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**Research article**

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# Iron-isopods: new records and new species of terrestrial isopods (Isopoda, Oniscidea) from Brazilian Amazon iron ore caves

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**Abstract.** Two new species of terrestrial isopods are described from iron ore caves in Brazil, within the Amazon biome, *Circoniscus mendesi* López-Orozco, Campos-Filho & Bichuette sp. nov. and *C. xikrin* López-Orozco, Campos-Filho & Carpio-Díaz sp. nov. (Scleropactidae). In addition, the knowledge of the distribution of *Ctenorillo ferrarai* Campos-Filho, Araujo & Taiti, 2014 (Armadillidae) is extended to Parauapebas, and *Benthanoides tarzan* Cardoso & Ferreira, 2023 to south area of the Campos Ferruginosos National Park, both in the State of Pará. Moreover, a distribution map and photographs of the species are given.

**Keywords.** Neotropical, iron caves, Parauapebas, Canaã dos Carajás, woodlice.

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## Introduction

Terrestrial isopods (Oniscidea) represent one of the most diverse groups among crustaceans, including more than 4000 species in more than 500 genera in 38 or 39 families (Schmalfuss 2003; Taiti 2004; Javidkar *et al*. 2015; Sfenthourakis & Taiti 2015; Dimitriou *et al*. 2019). Of these species, more than 300 have been recorded from subterranean environments around the world (e.g., Vandel 1973; Taiti & Gruber 2008; Bedek *et al*. 2011; Taiti & Xue 2012; Tabacaru & Giurginca 2013; Reboleira *et al*. 2015).

To date, more than 230 species of terrestrial isopods are known from Brazil, being the country with the higher diversity of Oniscidea within the Neotropical region (see Campos-Filho *et al*. 2018, 2019, 2020; Cardoso *et al*. 2020a, 2020b, 2021). In the last decade, the knowledge of the diversity of oniscideans associated with subterranean environments considerably increased in the Brazilian territory, from six species in 2011 to 78 in 2023 (Campos-Filho *et al*. 2018, 2019, 2020, 2022a, 2022b, 2023; Cardoso *et al*. 2020a, 2020b, 2021, 2023). Moreover, among them, more than 40 are considered obligatory cave-dwellers, representing more than 50% of the current diversity (Campos-Filho *et al*. 2018, 2019, 2020, 2022a, 2022b, 2023; Fernandes *et al*. 2019; Cardoso *et al*. 2020a, 2020b, 2021, 2023).

The Amazon biome has a great diversity of terrestrial isopods, which makes an important link between the evolutionary aspects of the group in the Neotropics (Lemos de Castro 1984; Leistikow 1999, 2001; Schmidt & Leistikow 2005; Schmidt 2007; Grangeiro *et al*. 2010, 2017, 2021). Regarding the cave fauna of the State of Pará, 18 species in the families Trichoniscidae Sars, 1899, Philosciidae Kinahan, 1857, Scleropactidae Verhoeff, 1938, Dubioniscidae Schultz, 1995, Platyarthridae Verhoeff, 1949, and Armadillidae Brandt, 1833 are currently known, of which eight are considered troglobitic, viz. *Benthana alba* Cardoso & Ferreira, 2023, *Benthanoides amazonicus* Cardoso & Ferreira, 2023, *B. tarzan* Cardoso & Ferreira, 2023, *Amazoniscus eleonorae* Souza, Bezerra & Araujo, 2006, *A. leistikowi* Campos-Filho, Araujo & Taiti, 2014, *A. spica* Campos-Filho, Aguiar & Taiti, 2020, *Circoniscus buckupi* Campos-Filho & Araujo, 2011, and *C. carajasensis* Campos-Filho & Araujo, 2011 (Souza *et al*. 2006; Campos-Filho & Araujo 2011; Campos-Filho *et al*. 2014, 2020; Cardoso & Ferreira 2023).

The present study aims to describe two new species of terrestrial isopods from Brazilian iron ore caves within the Amazon biome, State of Pará: *Circoniscus mendesi* López-Orozco, Campos-Filho & Bichuette sp. nov. and *C. xikrin* López-Orozco, Campos-Filho & Carpio-Díaz sp. nov. (Scleropactidae). In addition, the knowledge of the distribution of *Ctenorillo ferrarai* Campos-Filho, Araujo & Taiti, 2014 (Armadillidae) and *B. tarzan* (Philosciidae) is extended.

## Material and methods

### Study area

The specimens were collected in iron caves of Mineral Province Carajás, in the municipalities of Canaã dos Carajás and Parauapebas, State of Pará, corresponding to the Equatorial Amazonian Domain, at elevations of 600–800 m a.s.l. (Fig. 1A). The Carajás National Forest (FLONA de Carajás, from Portuguese *Floresta Nacional de Carajás*) and Campos Ferruginosos National Park (PARNA dos Campos Ferruginosos from Portuguese *Parque Nacional dos Campos Ferruginosos*) have a high rate of endemism and more than 2000 caves (Campos & Castilho 2012; Piló *et al*. 2015). The vegetation is composed of dense tropical rainforest and canga (savanna systems established on ferrous soils) (Mota

