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ARTICLE

New land microsnails of the genus *Gastrocopta* (Eupulmonata: Gastrocoptidae) in the semiarid region of Brazil

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Abstract. In Brazil, Gastrocoptidae Pilsbry, 1918 includes only land microsnails of the genus *Gastrocopta* Wollaston, 1878. Here, two new species of *Gastrocopta* are described from the phytogeographic domain of the Caatinga (semiarid scrubland): *Gastrocopta joaoherminioi* **sp. nov.** and *Gastrocopta caatinga* **sp. nov.** The shell morphology of *G. joaoherminioi* **sp. nov.** differs substantially from native and invasive congeners of Brazil, mainly in the greatly convex whorls as well as in the number and configuration of apertural barriers, which totals 11 very strongly developed teeth (except suprapalatal tooth) that greatly obstruct the region. The shell morphology of *G. caatinga* **sp. nov.** has a typical ovoid shape and apertural barriers totaling four teeth that do not obstruct the region (except for the projection of parieto-angular tooth). The new land snails, found in a dense layer of leaf litter on sandy soil at a semi-open dry tropical forest habitat, are compared with congeners from the neotropical region.

Keywords. South America; Tropical dry forest; Caatinga; Gastropoda; Gastrocoptinae.

INTRODUCTION

Brazil's phytogeographic domains are great storehouses of terrestrial invertebrates still unknown to Science (Almeida-Azevedo *et al.,* 2023; Becker, 2023; Bedoya-Roqueme *et al.,* 2023a, b; Campos-Filho *et al.,* 2023; James *et al.,* 2023; Bouzan *et al.,* 2024; López-Orozco *et al.,* 2024; Maia, 2024; Paredes-Munguía *et al.,* 2024; Pecly *et al.,* 2024; Tavares *et al.,* 2024). Land microsnails (smaller than 5 mm) represent an important component of the invertebrate biota in these domains (Simone, 2006) and are mainly associated with vegetable organic matter deposited on the soil (Maestrati *et al.,* 2015). Among the main families of microsnails found in Brazil are Charopidae Hutton, 1884, Diplommatinidae Pfeiffer, 1857, Euconulidae Baker, 1928, Gastrocoptidae Pilsbry, 1918, Gastrodontidae Tryon, 1866, Strobilopsidae Wenz, 1915, Valloniidae Morse, 1864, Vertiginidae Fitzinger, 1833 and Zonitidae Mörch, 1864 (Simone, 2006; Maestrati *et al.,* 2015; Salvador *et al.,* 2017, 2018).

Gastrocopta Wollaston, 1878 is a genus of the family Gastrocoptidae with the most expressive species richness and the most widely distributed through the planet's terrestrial ecosystems (MolluscaBase, 2024). Such gastrocoptids live in association with moss, shrubs, fallen trunks, leaf litter as well as clay, granite, schist, sandy soils, flood debris and cliffs (Solem, 1991; Pokryszko *et al.,* 2009; Nekola & Coles, 2010; Stanisic *et al.,* 2010, 2018; Miquel & Brito, 2019; Brito & Miquel, 2022; Herbert & Willows-Munro, 2022), as well as calciphilic environments (Solem, 1991; Vermeulen & Whitten, 1998; Hotopp *et al.,* 2013).

In Brazil, members of the family Gastrocoptidae include only representatives of the genus *Gastrocopta,* which are mainly found in the phytogeographic domains of the Atlantic Forest, Caatinga [*e.g., G. oblonga* (L. Pfeiffer, 1854)], Cerrado [*e.g., G. sharae* Salvador, Cavallari & Simone, 2017] and Pampa [*e.g., G. iheringi* (Suter, 1900)] (Simone, 2006; Salvador *et al.,* 2017, 2018; Cozer *et al.,* 2021). Other congeners were reported on Brazilian islands [*e.g., G. solitaria* (Smith, 1890) and *G. barbadensis* (Pfeiffer, 1853)] (Simone, 2006; Cunha *et al.,* 2015) and recognized as invasive taxa [*e.g., G. barbadensis* and *G. pelucida hordeacella* (Pilsbry, 1890)] (Kotzian & Amaral, 2013; Cunha

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et al., 2015; Batistão *et al.,* 2021; Miranda *et al.,* 2023; Abreu *et al.,* 2024).

