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First record of subterranean freshwater gastropods (Mollusca, Gastropoda, Cochliopidae) from the cenotes of Yucatán state

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Abstract

The biospeleological investigations of several cenotes in the eastern region of Yucatán state, Mexico, during January 2018 yielded, among other invertebrates, two new truncatelloid gastropod species described herein as *Mexicenotica xochii* **gen. n. et sp. n.** and *Pyrgophorus thompsoni* **sp. n.** Both species represent the first record of stygobiont gastropod species from the cenotes of Yucatán indicating the high biodiversity potential of the studied area.

Keywords

Mexico, cave, phreatic, stygobiont, *Pyrgophorus*

Introduction

The North American stygobiont or phreatic Gastropoda, represented by 15 genera, are mainly known from the caves and springs in the eastern part of United States (23 species) (Herschler and Holsinger 1990; Culver 2012) from Kentucky to Texas and Florida. The stygobiont Mollusca of Mexico are still poorly studied. In Mexico, Bole and Velkovrh (1986) recorded three stygobiont genera (*Coahuilix* O. Taylor, 1966,

Emmericiella Pilsbry, 1909 and *Pterides* Pilsbry, 1909) with six species, and two stygophile genera (*Potamopyrgus* Stimpson, 1865 = *Pyrgophorus* Ancey, 1888 and *Cochliopina* J. Morrison, 1946) with two gastropod species. A more recent inventory (Czaja et al. 2017) includes five recent genera: *Paludiscala* O. Taylor, 1966; *Coahuilix* O. Taylor, 1966; *Phreatoceras* Hershler & Longley, 1987; *Emmericiella* Pilsbry, 1906 and *Pterides* Pilsbry, 1909 with nine recent and two subfossil Holocene stygobiont species recorded. All the hitherto known Mexican stygobiont gastropod records come from Cuatro Ciénegas basin (Hershler 1985) with caves near, Coahuila Viesca (Czaja et al. 2017) and from San Luis de Potosí (Pilsbry 1939). Despite the enormous volume of the Yucatán cenote aquifer, no systematic study of local stygobiont Mollusca had been done so far, except the anchialine cenote Crustacea, located south of Puerto Morelos, Quintana Roo, Mexico with a record of a gastropod *Teinostoma brankovitsi* Rubio et al., 2016 from family Tornidae Sacco, 1896. Far fewer records are available for the subterranean gastropods of South America, limited to *Andesipyrgus sketi* Hershler & Velkovrh, 1993 from Colombia and Ecuador with *Potamotithus troglobius* Simone & Moracchioli, 1994 and *Spiripockia punctata* Simone, 2012 from Brazil. Most of the New World is still lacking information related to the presence of stygobiont Mollusca.

Material and methods

The studied material was collected during a SCUBA-dive biospeleological field trip during 2–6 January 2018 (Figs 1, 2.) Sediment samples were collected in marked 50 ml BD Falcon tubes from different depths of the cenote. Samples were stored in ice after the dives and were fixed in 70% ethanol in the laboratory in UNAM-UMDI Sisal, where minute invertebrates were selected under a stereomicroscope. Gastropod samples (empty shells) were labelled and dried for further analysis in Hungary and Slovakia. Afterwards, the dry samples were sorted again under an Olympus SZ-11 stereo microscope. Frontal, ventral and lateral view images of the shells were made by a Nikon SMZ25 microscope with Nikon D200 camera and an AF-S Micro NIKKOR 60 mm lens at Vienna Natural History Museum (**NHMW**), Austria.