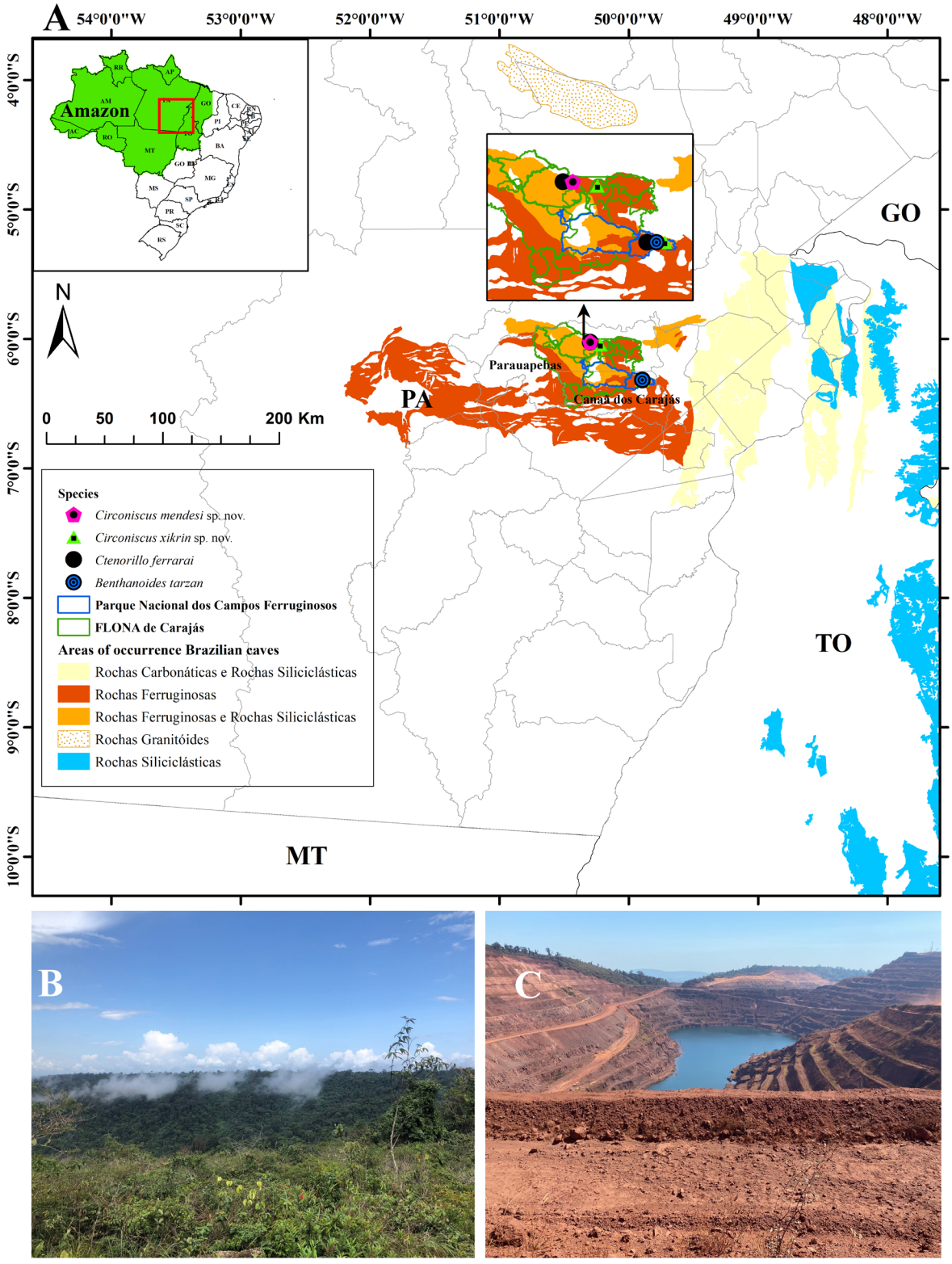


**Fig. 1.** Study area. **A**. Distribution of the species. **B**. Vegetation of FLONA de Carajás. **C**. Mineral exploitation mine.

*et al*. 2015). The region has a humid tropical climate, with a rainy period from November to April and a dry season from June to September, an average annual precipitation of over 1500 mm, and an average annual temperature of about 25°C (Köppen 1948; Kottek *et al*. 2006) (Fig. 1B). Although the cavities are inserted in conservation units, mineral exploitation is allowed on FLONA de Carajás, and the largest iron ore mine in the world is there, placing these cave systems under a high level of threat (Fig. 1C) (Carmo *et al*. 2012; ICMBIO 2020).

**Collections and taxonomy**

Specimens were collected by active search with the aid of tweezers and brushes, and stored in 75% ethanol. Information about the microhabitat of the caves was also recorded. The identifications are based on morphological characters with the use of micropreparations in Hoyer's medium (Anderson 1954). For each new species, the diagnosis, etymology, type material, description, and remarks are given. The illustrations were made with the aid of a camera lucida mounted on Zeiss Stemi SV6 stereo microscope and Leica DMLS microscope. The final illustrations were prepared using the software GIMP (ver. 2.8) with the method proposed by Montesanto (2015, 2016).

The material examined is deposited in the Collection of the Laboratório de Estudos Subterrâneos (LES), Universidade Federal de São Carlos, São Carlos, Brazil (curator: Maria E. Bichuette).

## Results

### *Systematic account*

Class Malacostraca Latreille, 1802
Order Isopoda Latreille, 1817
Suborder Oniscidea Latreille, 1802
Family Philosciidae Kinahan, 1857

Genus ***Benthanoides*** Lemos de Castro, 1958

**Type species**

*Benthanoides pauper* (Jackson, 1926), by original designation (see Schmidt & Leistikow 2004).

***Benthanoides tarzan*** Cardoso & Ferreira, 2023
Fig 1

*Benthanoides tarzan* Cardoso & Ferreira, 2023: 557, figs 2g, 3d, 8–9.

**Material examined**

BRAZIL – **Pará, Canaã dos Carajás** • 1 ♂; SB_0049 cave (also registered as GEM 1460 and known as Samuel II); 6°18′58.4″ S, 49°53′41.1″ W; 629 m a.s.l.; 16 Feb. 2022; J.E. Gallão, J.S. Gallo, D.F. Torres and V.F. Sperandei leg.; part in micropreparations; LES 0028764.