Gastrocopta is by far one of the least studied land microsnails in Brazil (Simone, 2006) with sparse periods of descriptions of new species throughout the centuries (Pfeiffer, 1852; Suter, 1900; Salvador *et al.,* 2017). This and other genera of microsnails have a species richness that is recognized as underestimated on account of the Brazilian megadiversity still being associated with many unexplored regions as well as the difficulty in sampling and, especially, screening of minute-small individuals from the different types of ecological environments (Salvador, 2019).

To the best of our knowledge regarding the richness of *Gastrocopta,* this paper describes two new species in the semiarid region of Brazil.

MATERIAL AND METHODS

Study area

Engenheiro Ávidos Ecological Park – EAEP (06°59′39.73″S, 38°27′14.47″W) is inserted in the municipalities of Cajazeiras and São José de Piranhas, state of Paraíba, northeastern Brazil. EAEP is situated between a mountainous chain with shrub-herbaceous and arboreal vegetation, hyperxerophilic phytophysiognomy (Araújo & Pereira, 2016; Souto *et al.,* 2019a) and aquatic ecosystems (Fig. 1), *e.g.,* Piranha reservoir, streams and marginal lagoons (Freitas, 2012; Souto *et al.,* 2019a, b). The temperature ranges from 23° to 33°C and average rainfall is 800 mm with rains concentrated between February and April (Feitosa, 2000). EAEP has shallow sandy-clay soil at the base of the mountain and is stony on the plateau (Bandeira, 2016).

EAEP is a priority area for biodiversity conservation due to the unique biota, which has been studied very little over the years and is extremely susceptible to anthropogenic disturbances (Araújo & Pereira, 2016; Feitosa *et al.,* 2002; Souto *et al.,* 2019a, b).

Collection and identification

Collections of litter (leaf and soil) were carried out for one year (2017 to 2018) in a less impacted area of EAEP. Collection areas included habitats bordering and entering the native vegetation. Substrates (10 to 15 kg of litter) from different points of the study area were collected for the screening of microsnails under a stereomicroscope. The litter was left to dry in the sun and micromollusks were then screened under a stereomicroscope. The material was processed at the Zoology Lab of the Professor Education Center of the Federal University of Campina Grande. Sampling was carried out with the authorization of *Sistema de Autorização e Informação em Biodiversidade* (SISBIO 60982-1) [Authorization and Information System in Biodiversity], *Instituto Chico Mendes de Conservação da Biodiversidade* [Chico Mendes Biodiversity Conservation Institute], *Ministério do Meio Ambiente* [Ministry of the Environment].

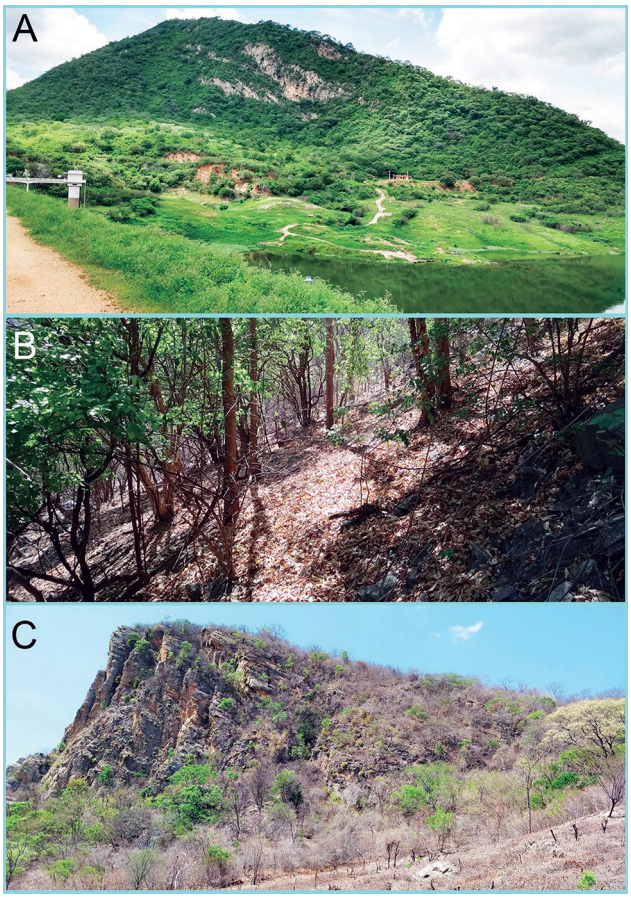

Figure 1. Photos showing study area where microsnails were collected in EAEP: (A) General view of the collection area in the rainy season; (B) General view of stretch where the microsnails were collected in the rainy season; (C) General view of stretch of the collection area in the dry season.