Abbreviations

HNHM	Hungarian Natural History Museum, Budapest
NHMW	Naturhistorische Museum Wien, Austria
UNAM	National Autonomous University of México, Faculty of Sciences, Academic Unit of Yucatán, Yucatán, Mexico
H	Shell height
W	Shell width
WB	Width of the body whorl
AH	Aperture height
AW	Aperture width

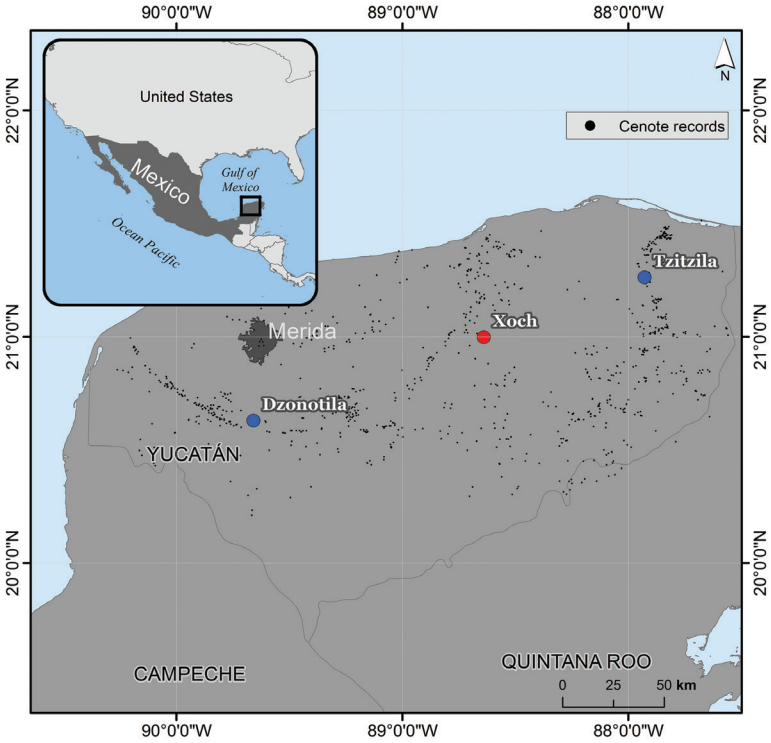


Figure 1. Map of the cenote distribution in the Yucatán state, Mexico with studied localities. The type locality of *Mexicenotica xochii* n. gen. sp. n. and *Pyrgophorus thompsoni* sp. n. in Cenote Xoch marked in red. Blue color indicates cenotes cited in this article as localities for *Pyrgophorus coronatus*.

Figure 2. Images of cenote Xoch, the type locality of *Mexicenotica xochii* n. gen. sp. n. and *Pyrgophorus thompsoni* sp. n.

Results

The scarce shell material obtained by sampling at a depth of 46 m in cenote Xoch near the municipality of Cenotillo contained two subterranean species not resembling hitherto known stygobiont species from Coahuila and San Luis de Potosí and described herein as new to the science.

Superfamily *Truncatelloidea* J. E. Gray, 1840

Family *Cochliopidae* Tryon, 1866

Genus *Mexicenotica* gen. n.
http://zoobank.org/419F28D8-1962-4495-8B5A-670DF596CDA0

