold. No nuchal node observed in females. Coloration brown, with dark spots posteriorly of the eyes and also around the dorsal sagittal line. Eyes well developed, not situated in prominences of the tentacles.

Operculum: corneous, transparent, light beige, paucispiral, elliptical in outline, slender, with semicircular scar. Occupies all aperture.

Mantle cavity: standard hydrobioid type (Fig. 5B), but with narrowed, not wide mantle border; osphradium elliptical and short; gill parallel to mantle border, with about 12 short filaments; spherical pericardium near the right extremity of gill; kidney between pericardium and reproductive glands. Female glands, prostate and intestine (described below) occupy a large space within mantle cavity.

Digestive system: stomach without chambers (Fig. 6B). Posterior part of stomach covered by digestive gland. Intestine wide, originating near the oesophageal insertion, curving around the style sac and back towards its base, then running anteriorly, emerging at the right side of the pallial oviduct or the prostate (Figs. 8B, 10B); weakly sigmoid in mantle cavity (Fig. 5B).

Radula: typically taenioglossate (Fig. 7B). Very minute teeth, about 40 μ m long each. Central tooth with 11 upper cusps and 4 basal cusps in each side; lateral tooth with 10 cusps; inner marginal tooth with about 18 cusps and outer marginal tooth with about 16 cusps.

Female reproductive system: uncoiled female shown in Fig. 8B, head and kidney tissue removed. Distinctive features are: 1) pallial oviduct divided into two parts, the posterior very large and the anterior minute; 2) anterior end of pallial oviduct far removed from mantle collar; 3) pallial oviduct squeezed between

columellar muscle and intestine; 4) gonad with delicate branching system. Bursa copulatrix and posterior half of albumen gland on the right side of style sac and intestine loop. Bursa copulatrix, seminal receptacle, albumen gland and ventral channel with a common opening (Fig. 9B), after the posterior half of mantle cavity. Furrow of ventral channel opens to the pallial oviduct, being an enclosed tube only between the pallial oviduct and the common genital opening. Common genital opening on the floor of mantle cavity, beside the neck, below the capsule gland. Relatively small sac-like bursa copulatrix; smaller seminal receptacle, pressed against the bursa (Fig. 9B). Duct of bursa relatively elongated; that of seminal receptacle short. Connection of oviduct after the junction of bursa and receptacle ducts.

Male reproductive system: prominent penis, coiled in typical hydrobiid fashion, in the head-neck region (Fig. 4B). Penis proportionally very large, of simple form, without papilla or preputial structures (Fig. 11B). Base of penis large, narrowing towards the pointed tip; base simple, without horseshoe-shaped muscle. Vas deferens positioned near convex edge of penis, non-undulating. Other distinctive features are: 1) prostate squeezed between columellar muscle and intestine; 2) gonad with delicate branching system; 3) gonad posterior to the stomach; 4) seminal vesicle a little convoluted and well developed, with a smooth wall; 5) prostate not divided into anterior and posterior regions; 6) vas deferens runs alongside the prostate, but does not enter it (Fig. 10B).

Remarks: serial sections show mature gonads.

Measurements: Holotype (MZUSP 27943) length = 2.0 mm, width = 1.5 mm; Paratypes: MZUSP 27944: 2.1 mm \times 1.6 mm; MZUSP 27945: 1.9 mm \times 1.6 mm.