Identification of the microsnails was performed under a stereomicroscope. Shells were also studied based on photographs taken with a stereoscopic microscope. The description of apertural barriers (clockwise in aperture) is based on Whisson & Köhler (2012: 17, fig. 1).

Microsnails are deposited in the following scientific collections: UFPB.MOL – Coleção de Invertebrados Paulo Young, Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba (UFPB), João Pessoa, Paraíba, Brazil; CMPHRM-B – Coleção Malacológica Prof. Henry Ramos Matthews (Série B), Departamento de Biologia, Universidade Federal do Ceará, Fortaleza, Ceará, Brazil.

RESULTS

Gastrocopta joaoherminioi sp. nov. (Fig. 2)

Type material: Holotype – UFPB.MOL-44073 (Figs. 2A-C, E); Paratypes – UFPB.MOL-44074 (9 shells) (Fig. 2D), CMPHRM7521B (4 shells), all from type locality; CMPHRM7520B (5 shells), Brazil, Paraíba, municipality of Cajazeiras, EAEP, sampling area 9, 06°59′07″S, 38°27′34″W (410 m), litter (leaf and soil), 25.XI.2017, Evandro C.T. Abreu collector.

Type locality: Brazil, Paraíba, municipality of Cajazeiras, EAEP, sampling area 8, 06°59′06″S, 38°27′32″W (401 m), litter (leaf and soil), 25.XI.2017, Evandro C.T. Abreu collector.

Etymology: The species is named to honor Prof. Dr. João Hermínio da Silva (1961-2023). Prof. João Hermínio, as he was called among his colleagues and students, obtained a degree in Mathematics from the *Universidade Estadual do Ceará* (UECE: 1984-1989), a master's degree in Energy and Nuclear Technologies from the *Universidade Federal de Pernambuco* (UFPE: 1997-1999), a PhD in Physics from the *Universidade Federal do Ceará* (UFC: 2002-2007) and a Post-Doctorate from the *Universidade Federal do Piauí* (UFPI: 2015-2016). He was a professor at the *Universidade Estadual do Tocantins* (Unitins: 1995-1996), *Universidade Federal Rural de Pernambuco* (UFRPE: 1997-1999), UFC (2002-2006), *Instituto Centro de Ensino Tecnológico* (Centec: 2006-2007), *Centro Universitário Farias Brito* (FB UNI: 2007-2007), UFC (2010-2015) and finally *Universidade Federal do Cariri* (UFCA: 2016-2023). He was a research productivity fellow at the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq) due to his important scientific, technological and innovation production involving raman and infrared spectroscopy, materials subjected to high temperatures and high