**Distribution**

Presently known from several caves on central part of the PARNA dos Campos Ferruginosos (Cardoso & Ferreira 2023). This work expands its distribution to the southern zone of the park, in SB_0049 cave (also registered as GEM 1460 and known as Samuel II by local people) (Fig. 1).

Family Scleropactidae Verhoeff, 1938

Genus ***Circoniscus*** Pearse, 1917

**Type species**

*Circoniscus gaigei* Pearse, 1917, by monotypy (see Schmidt & Leistikow 2004).

***Circoniscus mendesi*** López-Orozco, Campos-Filho & Bichuette sp. nov.
urn:lsid:zoobank.org:act:5AEA1F23-397B-4C4B-A423-3659311F11C8
Figs 1–4, 8A–B

**Diagnosis**

Pigment and eyes absent; schisma on pereonite 1 and ventral triangular lobe in pereonite 2; antennula bearing eight lateral aesthetascs arranged in three sets; pleopod 1 and 2 exopods with respiratory areas; pereopod 7 merus bearing triangular lobe on rostral portion; pleopod 5 exopod apex elongated and acute.

**Etymology**

The new species is named after Francisco Alves Mendes Filho, popularly known as Chico Mendes, a rubber tapper and activist who gained an international reputation for the defense of the Amazonian biodiversity. Furthermore, the present name honors all workers of the ICMBio (in Portuguese, Instituto Chico Mendes de Conservação da Biodiversidade), who continue to keep alive Mendes' ideals.

**Material examined**

**Holotype**

BRAZIL – **Pará, Parauapebas** • ♂; CAV-N1-0174; 6°01′27.20″ S, 50°17′54.73″ W; 649 m a.s.l.; 22 Aug. 2021; M.E. Bichuette, J.E. Gallão and D.F. Torres leg.; LES 0028767.

**Paratypes**

BRAZIL – **Pará, Parauapebas** • 1 ♂, 1 ♀; same collection data as for holotype; part in micropreparations; LES 0028768 • 3 ♂♂, 4 ♀♀; same collection data as for holotype; LES 0028769 • 1 ♂, 1 ♀; same locality as for holotype; 12 Feb. 2022; J.E. Gallão, J.S. Gallo, D.F. Torres and V.F. Sperandei leg.; LES 0028770 • 3 ♂♂; same collection data as for preceding; LES 0028771.

**Description**

Measurements. Maximum body length: male 5 mm, female 6 mm.

Body. Color pale yellowish, with typical muscle spots insertions. Exoantenal conglobation (Fig. 2A); body strongly convex (Fig. 2A); dorsal surface smooth, bearing small triangular scale-setae (Fig. 2B). Noduli laterales not discernible at 400× magnification.

Cephalon. Wider than long, frontal shield obtuse on medial upper margin and straight lateral margins, lateral lobes and eyes absent (Fig. 2C–E).

Pereon. Pereonite 1 epimera with schisma, anterior corners directed frontwards (Fig. 2A, E–F); pereonite 2 with ventral triangular lobes, epimera with outer margin rounded (Fig. 2A, E–F); pereonites 3–4 epimera with outer margin rounded (Fig. 2A); pereonites 5–7 epimera subquadrangular (Fig. 2A).

Pleon. Pleonites 3–5 epimera with outline continuous with that of pereonite 7, apex acute and directed backwards (Fig. 2G); telson triangular, slightly broader than long, with slightly concave sides, rounded apex (Fig. 2G).