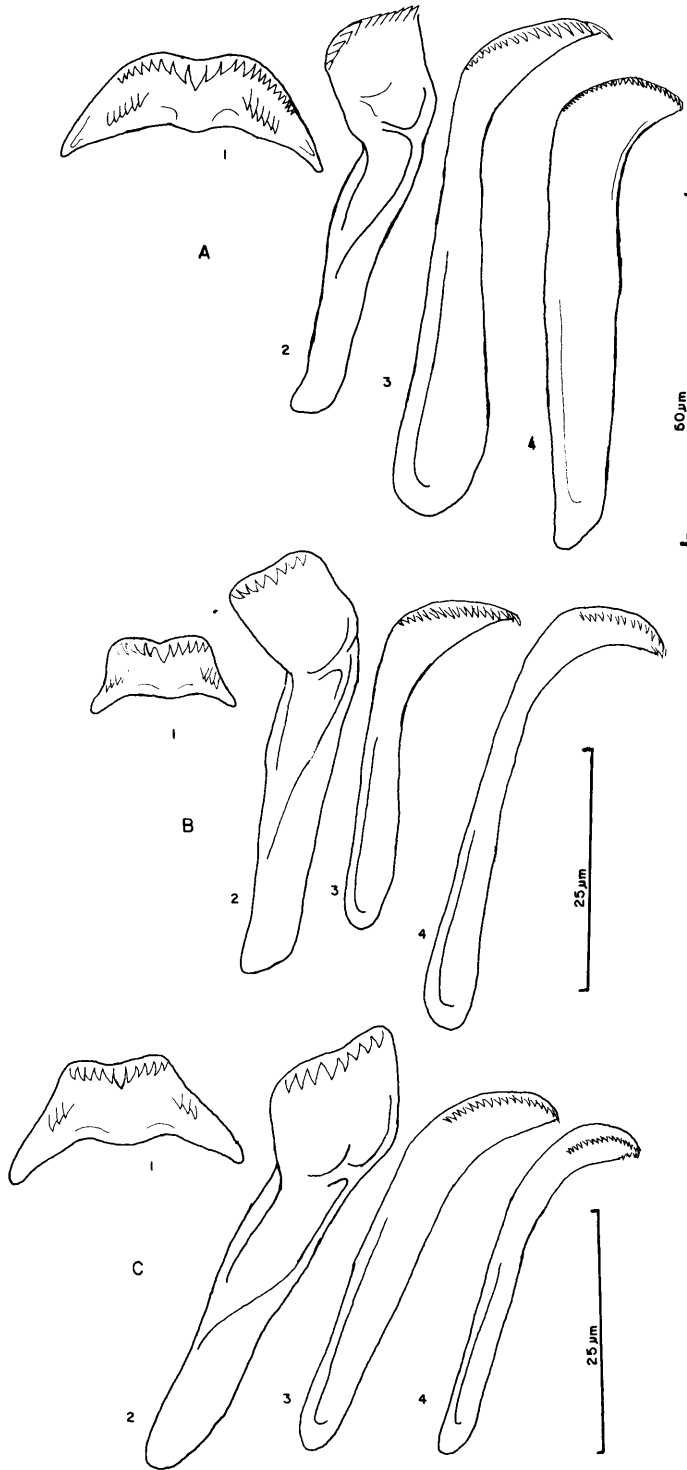


Figure 7 Radular teeth: 1-central tooth; 2-lateral tooth; 3-inner marginal tooth; 4-outer marginal tooth. **A:** *Potamolithus ribeirensis*. **B:** *P. karsticus*. **C:** *P. troglobius*.