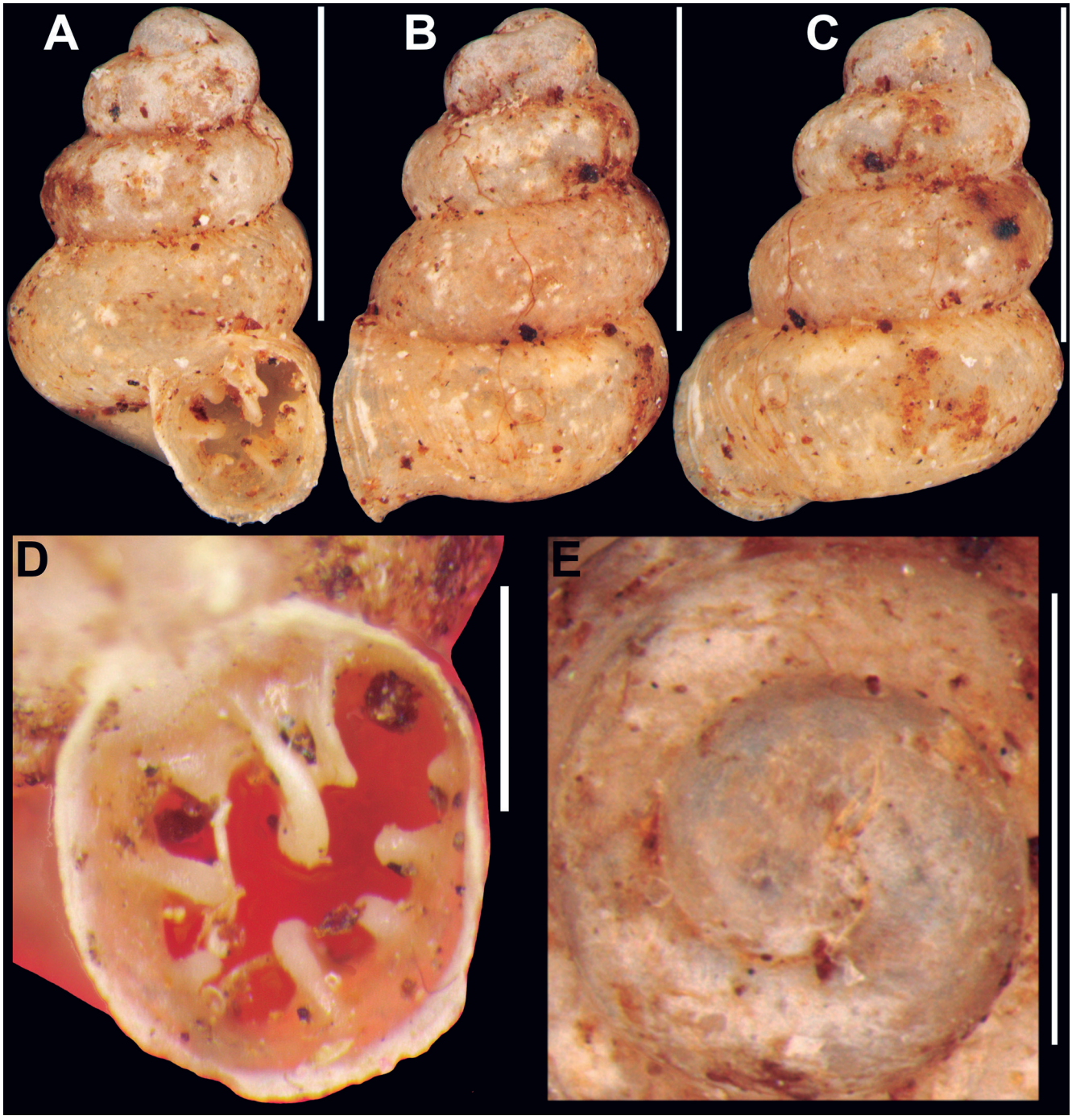

Figure 2. *Gastrocopta joaoherminioi* **sp. nov.** collected from the EAEP: (A) Ventral view, (B) Right view, (C) Dorsal view, (D) Detail of aperture, (E) Apical view. Scale bars: A-C = 1 mm (holotype), D = 0.2 mm (paratype – UFPB.MOL-44074), and E = 0.5 mm (holotype).

pressures, vibrational properties of amino acid crystals, growth and characterization of amino acid crystals, application of radioisotopes, Physics and Microbiology, Physics Applied to Paleontology and Archeology and Teaching Physics. He dedicated part of his life to the study of fossils from the Araripe Basin (located between the south of the state of Ceará, the west of the state of Pernambuco and the east of Piauí) contributing to paleontological research, mainly in the Cariri of the state of Ceará, as well as the training of researchers and teachers in the areas of Physical, Geological, Paleontological and Biological Sciences. Prof. João Hermínio passed away at the age of 62.