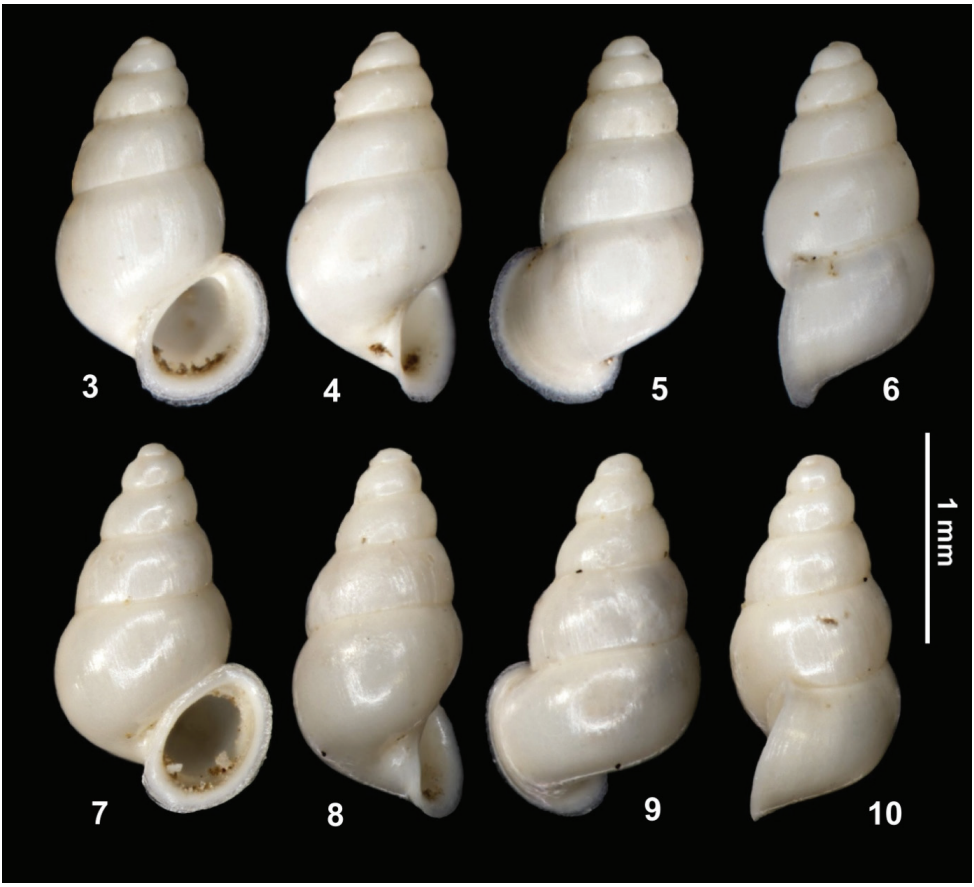
Diagnosis. The diagnostic features of the genus are the same as those of the type species *Mexicenotica xochii* sp. n. The minute size with tear shaped shell and expanded oval aperture with a fragile flaring corrugated margin distinguish the new genus from any other related genera of Cochliopidae or Pomatiopsidae.

Etymology. Named after the country of origin and cenotes, the specific vertical sinkhole karstic formations of Yucatán´s plateau, whose phreatic waters and aquifers host the new genus.

***Mexicenotica xochii* sp. n.**
http://zoobank.org/909D9B86-182F-4125-B1B7-0263604AE82D
Figures 3–10

Diagnosis. The shell shape of the new species closely resembles subterranean species belonging to family Pomatiopsidae from Laos (*Tricula valenasi* Grego, 2018 and *Tricula spelea* Grego, 2018), and the fine fragile faintly corrugated aperture margin is reminiscent of some cave dwelling specimens of pomatiopsid *Spiripockia punctata* (Simone 2012) from Brazil. However, the geographical distance and absence of pomatiopsid species hitherto known from the Yucatán region rather suggest the resemblance in the shell shape of a cochliopid species. From the geographically close Cochliopidae species, the closest resemblance in the shell shape is found in the Mesoamerican genus *Aroapyrgus* H.B. Baker, 1931 (*Aroapyrgus pasionensis* (Goodrich & Van der Schalie, 1937) from Alta Verapaz, Guatemala), but the new species differs by its more elongated conical shape, with a less prominent body whorl and a proportionally smaller aperture. Furthermore, the aperture of *M. xochii* sp. n. is expanded and finely marginated by a tiny, corrugated structure, while *A. pasionensis* has a rather smooth peristome.

Type locality. Mexico, Yucatán state, Cenotillo Municipality, Cenote Xoch, at 46m deep by SCUBA dive, inside cave sediments, 20,997565°N; 87,936659°W.