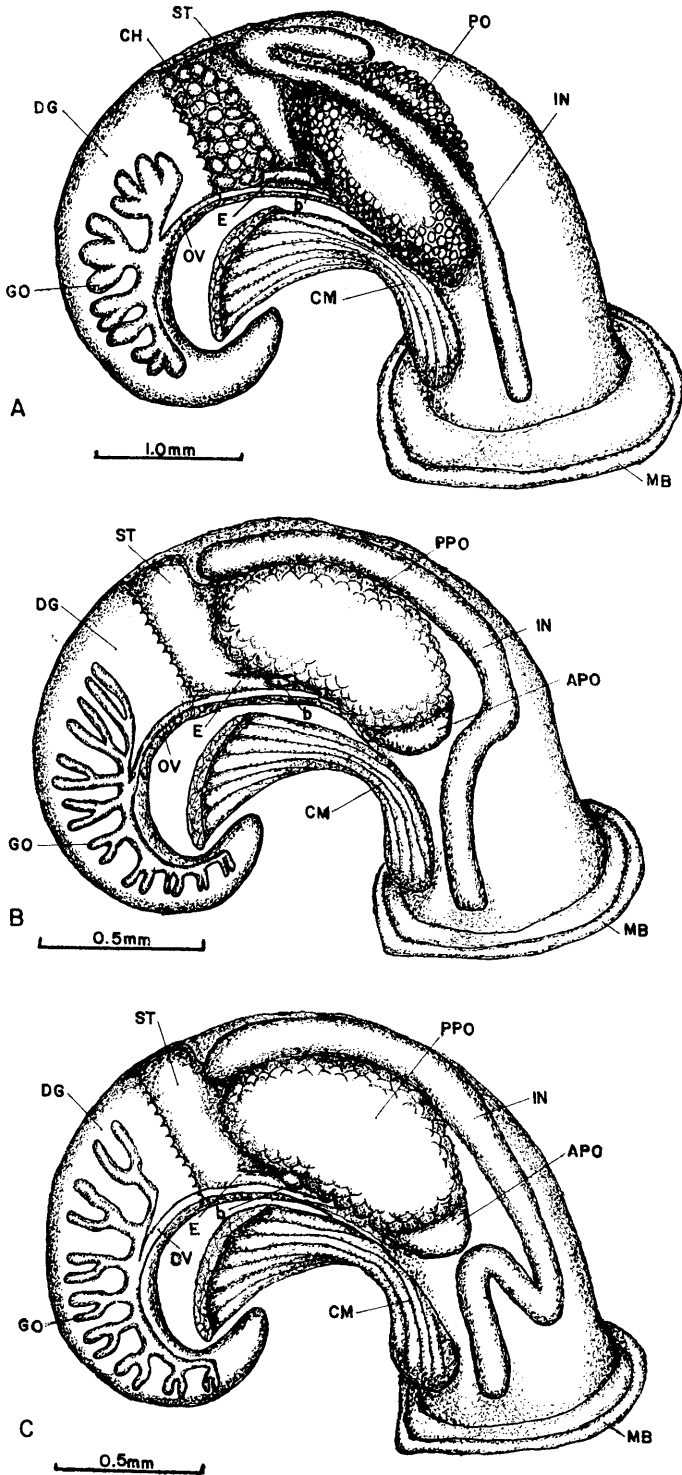


Figure 8 Scheme of an uncoiled female, dorsal view: A: *Potamolithus ribeirensis*; B: *P. karsticus*; C: *P. troglobius*.