Diagnosis: Apertural barriers with 11 very strongly developed teeth (except suprapalatal tooth) greatly obstructing aperture, not extending to lip margin. Parietal to angular region with five teeth – infraparietal tooth apparently semicircular, completely anastomosed with parieto-angular tooth 1; parieto-angular tooth 2 longest of all teeth, slightly or strongly anastomosed to adjacent teeth, recurved to left, bulbous in distal region, tapered in proximal region; parieto-angular tooth 3 semicircular, partially anastomosed to adjacent teeth, forming minute apical space between them or completely anastomosed to adjacent teeth not forming space between them; angular tooth moderately long, with similar thickness along its length, slightly recurved to right, connected in distal region or completely anastomosed to parieto-angular tooth 2. Palatal region with four well-spaced, rounded teeth – suprapalatal tooth minute, tubercular (inconspicuous in some shells); upper palatal tooth and interpalatal tooth semicircular, with similar size; lower palatal tooth semicircular, larger and more robust among palatal teeth. Basal tooth low, semicircular. Columellar tooth semicircular, strong, thick, moderately long, oblique (diagonal) or perpendicular to columellar axis, located at about midpoint of columellar wall. Columellar tooth and lower palatal tooth similar in size and outline.

Description: Shell dextral, whitish to light cream, thin, minute (length about 1.2 mm), pupilloid-conical (Figs. 2A-C), surface worn (mostly devoid of periostracum) marked by growth striations (Fig. 2E). Apex obtuse, blunt, strongly domed. Protoconch smooth, bulbous, blunt, with about 1.5 whorl; proto-teleoconch transition marked by faint edge (Fig. 2E). Spire weakly convex (about 45% of total length), blunt-obtuse (Figs. 2A-C). Teleoconch with 3.5 to 4.0 inflated, globose, greatly convex whorls, rather increasing conspicuously in size; sculptured by closely spaced, rather regular, faint, fine, prosocline axial riblets visible on an unworn surface (Figs. 2A-C, E). Body whorl with about 55% of total length, expanded, oval, width with about 60% of total length of shell (Fig. 2A), contour strongly projected to left in ventral view (Fig. 2A), lateral view with depression (Fig. 2B). Umbilicus large and rounded. Suture deeply impressed, oblique (diagonal) to columellar axis (Figs. 2A-C, E). Peristome subcircular (not virtually complete) very slightly reflexed on columellar and parietal areas (parietal callus slightly distinct, thin). Lip thin, narrow. Aperture subcircular, about 35% of total length. Apertural barriers with 11 very strongly developed teeth (except suprapalatal tooth) greatly obstructing aperture, not extending to lip margin. Parietal to angular region with five teeth – infraparietal tooth apparently semicircular, completely anastomosed with parieto-angular tooth 1; parieto-angular tooth 2 longest of all teeth, slightly or strongly anastomosed to adjacent teeth, recurved to left, bulbous in distal region, tapered in proximal region; parieto-angular tooth 3 semicircular, partially anastomosed to adjacent teeth, forming minute apical space between them (Fig. 2D) or completely anastomosed to adjacent teeth not forming space between them; angular tooth moderately long, with similar thickness along its length, slightly recurved to right, connected in distal region (Fig. 2D) or completely anastomosed to parieto-angular tooth 2. Palatal region with four well-spaced, rounded teeth – suprapalatal tooth minute, tubercular (inconspicuous in some shells); upper palatal tooth and interpalatal tooth semicircular, with similar size; lower palatal tooth semicircular, larger and more robust among palatal teeth. Basal tooth low, semicircular. Columellar tooth semicircular, strong, thick, moderately long, oblique (diagonal) (Fig. 2D) or perpendicular (Fig. 2A) to columellar axis, located at about midpoint of columellar wall. Columellar tooth and lower palatal tooth similar in size and outline (Figs. 2A, D).

Distribution: Known only from the municipality of Cajazeiras, Paraíba, Brazil.