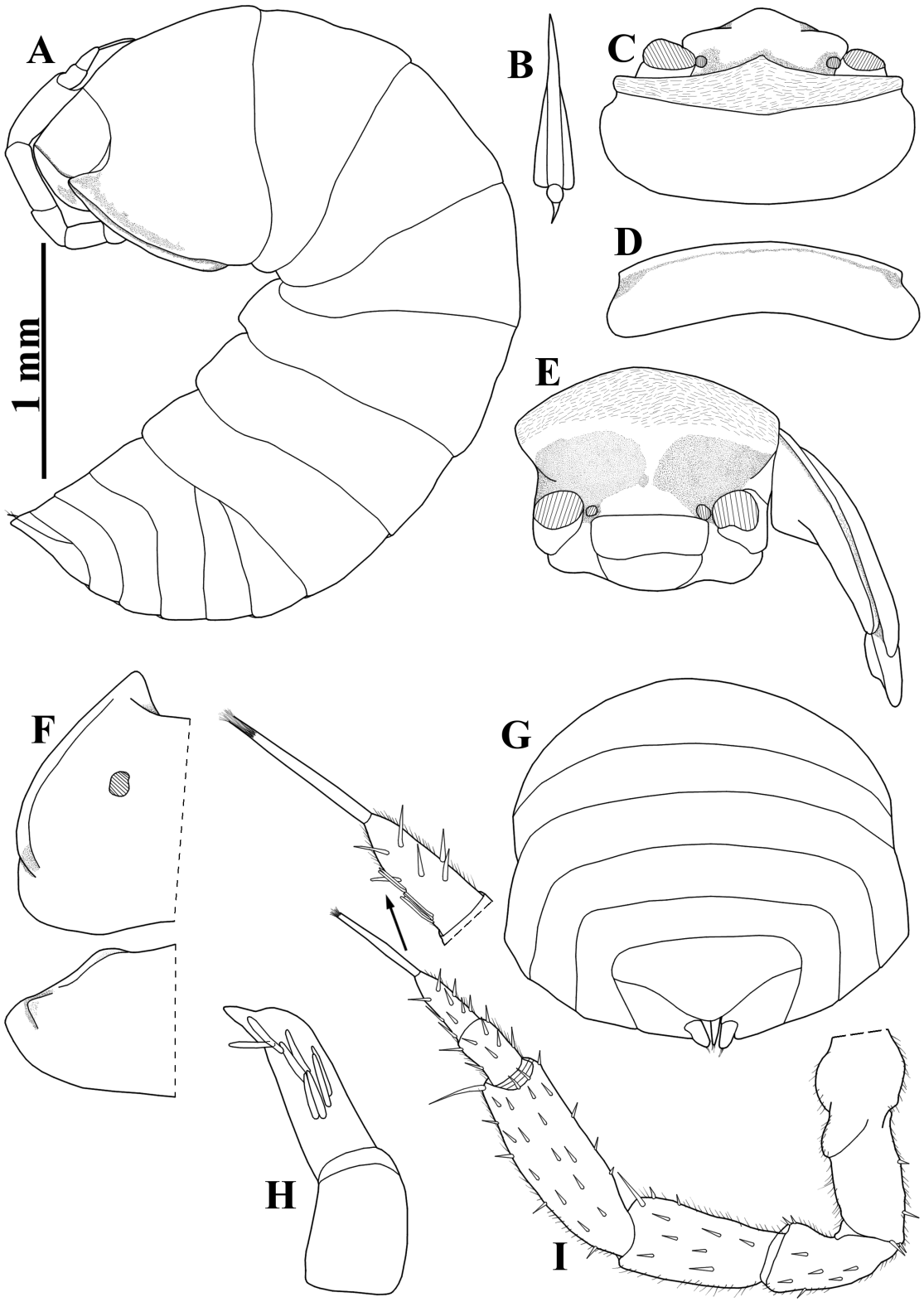


**Fig. 2.** *Circoniscus mendesi* López-Orozco, Campos-Filho & Bichuette sp. nov., ♀, paratype (LES 0028768). **A**. Habitus, lateral view. **B**. Dorsal scale-seta. **C**. Cephalon, dorsal view. **D**. Cephalon, back view. **E**. Cephalon and pereonites 1 and 2, frontal view. **F**. Pereonite 1 and 2 epimera, ventral view. **G**. Pleonites 3–5, telson and uropods. **H**. Antennula. **I**. Antenna, with flagellum detail.

Antennula. Composed of three articles, distal article longest and conical, bearing eight lateral aesthetascs arranged in three sets and apical tip (Fig. 2H).

Antenna. Short and stout, not surpassing pereonite 1 when extended backwards; flagellum consisting of two subequal articles, distal article bearing seven lateral aesthetascs in two groups; apical organ longer than distal article of flagellum (Fig. 2I).

Mouth. Mandibles with molar penicil of many branches; left mandible (Fig. 3A) with 2 + 1 free penicils, right mandible (Fig. 3B) with 1 + 1 penicils. Maxillula (Fig. 3C) inner endite with two apical penicils, distal margin bearing outer tip; outer endite with 5 + 5 teeth, inner set with four teeth apically cleft.