Figures 3–10. 3–6: *Mexicenotica xochii* sp. n. 46 m deep from Cenote Xoch, Cenotillo, Yucatán, Mexico (holotype, HNHM 104156) **7–10:** *M. xochii* sp. n. (paratype, coll. JG).

Type material. Holotype, Type locality: leg. Angyal and Liévano, 5 Jan. 2017. (HNHM 104156). Paratypes, same data (coll. Grego 1 specimen); type locality, leg. Angyal and Liévano.

Measurements. Holotype: H 1.84 mm; W 1.05 mm; WB 0.85 mm; AH 0.74, AW 0.56 (holotype). Figs 3–6. Paratype: H 1.82 mm; W 1.08 mm; WB 0.87 mm; AH 0.74, AW 0.56 (holotype). Figs 7–10.

Etymology. Derived from the type locality in Cenote Xoch, Cenotillo municipality, Yucatán state, Mexico.

Description. The snow-white elongate-conical shell with five rounded slightly convex whorls with a weak suture and a blunt apex. The surface smooth and shiny with very faint, almost invisible, transverse growth lines. Aperture elongate oval, ear-shaped, adapically, separated from the body whorl by a weak furrow. The peristome margin expanded, and its reflexed outline bordered by a slightly corrugated, thin and fragile collar. The columellar lip very slightly wavy in its lateral plane, the outer lip straight. Umbilicus closed and obscured.

Habitat. The cenote Xoch is a deep vertical cavern (Fig. 2.) with abundant sediments of plant debris found up to its depth at more than 70m. The cave system has one shallower and a deeper horizontal cave passage at 21m and more than 50m, respectively. The water temperature is 25°C. The organic material deposited in the cenote has two main resources: the epigean decaying dead plants and the belt of indigenous live green algae alongside the cavern walls from the water surface down to 11m depth. The sample with empty shells was taken during dive into 53m depth and at 400m horizontal cave passage. It was taken from a thick organic sediment deposited at 46 m depth. Inside the same sample, specimens of minute bivalvians of cf. *Pisidium* sp. and a few specimens of ostracods were also found. During the research dive, individuals of stygobiont crustaceans, such as *Antromysis cenotensis* Creaser, 1936, *Creaseriella anops* (Creaser, 1936), and *Typhlatya* sp. were also collected at the free water column of the cavern. Trichoptera and Plecoptera larvae, as well as ostracods and water mites were collected in the green algae layer from the cave walls.

Distribution. Only known from the type locality. Within the type locality the new species was found together with the *Pyrgophorus thompsoni* sp. n., and cf. *Pisidium* sp.

Remarks. Due to absence of molecular and anatomical data, the proposed positioning of the new genus in the family Cochliopidae is only provisional, based on the closest resemblance to the geographically closest relatives, but the overall shell shape with flaring margin shows some resemblance also to the Southeast Asian and Brazilian members of the family Pomatiopsidae, which have no close geographical analogue in the region. The new species rather represent by its shape an evolutionary resemblance of a cochliopid species induced by the similar environment to that of the Pomatiopsidae.

Genus *Pyrgophorus* Ancey, 1888

Pyrgophorus thompsoni sp. n.