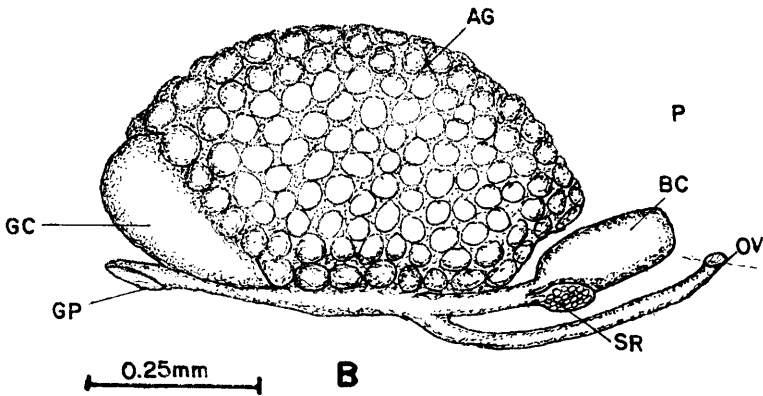
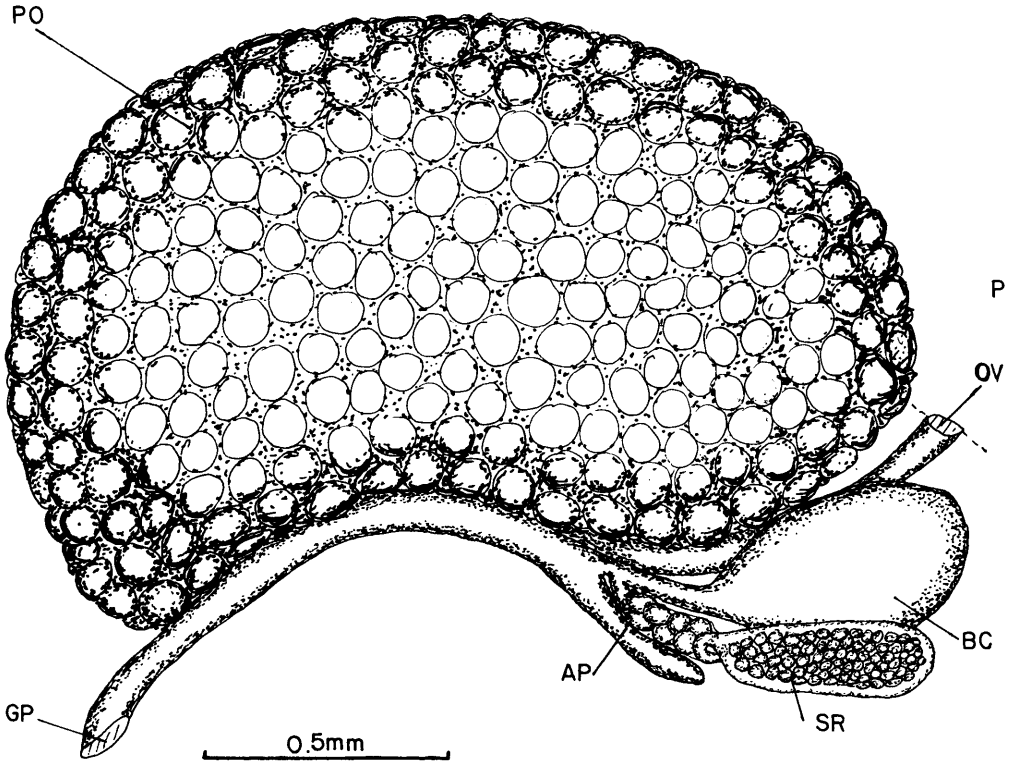


Figure 9 Ventral-lateral-left view of pallial oviduct: **A:** *Potamolithus ribeirensis*. **B:** *P. karsticus*. P = posterior region.