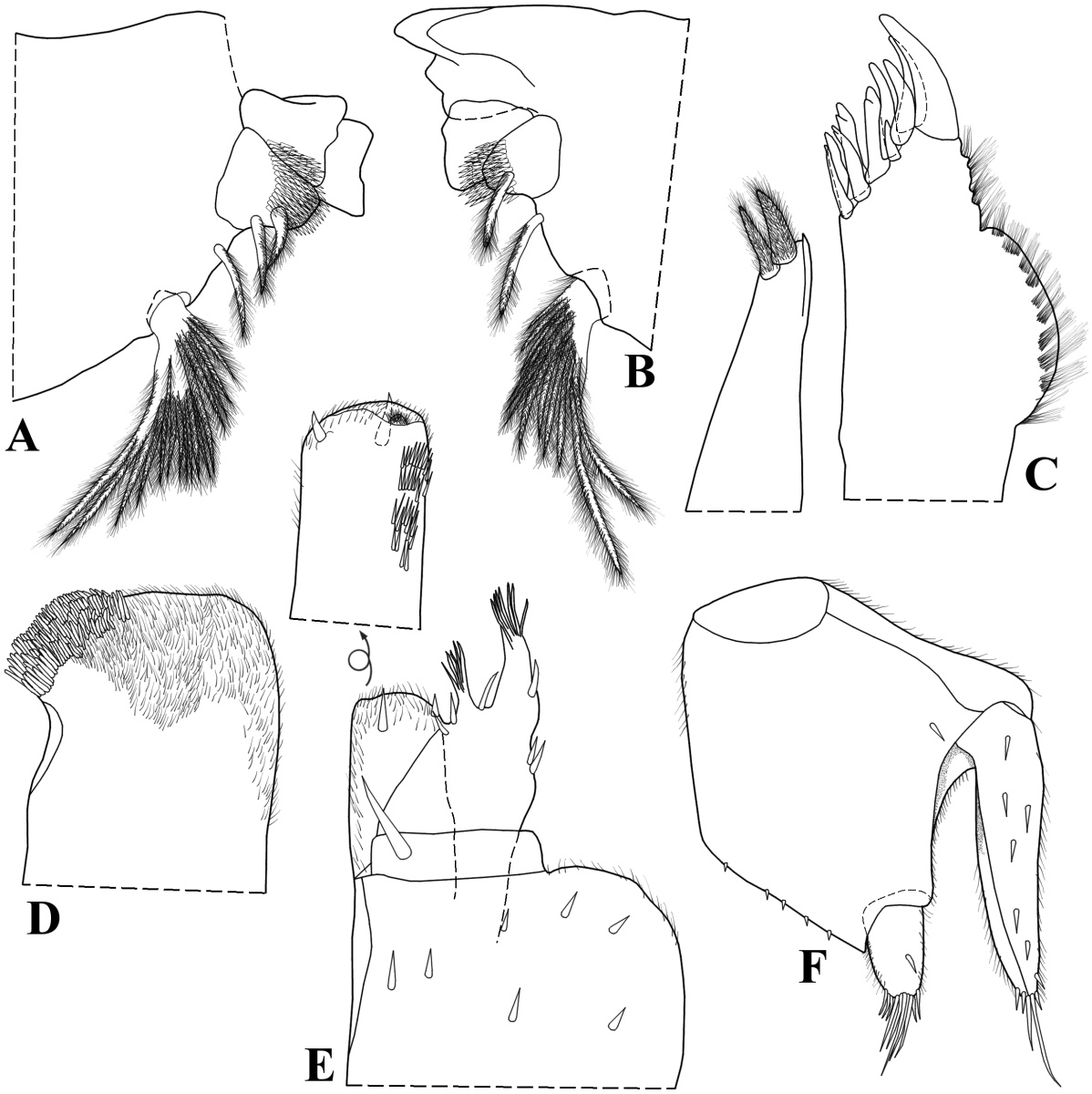


**Fig. 3.** *Circoniscus mendesi* López-Orozco, Campos-Filho & Bichuette sp. nov., ♀, paratype (LES 0028768). **A**. Left mandible. **B**. Right mandible. **C**. Maxillula. **D**. Maxilla. **E**. Maxilliped, arrow illustrating the endite in caudal view. **F**. Uropod. Figure not to scale.

Maxilla (Fig. 3D) inner lobe rounded and covered with thick setae; outer lobe about twice as wide as inner lobe, covered with thin setae. Maxilliped (Fig. 3E) basis rectangular bearing sparse scale-setae; palp with one setae on proximal article, medial and distal articles with two tufts of setae; endite subrectangular, medial seta long, surpassing distal margin, distal margin covered with thin setae and bearing one seta on outer portion, rostral surface with setose sulcus ending with one short penicil.

Uropod. Protopod flattened and enlarged, filling gap between pleonite 5 and telson, surpassing distal margin of telson; exopod inserted on median margin, endopod twice as long as exopod and inserted proximally (Fig. 3F).

Pereopod 1. Carpus short, transverse antennal grooming brush; dactylus with inner claw surpassing median portion of outer claw, ungual seta and dactylar organ simple, surpassing distal margin of outer claw (Fig. 4A).

Pleopod exopods. Pleopod 1 and 2 exopods with respiratory areas.

**Male**

Pereopod 1. Without particular modifications (Fig. 4A).

Pereopod 7. Ischium elongated, sternal margin straight; merus bearing triangular lobe on rostral portion (Fig. 4B).

Genital papilla. Triangular ventral shield and subapical orifices (Fig. 4C).

Pleopods. Pleopod 1 (Fig. 4C) exopod ovoid; endopod about twice as long as exopod and bent outwards, apex acute and bearing small setae along inner margin. Pleopod 2 (Fig. 4D) exopod triangular, outer margin concave with one seta; endopod flagelliform, longer than exopod. Pleopod 3–4 exopods as in Fig. 4E–F. Pleopod 5 (Fig. 4G) exopod triangular, outer margin almost straight with one tiny setae, inner margin covered with small setae, apex elongated and acute.

**Taxonomic remarks**

The genus *Circoniscus* comprises 11 species with a distribution restricted to South America (Schmidt 2007; Campos-Filho *et al*. 2017, 2018, 2023; Ocampo-Maceda *et al*. 2022). To date, except for *Circoniscus pallidus* Arcangeli, 1936, in the State of São Paulo, and *Circoniscus caeruleus* Campos-Filho, Sfenthourakis & Bichuette, 2023, in the state of Mato Grosso, all species are recorded from the State of Pará (Campos-Filho *et al*. 2018, 2023). The genus was morphologically defined by Schmidt (2007). Among the species of the genus, *Circoniscus buckupi* Campos-Filho & Araujo, 2011 and *C. carajasensis* Campos-Filho & Araujo, 2011 are considered troglobitic, with records from several caves in the State of Pará (Campos-Filho & Araujo 2011; Campos-Filho *et al*. 2022c).

In the absence of body pigments and eyes, *C. mendesi* sp. nov. is similar to *C. buckupi* and *C. carajasensis*; however, it can be distinguished by the triangular sternal lobe of the male pereopod 7 merus, and male pleopod 5 exopod acute. The triangular steral lobe on the merus 7 is also present in the species of *Circoniscus* in the paper of Campos-Filho *et al*. (2023) from Gruta Lagoa Azul, Bonito, State of Mato Grosso; however, this species is considered to be a troglophilic with characters easily distinguishable from *Circoniscus mendesi* sp. nov.

**Ecological remarks**

The specimens were collected in the twilight zone, living under rocks, in leaf litter, between roots, and in moist soil (Fig. 11A–B). This species is considered to be troglobitic due to the absence of body pigments and eyes and to the presence of elongated pereopods.


**Fig. 4.** *Circoniscus mendesi* López-Orozco, Campos-Filho & Bichuette sp. nov., ♂, paratype (LES 0028768). **A**. Pereopod 1, arrow illustrating the dactylus in rostral view. **B**. Pereopod 7. **C**. Genital papilla and pleopod 1. **D**. Pleopod 2. **E**. Pleopod 3 exopod. **F**. Pleopod 4 exopod. **G**. Pleopod 5 exopod. Figure not to scale.

**Distribution**

Presently known only from N1_0174 cave, FLONA de Carajás, Parauapebas, Pará, Brazil (Fig. 1).