Remarks: The shell morphology of *Gastrocopta joaoherminioi* **sp. nov.** differs substantially from the native and invasive congeners of Brazil, mainly in the greatly convex whorls (Figs. 2A-C) as well as in the number and configuration of apertural barriers (Fig. 2D). The shell morphology of *G. joaoherminioi* **sp. nov.** and *G. sharae* correspond in their pupilloid-conical shape, markedly convex whorls associated with a deep suture and strongly developed apertural dentition. These species also have a columellar tooth and lower palatal tooth with similar outline and inclination. *Gastrocopta joaoherminioi* **sp. nov.** differs markedly from *G. sharae* due to the presence of 11 apertural barriers that greatly obstruct the region (Fig. 2D). In contrast, this cave gastrocoptid discovered in the state of Goiás (Central-West of Brazil) only have four apertural barriers (upper palatal tooth, lower palatal tooth, columellar lamella and anguloparietal lamella) (Salvador *et al.,* 2017: 136-139, figs. 2-6). The new species has infraparietal tooth, three parieto-angular teeth, suprapalatal tooth, interpalatal tooth and basal tooth (Fig. 2D), which are non-existent in *G. sharae* (Salvador *et al.,* 2017: 136-139, figs. 2-6).

Gastrocopta joaoherminioi **sp. nov.** and *G. aliciae* Miquel & Brito, 2019 [from the Galapagos Islands (Ecuador)] have strongly developed teeth greatly obstructing aperture. Both species also share similar arrangement and strength of the columellar tooth, parietoangular tooth and angular tooth. The new species differs sub-

stantially from *G. aliciae* in having greatly convex teleoconch whorls, a greater number of teeth in the parietal region and absence of supracolumellar and subcolumellar teeth.

Gastrocopta joaoherminioi **sp. nov.** has 11 strongly developed teeth greatly obstructing aperture (Figs. 2A, D) while *G. crucifera* Hylton Scott, 1948 and *G. pulvinata* Hylton Scott, 1948 [both from Argentina] have six to seven apertural barriers that do not obstruct the aperture. The new species has a columellar tooth located at about midpoint of columellar wall (Figs. 2A, D), while *G. crucifera* and *G. pulvinata* have columellar tooth located near the infraparietal region (Hylton Scott, 1948: 245, fig. 1; 246, fig. 2, respectively). *Gastrocopta joaoherminioi* **sp. nov.** has a well-developed basal tooth (Figs. 2A, D), while it is absent in *G. crucifera* (Hylton Scott, 1948: 245, fig. 1). The aperture of *G. joaoherminioi* **sp. nov.** has three well-developed parieto-angular teeth and four palatal teeth (Fig. 2A, D), while aperture of *G. pulvinata* presents only one parieto-angular tooth and two palatal teeth (Hylton Scott, 1948: 246, fig. 2).

Gastrocopta caatinga sp. nov.
(Fig. 3)

Type material: Holotype – UFPB.MOL-44075 (Fig. 3); paratypes – UFPB.MOL-44076 (1 shell) and CM-PHRM7522B (1 shell), all from type locality.

Type locality: Brazil, Paraíba, municipality of São José de Piranhas, EAEP, sampling area 17, 06°59′23″S, 38°27′28″W (404 m), litter (leaf and soil), 10.II.2018, Evandro C.T. Abreu collector.

Etymology: The specific name honors the phytogeographic domain of the *Caatinga* – from the Tupi-Guarani, meaning "white forest" referring to the landscape consisting of leafless vegetation and whitish trunks typical of the dry season, or a large geographic area covering the greater part of northeastern Brazil characterized by the variety of vegetation cover, which is usually deciduous and hyperxerophilic.

Diagnosis: Apertural barriers with four teeth that do not obstruct the region (except for projection of parieto-angular tooth). Parieto-angular tooth longest of all teeth, slightly bifid, recurved to right, located at midpoint of parietal region. Upper palatal tooth minute. Lower palatal tooth rounded, second biggest tooth. Columellar tooth low, semicircular, slightly oblique (diagonal) to columellar axis, located at midpoint of columellar wall.