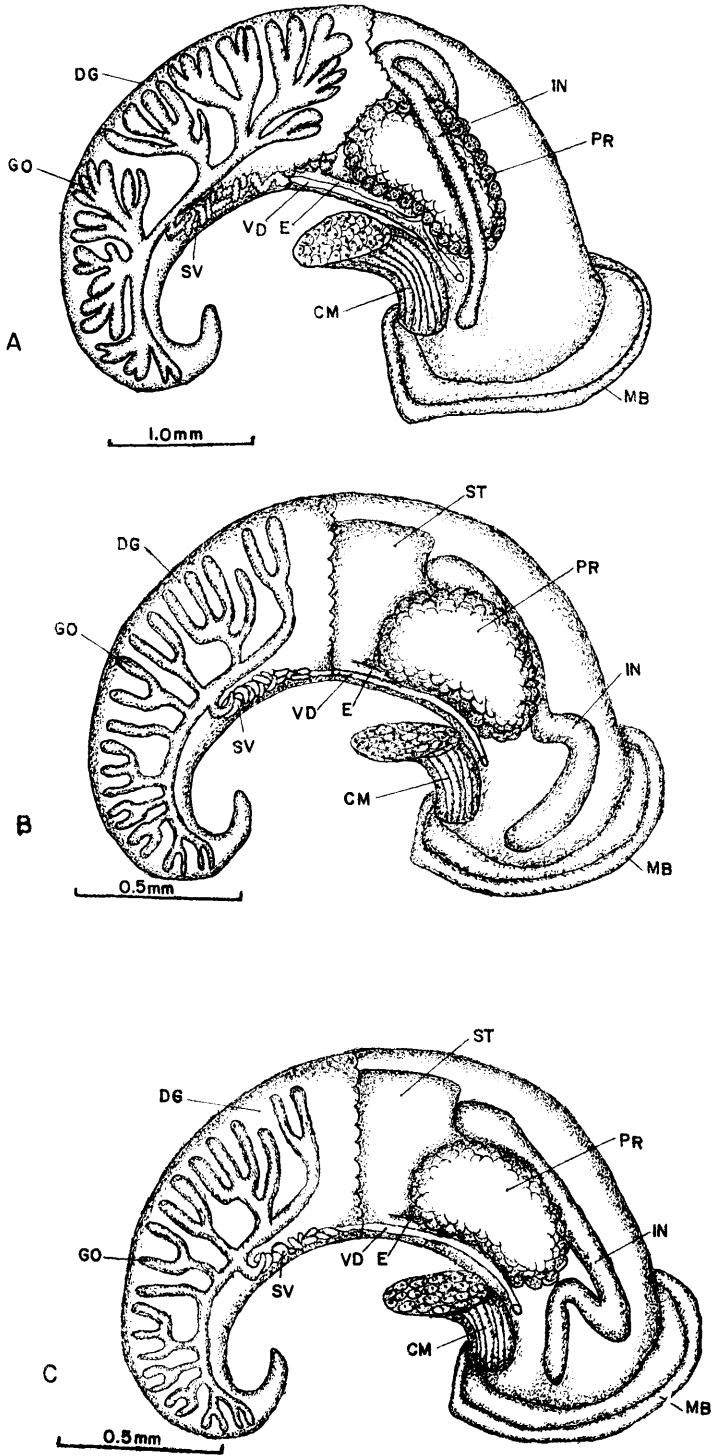


Figure 10 Scheme of a dorsal view of a uncoiled male: A: *Potamolithus ribeirensis*; B: *P. karsticus*; C: *P. troglobius*.

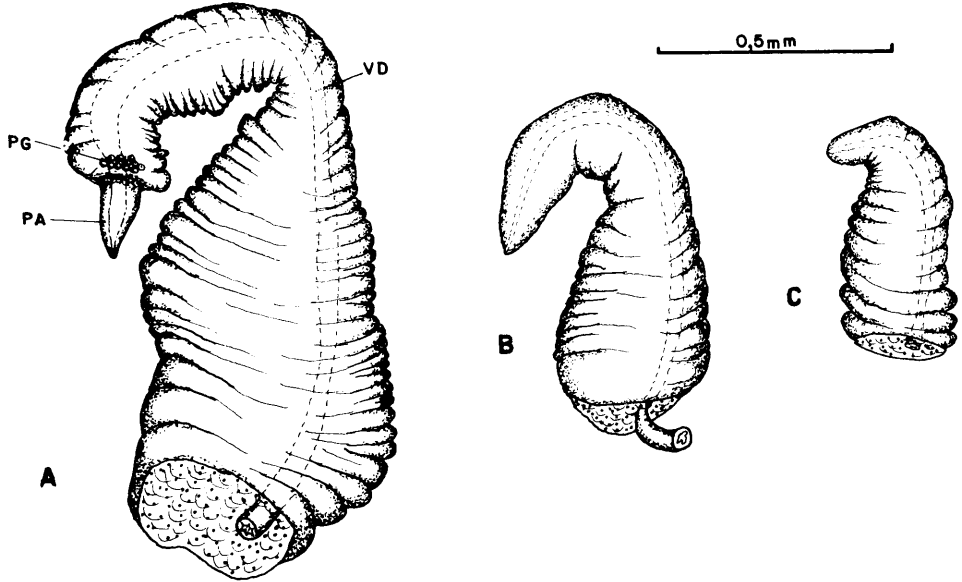


Figure 11 Dorsal view of an uncoiled penis: A: *Potamolithus ribeirensis*. B: *P. karsticus*. C: *P. troglobius*.