***Circoniscus xikrin*** López-Orozco, Campos-Filho & Carpio-Díaz sp. nov.
urn:lsid:zoobank.org:act:A22A4823-7BC1-428A-AE59-39C00021300B
Figs 1, 5–7

**Diagnosis**

Pigment and eyes absent; schisma on pereonite 1, pereonite 2 without ventral lobe; telson with acute apex; antennula bearing eleven lateral aesthetascs arranged in six sets; pleopod 1 and 2 exopods with respiratory areas; pereopod 7 ischium elongated, bearing semicircular lobe on rostral portion, merus bearing semicircular lobe on rostral portion; pleopod 5 exopod apex short and acute.

**Etymology**

The new species is named for the Xikrin native people, inhabitants of Terras Indígenas Cateté and Trincheira Bacajá, State of Pará.

**Material examined**

**Holotype**

BRAZIL – **Pará, Canaã dos Carajás** • ♂; SB_0049 cave (also registered as GEM 1460 and known as Samuel II by local people); 6°18′58.4″ S, 49°53′41.1″ W; 629 m a.s.l.; 16 Feb, 2022; J.E. Gallão, J.S. Gallo, D.F. Torres and V.F. Sperandei leg.; part in micropreparations; LES 0028772.

**Paratype**

BRAZIL – **Pará, Parauapebas** • 1 ♀; N3_0026 cave; 6°02′40.3″ S, 50°13′10.6″ W; 18 Feb. 2022; same collectors as for holotype; LES 0028773.

**Description**

Measurements. Maximum body length: male 5.8 mm, female 6 mm.

Body. Color pale yellowish, with typical muscle spots insertions. Exoantennal conglobation (Fig. 5A); body strongly convex (Fig. 5A); dorsal surface smooth, bearing small fan-shaped scale-setae (Fig. 5B). Noduli laterales not discernible at ×400 magnification.

Cephalon. Wider than long, frontal shield obtuse on medial upper margin and straight lateral margins, lateral lobes and eyes absent (Fig. 5C–E).

Pereon. Pereonite 1 epimera with schisma, anterior corners directed frontwards (Fig. 5A, E–F); pereonite 2 without ventral lobes, epimera with outer margin rounded (Fig. 5A, E–F); pereonites 3–4 epimera with outer margin rounded (Fig. 5A); pereonites 5–7 epimera subquadrangular (Fig. 5A).

Pleon. Pleonites 3–5 epimera with outline continuous with that of pereonite 7, apex acute and directed backwards (Fig. 5G); telson triangular, broader than long, with slightly concave sides, acute apex (Fig. 5G).

Antennula. Composed of three articles, distal article longest, conical, proximal portion protruding, bearing 11 lateral aesthetascs arranged in six sets plus apical tip (Fig. 5H).