Description: Shell dextral, whitish to light cream, thin, minute (length about 1.2 mm), ovoid (Figs. 3A-C). Apex cap shape, apically subflattened. Protoconch worn, apparently smooth, with about 1.5 whorl; proto-teleoconch transition marked by faint edge and appearance of numerous, faint growth striations (Fig. 3E). Spire moderately convex (about 60% of total length). Teleoconch with about 4 inflated, globose, moderately convex whorls, increasing moderately in size, sculptured by closely spaced, rather regular, faint, fine, prosocline axial riblets visible on unworn surface (Figs. 3A-C). Body whorl with about 40% of total length, expanded, strongly oval, width about 68 to 69% of total length of shell (Figs. 3A-C). Umbilicus large and rounded. Suture well impressed, moderately deep, slightly oblique (diagonal) to columellar axis (Figs. 3A-C). Peristome slightly reflexed (little more prominent on columellar area), rounded in columellar to lower palatal area, flattened in upper palatal area; suprapalatal region with distinct angulation. Lip moderately thickened, narrow. Aperture subsquare, about 37 to 38% of total length. Apertural barriers with four teeth that do not obstruct region (except for projection of parieto-angular tooth), not extending to lip margin. Parieto-angular tooth longest of all teeth slightly bifid, recurved to right located at midpoint of parietal region. Upper palatal tooth minute. Lower palatal tooth rounded, second larger tooth. Columellar tooth low, semicircular, slightly oblique (diagonal) to columellar axis, located at midpoint of columellar wall (Figs. 3A, C-D).

Geographical distribution: Known only from the municipality of São José de Piranhas, Paraíba, Brazil.

Remarks: *Gastrocopta caatinga* **sp. nov.** differs substantially from native and invasive Brazilian congeners in having basically an ovoid shape (Figs. 3A-C) and apertural barriers with distinctive size, outline and/or inclination of the dentition (Figs. 3A, D). In Brazilian phytogeographical domains, there is no species of *Gastrocopta* with shell morphology similar to *G. caatinga* **sp. nov.**

The new species superficially resembles *G. barbadensis* [Cunha *et al.,* 2015: fig. 2D], *G. iheringi* [Simone, 2006: fig. 346], *G. oblonga* [Simone, 2006: fig. 347] and *G. solitaria* [Simone, 2006: fig. 349] in the outline of the teleoconch whorls; *G. barbadensis* in the distinct angulation of the suprapalatal region; *G. oblonga* in its subsquare aperture; and *G. sharae* [Salvador *et al.,* 2017: figs. 2-6] in the arrangement of teeth on the columellar and palatal areas.

DISCUSSION

The new species were found in a dense layer of leaf litter (Fig. 1B) on sandy soil at a semi-open dry tropical forest habitat composed of shrubs (*e.g., Croton jacobinensi* and *Jatropha mollissima* – Euphorbiaceae) and mainly trees (*e.g., Anadenanthera colubrina, Mimosa arenosa, M. tenuiflora, Piptadenia moniliformis, P. retusa* and *Senegalia polyphylla* – Fabaceae; *Cochlospermum vitifolium* – Cochlospermaceae; *Astronium urundeuva* – Anacardiaceae) (Figs. 1A, C), which partially shaded the site (Fig. 1B).

The shells of *Gastrocopta joaoherminioi* **sp. nov.** and *G. caatinga* **sp. nov.** presented a remnant of periostracum and axial riblets visible only on an unworn surface (Figs. 2-3), probably due to wear caused by the biodegra-