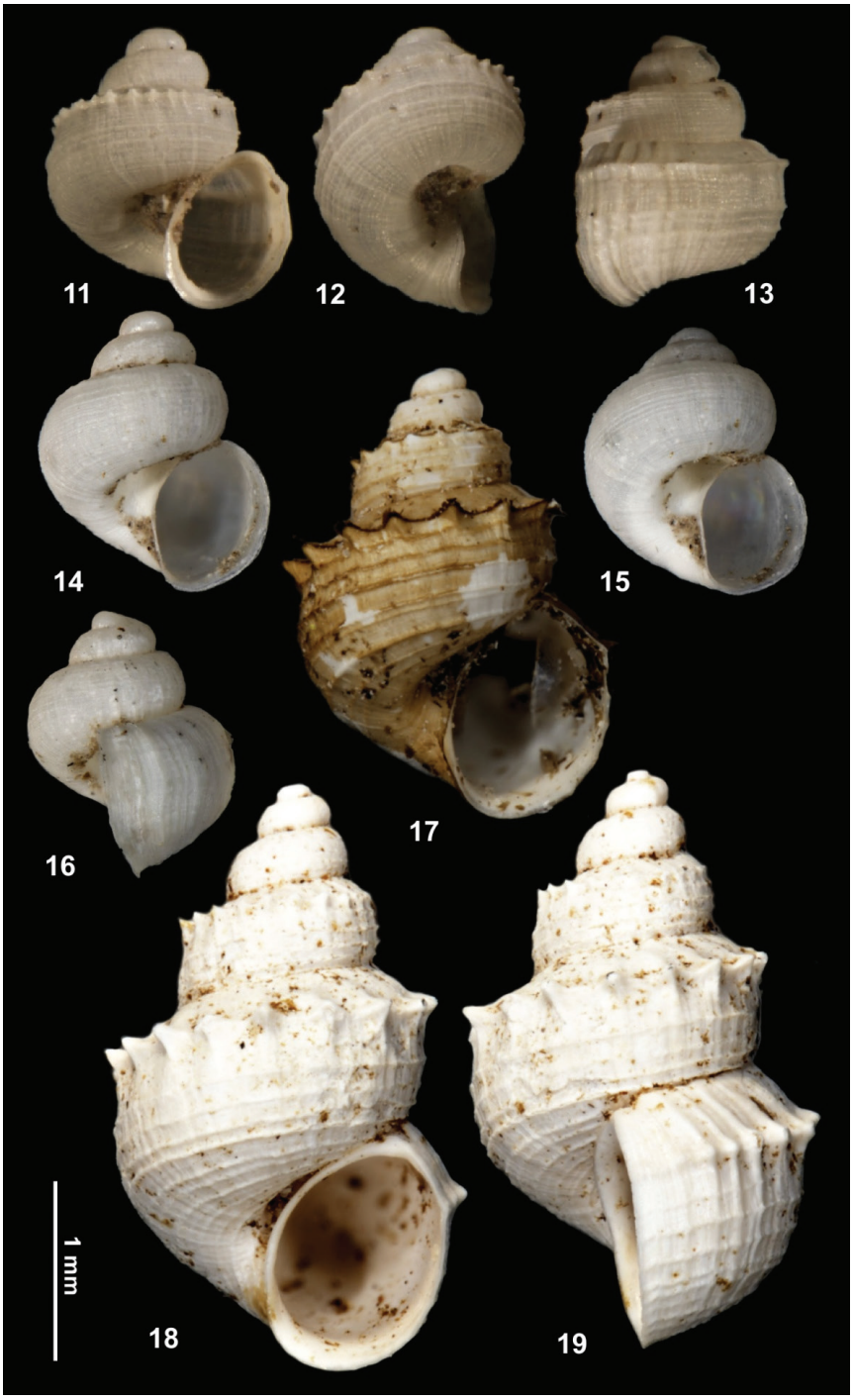
http://zoobank.org/D324A453-1294-48AB-AC2E-6DC359763FF7
Figures 11–16

Diagnosis. Compared to the most closely related *Pyrgophorus coronatus* (L. Pfeiffer, 1840), found in other cenotes and surface waters of Yucatán (Figs 17–19), the new species differs by its smaller and more pyramidal shell shape with blunter apex and finer surface sculpture, whitish periorostracum, flat protoconch and less numerous whorls, more opened umbilicus, smaller and more numerous nodules and different shape of the aperture with a characteristic sinuation at its columellar edge.

Type locality. Mexico, Yucatán state, Cenotillo Municipality, Cenote Xoch, at 46 m deep by SCUBA, buried in cave sediments, 20,997565°N; 87,936659°W.