Range: *P. karsticus* is known only from type-locality.

Habitat: The water is clean and clear, with continuous flow. The stream is about 3 m wide. Snails were common on all sides of submerged rocks and boulders, inside and outside the cave, all through the year.

Etymology: The specific name is derived from the geomorphological term 'karst'.

Potamolithus troglobius new species
(Figs: 2G, 2H, 2I, 3 4C, 5C, 7C, 8C, 10C, 11C)

Types: Holotype: MZUSP 27947; Paratypes: MZUSP 27948 (1 specimen); MZUSP 27949 (1 specimen); MZUSP 27950 (45 specimens); MZUSP 27951 (33 specimens); MZUSP 27952 (13 specimens); MZUSP 27953 (10 specimens); MZUSP 27954 (12 specimens). MNRJ 6937 (2 specimens). MCN 33590 (2 specimens).

Type locality: Brazil, São Paulo State, Iporanga City, Areias stream, in Areias Caves and in the short epigeal course between Areias I and Areias II caves (Fig. 1 sites B + C) (24°35'20"S 48°42'05"W).

Diagnosis: Shell obese, with colourless peristramum, very minute. Head without nuchal

node, gill with about 10 filaments, short osphradium. Stomach without chambers, intestine wide, strongly sigmoid in pallial cavity. Radula cusps 11/3, 8, 17, 19. Delicate branching gonad, female genital opening as a tube; penis simple, without glands or papilla, proportionately small, with rounded tip. Vas deferens runs alongside the prostate but does not enter it.

Description: Shell (Figs 2G, H and I): minute (to 2.5 mm), obese, largest specimens with small umbilicus; colourless. Protoconch with one whorl, flattened and smooth. Teleoconch with maximum of 3 convex whorls, suture shallow, spire low, body whorl not outstandingly large. Periostracum heavy and opaque. Aperture round and wide, inclined at about 30 to 40° towards the axis of coiling; lips a little thickened. Columella heavy and slightly concave (Fig. 2G).

Head-Foot: head broad and squat, with thick stubby tentacles; snout relatively short, with about the same width as the neck (Fig. 4C); foot wide and powerful, with the usual anterior mucous groove, without any other groove or fold. No nuchal node observed in females. Coloration clear yellow. Eyes missing.

Operculum: corneous, transparent, clear yellow, paucispiral, elliptical in outline, slender, with semicircular scar (Fig. 3). Occupies all aperture.

Mantle cavity: standard hydrobioid type (Fig. 5C); but with narrowed, not wide mantle border; osphradium elliptical and short; gill parallel to mantle border, with to 10 short filaments; spherical pericardium near the right extremity of gill; kidney between pericardium and reproductive glands. Reproductive glands and intestine (described below) occupy a large space within mantle cavity.

Digestive system: stomach without chambers (as in Fig. 6B). Intestine wide, originating near the oesophageal insertion, curving around the style sac and back towards its base, then running anteriorly, emerging at the right side of the pallial oviduct or the prostate (Figs 8C, 10C); strongly sigmoid in mantle cavity (Fig. 5C).

Radula: typically taenioglossate (Fig. 7C). Minute teeth, about 40 μm long each. Central tooth with 11 upper cusps and 3 basal cusps in each side; lateral tooth with 8 cusps; inner marginal tooth with about 17 cusps and outer marginal tooth about 19 cusps.

Female reproductive system: morphological characters very similar to those of *P. karsticus*, but with a proportionally smaller pallial oviduct (Fig. 8C).