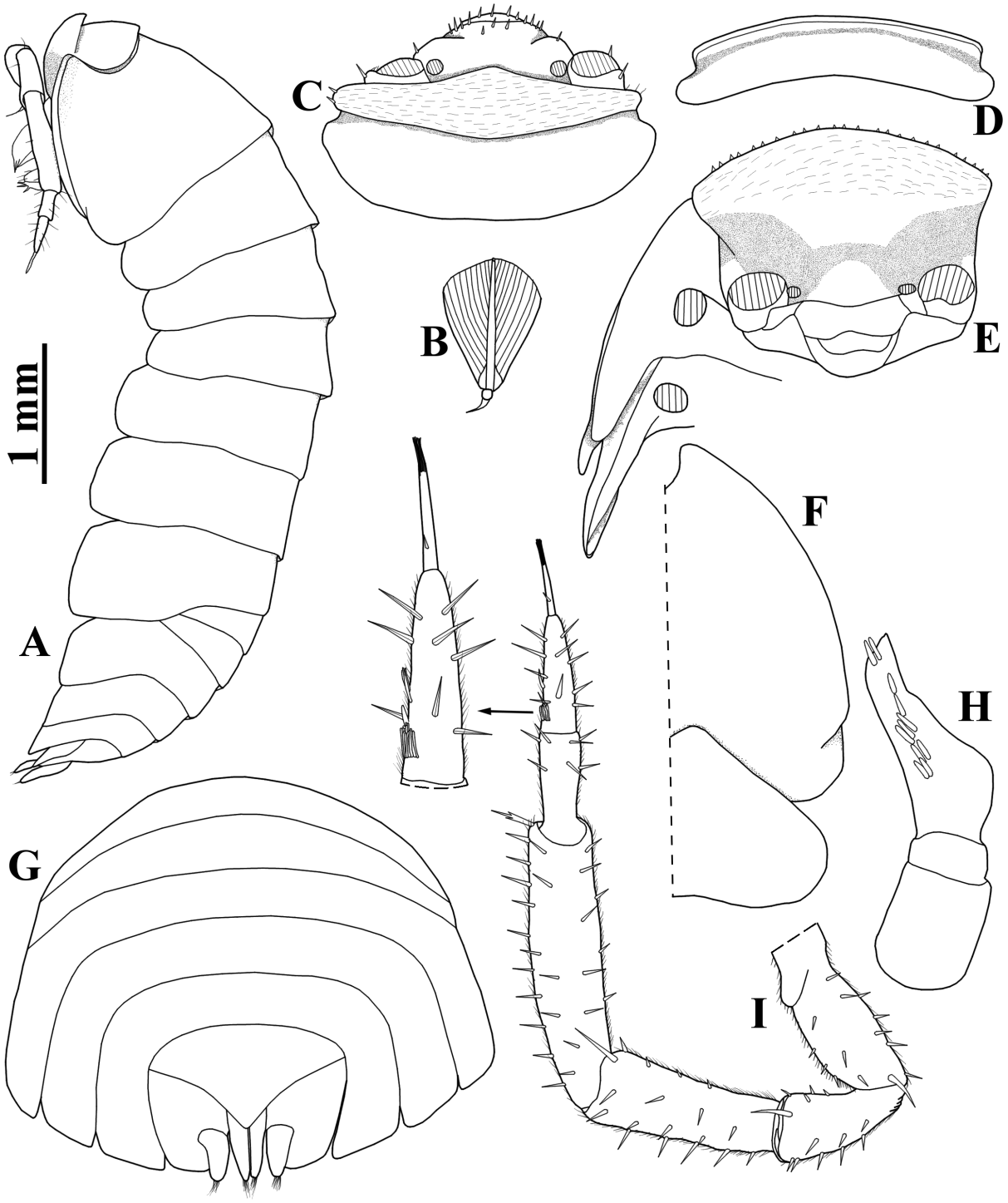


**Fig. 5.** *Circoniscus xikrin* López-Orozco, Campos-Filho & Carpio-Díaz sp. nov., ♂, holotype (LES 0028772). **A**. Habitus, lateral view. **B**. Dorsal scale-seta. **C**. Cephalon, dorsal view. **D**. Cephalon, back view. **E**. Cephalon and pereonites 1 and 2, frontal view. **F**. Pereonite 1 and 2 epimera, ventral view. **G**. Pleonites 3–5, telson and uropods. **H**. Antennula. **I**. Antenna, with flagellum detail.

Antenna. Short and stout, not surpassing pereonite 2 when extended backwards; flagellum consisting of two subequal articles, distal article bearing 17 lateral aesthetascs in two groups; apical organ short than distal article of flagellum (Fig. 5I).

Mouth. Mandibles with molar penicil of seven branches; left mandible (Fig. 6A) with 2+1 free penicils, right mandible (Fig. 6B) with 1+1 penicils. Maxillula (Fig. 6C) inner endite with two apical penicils, distal margin bearing outer tip; outer endite with 4+6 teeth, inner set with four teeth apically cleft. Maxilla (Fig. 6D) inner and outer lobe rounded and covered with thick setae. Maxilliped (Fig. 6E) as in *C. mendesi* sp. nov.

Uropod. Protopod flattened and enlarged, filling gap between pleonite 5 and telson, surpassing distal margin of telson; exopod inserted on median margin; endopod short, twice as long as exopod and inserted proximally (Fig. 6F).