Type material. Holotype, Type locality: leg. Angyal and Liévano, 5 Jan. 2017. (HNHM 104157). Paratypes, same data (coll. Grego 1 specimen); type locality, leg. Angyal and Liévano.

Measurements. Holotype: H 1.58 mm; W 1.56 mm; WB 1.08 mm; AH 0.90, AW 0.70 (holotype). Figs 11–13. Paratype: H 1.56 mm; W 1.30 mm; WB 1.06 mm; AH 0.84, AW 0.66 (holotype). Figs 14–16.



Figures 11–19. 11–13: *Pyrgophorus thompsoni* sp. n. 46 m deep from Cenote Xoch, Cenotillo, Yucatán, Mexico (holotype HNHM 104157) **14–16:** *P. thompsoni* sp. n. (paratype) **17–19:** *Pyrgophorus coronatus* (L. Pfeiffer, 1840) 8 m deep in Cenote Tzitzila, Dzonot Aké, Yucatán, Mexico (**17**) 27 m deep from Cenote Dzontila, Mucuyché, Yucatán, Mexico (**18–19**).

Etymology. Named after renowned malacologist and good friend Fred Thompson from University of Florida, Gainesville, who contributed much to the knowledge of Cochliopidae of US and Mexico and compiled the first checklist of terrestrial and freshwater gastropods of Mexico and Central America (Thompson 2008).

Description. The milky whitish, translucent conical shell with 3 inflated convex whorls with a deep suture, blunt apex, and flat protoconch. The first teleoconch whorls rapidly expanding, forming a characteristic depressed, sometimes umbilicated appearance. The surface finely lirated, crossed by very fine axial ribs. The spiral lirated sculpture gradually coarsened towards the upper suture of the body whorl, on which the prominent carina-like spiral rib with fine regular conical spines. In some specimens only nodules or only faint knobs present (paratype 1). The body whorl broadened near the aperture. The aperture axially elongated and oval; the columellar peristome reflexed and characteristically sinuated. Umbilicus broad and open.

Habitat. See *Mexicenotica xochii* sp. n.

Distribution. Only known from the type locality. Within the type locality the new species was found together with the *Mexicenotica xochii* sp. n. and cf. *Pisidium* sp.

Discussion

The empty shells of both new taxa were found in organic sediments in the vertical cavern at a depth of 46 m below the water surface. The almost stagnant freshwater at the sampling point would exclude longer transportation of empty shells and accumulation in thanatocoenosis. As the total volume of the phreatic caves under cenote Xoch is huge, additionally the phreatic cave walls surface with bottom floor comprise complicated forms of cave morphology increasing the surface of possible habitats, it is very hard to estimate the exact spot of the true habitat of both minute species within the spread of the cave system. Most likely the new species inhabits the rocky cave surfaces of the cave, feeding on the chemolithotrophic bacterial mats, likely on the blotches with rusty brown, orange or black incrusts layers of oxidation residuals after chemolithotrophic process or on any cave sediments covered by similar layers. We cannot exclude, that the main food could be also exogenous organic plant debris originating on the surface. Nevertheless, to find the site with live specimens of both new species will be rather challenging and more likely depending on luck than knowledge of the habitat.

Conclusions

The first findings of subterranean freshwater gastropod species in the cenote Xoch also indicates the possible larger distribution and diversity of stygobiont gastropods within the remarkable cavernous karstic aquifer of Yucatán. The several hundred kilometers-long cave systems inside the Yucatán carbonate plateau suggest the potential

for existence of a very high, so far unexplored, molluscan biodiversity. Due to large cave systems accessible only by SCUBA diving, frequently with complicated logistic of material transport over very long distances, the research of minute cave animals has thus far been nearly impossible. We hope this study will motivate future researches to focus on the study of tiny cave invertebrates inhabiting the freshwater saturated cave labyrinths of the Yucatán Peninsula.

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