Male reproductive system: prominent penis, coiled in typical hydrobiid fashion, in the head-neck region (Fig. 4C). Penis proportionally small, of simple form, without papilla or preputial structures (Fig. 11C). Base of penis large, cylindrical and curved; tip of penis rounded; base simple, without horseshoe-shaped muscle. Vas deferens positioned near convex edge of penis, non-undulating. Other distinctive features are: 1) prostate squeezed between columellar muscle and intestine; 2) gonad with delicate branching system; 3) gonad posterior to the stomach; 4) seminal vesicle a little convoluted and well developed, with a smooth wall; 5) prostate not divided in anterior and posterior regions; 6) vas deferens runs alongside the prostate but does not enter in it (Fig. 10C).

Remarks: animal depigmented; eyespots not observed macroscopically (Fig. 4C) or in histological sections. The serial sections show mature gonads.

Measurements: Holotype (MZUSP 27947) length = 1.9 mm \times width = 1.6 mm; Paratypes: MZUSP 27948 = 2.4 mm \times 1.9 mm; MZUSP 27949 = 2.0 mm \times 1.8 mm.

Range: *P. troglobius* is known only from type-locality.

Habitat: The stream is of clean, clear water,

with continuous water flow. It is about 3 m wide. All collected snails were blind and depigmented. They were abundant all through the year on undersides of submerged rocks and boulders. A few specimens were found in the epigeal course of the stream.

Etymology: The specific name refers to the term 'troglobite', meaning an obligate subterranean species.

DISCUSSION

The trend in size reduction of cavesnails when compared to their epigeal relatives may be an ecological correlate of a stygobiont habitat, usually a food-poor environment (Hershler & Longley, 1986; Hershler & Holsinger, 1990). According to these authors, features apparently associated with snail miniaturization include complex coiling of intestine, loss or reduction of ctenidium and loss or reduction of seminal receptacle. These characters were observed in *P. karsticus* and in *P. troglobius*. The lack of external differentiation of the stomach chambers found in *P. karsticus* and *P. troglobius* was also found in *Phreatodrobia* spp. (Hershler & Longley, 1986), and may also have some correlation with the hypogean habitat adaptation.

Adult and young individuals of *P. karsticus* were found in abundance in Calcário Branco Cave, indicating that they live and reproduce within this cave. Specimens were also abundant outside the cave, along the same stream. These suggest that it is a stygophilic species. *P. troglobius* is found only in the Areias Caves, with few specimens in the short epigeal course between both caves. Such distribution, associated with the loss of eyes and depigmentation, allow us to classify it as stygobiontic.

Table 1 summarises anatomical data for the four species of *Potamolithus* with known anatomy. Similarities between characters of penis, stomach, radula, shell, osphradium, gonad and individual maximum size divide these species into two groups: *P. ribeirensis* Pilsbry, 1911 and *P. ribeirensis sensu* Davis & Pons da Silva (1984) in one group; *P. karsticus* and *P. troglobius* in the other.

P. ribeirensis Pilsbry, 1911 differs from *P. ribeirensis sensu* Davis & Pons da Silva (1984) by having: 1) wider snout; 2) tentacles without eye protuberance; 3) absence of nuchal node in females; 4) ctenidium with less filaments; 5) different position of ctenidium and osphradium in mantle cavity; 6) radula with different number

Table 1. Differences between the four *Potamolithus* species with known anatomy. For some characters: - means 'absent', + 'present'.