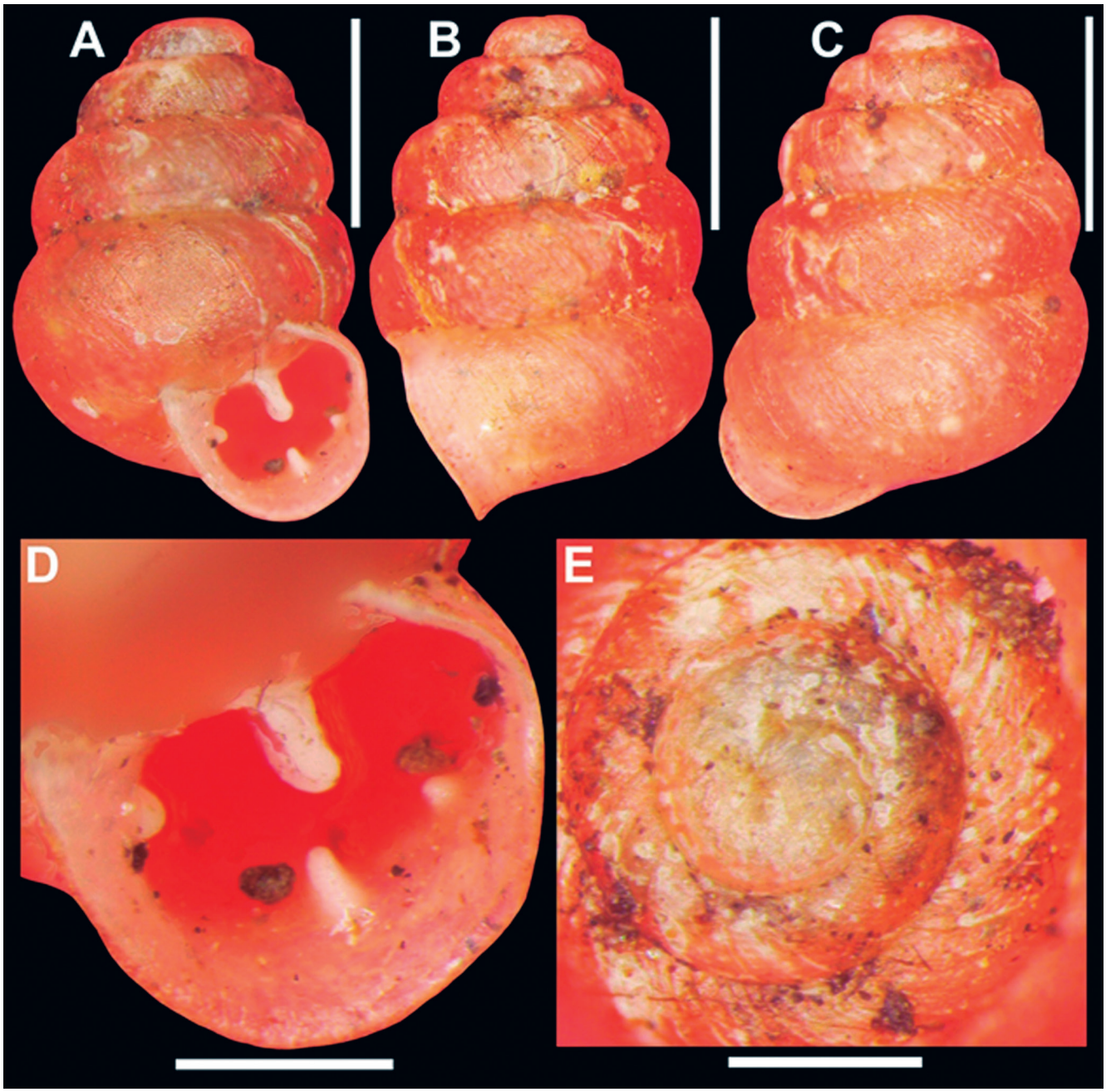

Figure 3. *Gastrocopta caatinga* **sp. nov.** (holotype) collected from the EAEP: (A) Ventral view, (B) Right view, (C) Dorsal view, (D) Detail of aperture, (E) View of protoconch. Scale bars: A-C = 0.5 mm, D-E = 0.2 mm.

dation of dead organic matter in the soil and some bearing on the studied region. It is worth highlighting that the topography of the collection site does not allow the transport of the examined shells to a remote area with distinct environmental features and the collection environment is not composed of soils rich in calcium carbonates.

The new species were found in one of the least anthropic sites of an ecological park. EAEP suffers anthropogenic impacts due to agricultural practices and the planting of invasive exotic vegetation. Shrub and tree seedlings are widely transported by humans between regions of the phytogeographical domains of northeastern Brazil (including within the boundaries of the EAEP). This provides immense potential for the accidental spread of exotic and invasive land snails in Brazil (Abreu *et al.,* 2024). The new species of *Gastrocopta* have very distinctive conchological characteristics (Figs. 2-3) when comparing native/invasive congeners of Brazil (Simone, 2006: figs. 346-350; Veitenheimer-Mendes & Oliveira, 2012: figs. 1-4; Kotzian & Amaral, 2013: figs. 6g-i; Cunha *et al.,* 2015: fig. 2D; Salvador *et al.,* 2017: figs. 2-11; Batistão *et al.,* 2021: fig. 2; Miranda *et al.,* 2023: fig. 2) and other geographic ecoregions (Nekola & Coles, 2010: figs. 1-2; Brito & Miquel, 2022: figs. 2-3, 5, 7-8, 10, 12-13, 15).

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