	<i>P. ribeirensis</i> *	<i>P. ribeirensis</i>	<i>P. karsticus</i>	<i>P. troglobius</i>
Basin	Jacui	Pilsbry Ribeira	Ribeira	Riberia
Living in cave	+	-	+	+
Coloration	globose	+	+	-
Shell	narrow	globose	ovate	ovate
Snout	+	wide	wide	wide
Eyes presence	+	+	+	-
Eye protuberance	+	-	-	-
Nuchal node	wide & thick	-	-	-
Mantle border	perpendicular	wide & thick	narrow	narrow
Position of gill and osphradium to mantle border	27	parallel	parallel	parallel
Filaments in gills	long	19	12	10
Length of filaments	long	long	short	short
Osphradium	11	long	short	short
Cusps in central tooth	2	21	11	11
Pair of basal cusps in central tooth	11	6	4	3
Cusps in lateral teeth	23 to 25	12	10	8
Cusps in inner marginal teeth	28 to 30	18	18	17
Cusps in outer marginal teeth	2	25	18	19
Chambers in stomach	-	1	16	0
Thick intestine	-	-	0	+
Intestine strongly sigmoid	-	-	+	+
Gonad with delicate digitations	-	w	-	+
Digestive gland touching prostate	+	-	+	-
Prostate with two regions	+	-	-	-
Vas deferens entrance in prostate	+	+	-	-
Penis with papilla	+	+	-	-
Penis with preputial structures	+	+	-	-
Penis with muscle root	-	-	-	-
Penis proportionally very large	-	-	-	-
Penis tip round	-	-	+	+
Oviduct clearly divided into anterior and posterior parts	+	-	-	+
Massive pallial oviduct	-	+	+	+

* Based on Davis & Pons da Silva (1984).

of cusps in central and inner marginal teeth; 7) stomach with only one chamber; 8) digestive gland touching prostate in males; 9) prostate not divided in two parts; 10) penis without muscular rooting; 11) pallial oviduct not clearly divided into anterior and posterior parts. This allows us to conclude that the population studied by Davis & Pons da Silva (1984) may correspond to another species.

P. troglobius differs from *P. karsticus* by having: 1) more globose shell, with a wider and more oblique aperture; 2) depigmented shell and tegument; 3) absence of eyes; 4) proportionally smaller penis; 5) penis with a rounded tip; 6) larger intestine, strongly sigmoid in mantle cavity.

According to the classification of Davis & Pons da Silva (1984: 99), the studied species can be placed as Lithoglyphinae, but some characters

attributed by these authors to *Potamolithus* were not observed here (*op. cit.*, table 9:94-95): character '10', osphradium, of *P. karsticus* and of *P. troglobius* is not elongated; character '13', penis, these two cavernicolous species have no eversible papilla; character '29', nuchal node, absent in the three species studied here.

From the 30 known species of *Potamolithus* (Davis & Pons da Silva, 1984:75), those which occur near the study area were selected for comparison. *Potamolithus karsticus* and *P. troglobius* differ conchologically from *P. chloris* Pilsbry 1911 in having small size, different colour and the parietal wall not so calloused; both differ from *P. intracallous* Pilsbry, 1911 in having small size, shorter spire, different colour and the columella thinner; both differ from *P. catharinae* Pilsbry, 1911 in having small size, thinner shell walls, small umbilicus and round-

ed spire; and both differ from *P. paranensis* Pilsbry, 1911 in having small size, more elongate outline, different colour and lacking spiral striae.

The two new species described here were placed in the genus *Potamolithus* due to their geographical distribution, freshwater habitat, and conchological characters—heavy periostracum and shell wall, short spire, and aperture inclined towards the axis of coiling (Pilsbry, 1896; 1911). With the lack of anatomical data concerning other species of *Potamolithus*, the monophyly of this genus is not certain, and a traditional systematic approach was adopted.

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APPENDIX

Key to symbols

AG: albumen gland	OV: oviduct
APO: anterior pallial oviduct	P: penis
BC: bursa copulatrix	PA: papilla
b: bursa copulatrix	PC: pericardium
CH: stomach chamber	PG: preputial gland
CM: columellar muscle	PO: pallial oviduct
CT: ctenidium	PPO: posterior pallial oviduct
DG: digestive gland	PR: prostrate gland
E: eye	SN: snout
ES: oesophagus	SR: receptaculum seminalis
CG: capsule gland	ST: stomach
GO: gonad	STI: style sac
K: kidney	SV: seminal vesicle
MB: mantle border	T: tentacle
OS: osphradium	VD: vas deferens

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