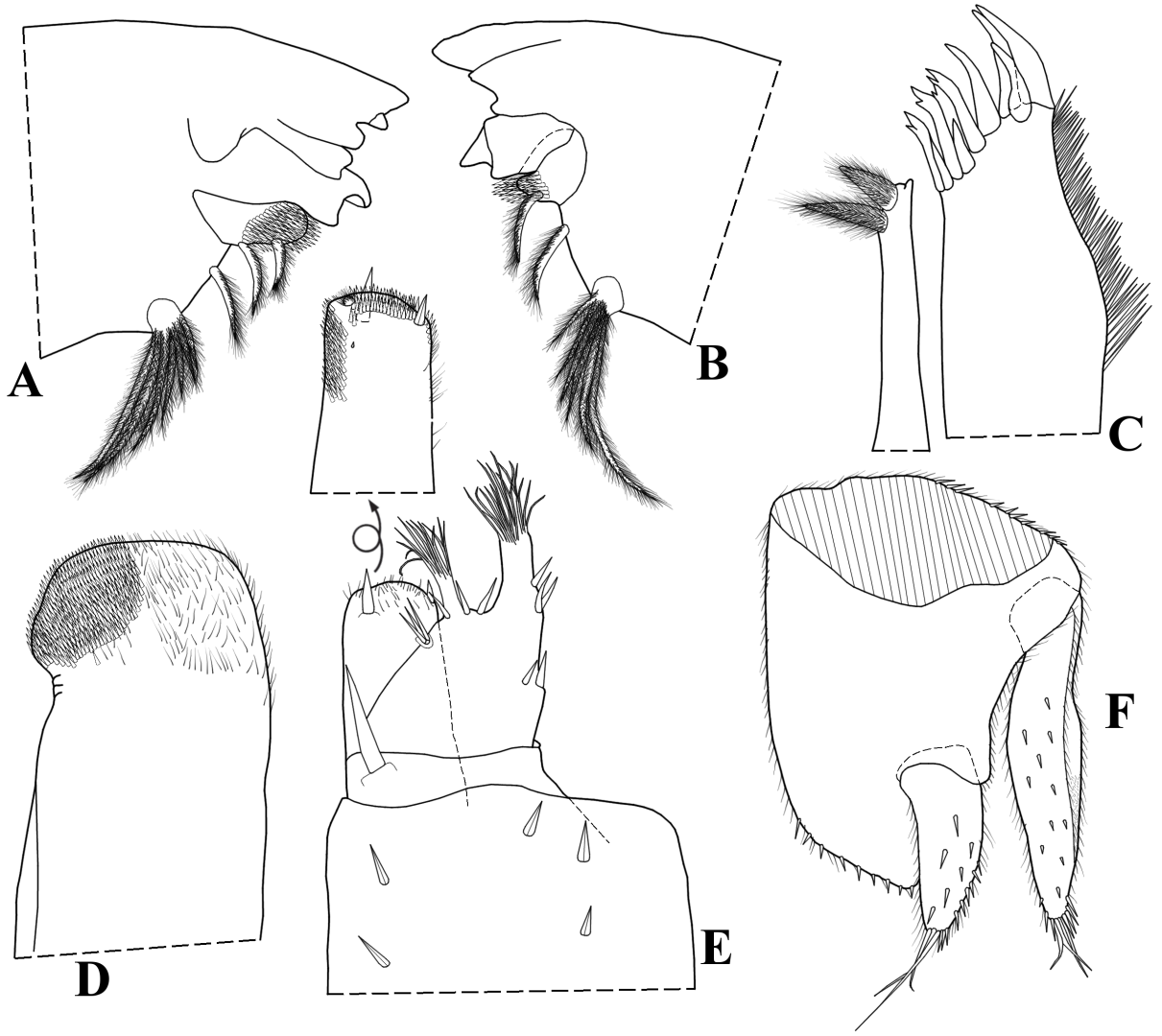


**Fig. 6.** *Circoniscus xikrin* López-Orozco, Campos-Filho & Carpio-Díaz sp. nov., ♂, holotype (LES 0028772). **A**. Left mandible. **B**. Right mandible. **C**. Maxillula. **D**. Maxilla. **E**. Maxilliped, arrow illustrating the endite in caudal view. **F**. Uropod. Figure not to scale.

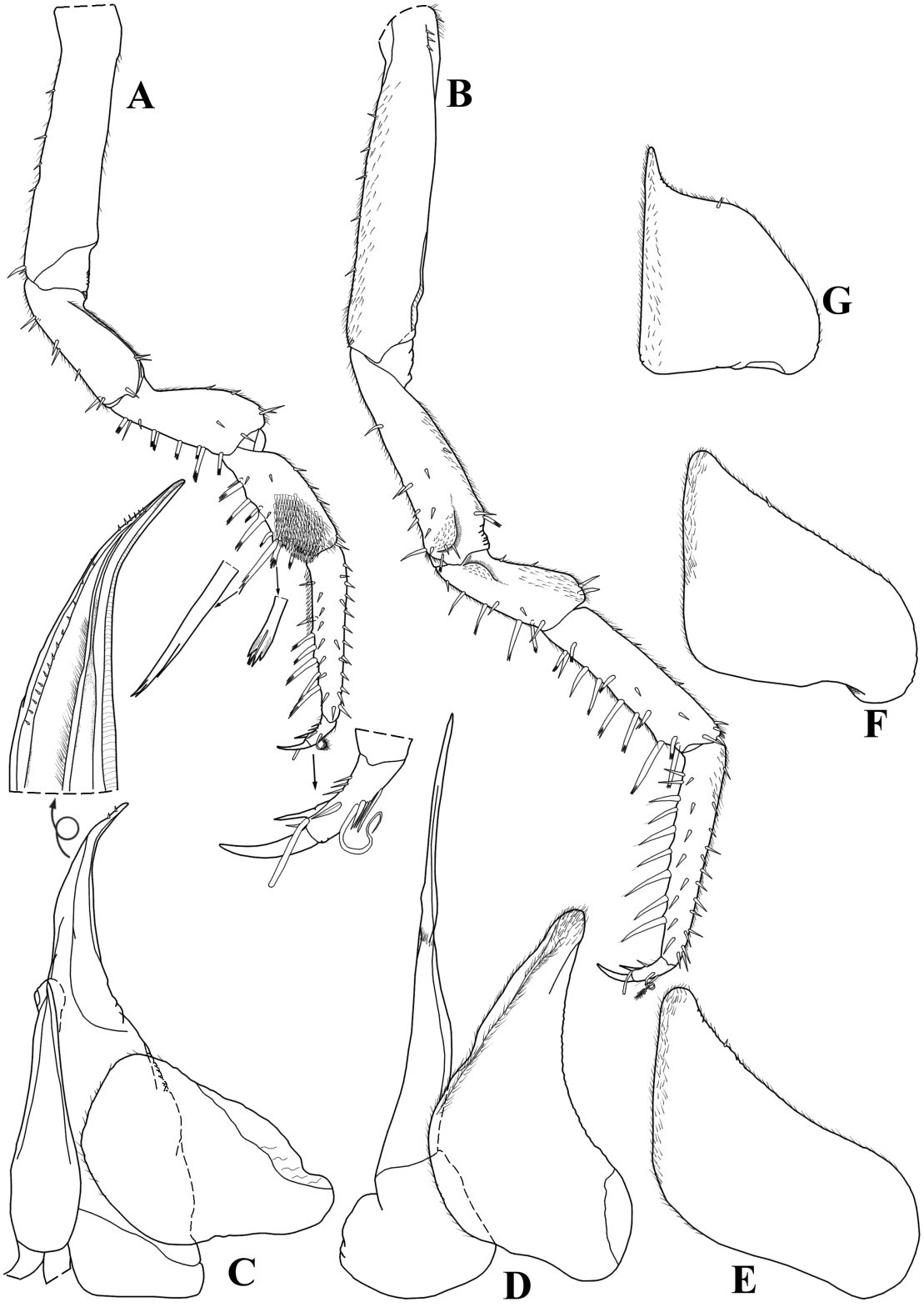


**Fig. 7.** *Circoniscus xikrin* López-Orozco, Campos-Filho & Carpio-Díaz sp. nov., ♂, holotype (LES 0028772). **A**. Pereopod 1, arrow illustrating the dactylus in rostral view. **B**. Pereopod 7. **C**. Genital papilla and pleopod 1. **D**. Pleopod 2. **E**. Pleopod 3 exopod. **F**. Pleopod 4 exopod. **G**. Pleopod 5 exopod. Figure not to scale.

Pereopod 1. Elongated, carpus short, transverse antennal grooming brush; dactylus with inner claw not surpassing median portion of outer claw, ungual seta, and dactylar organ simple not surpassing distal margin of outer claw (Fig. 7A).

Pleopod exopods. Pleopod 1 and 2 exopods with respiratory areas.

**Male**

Pereopod 1. Without particular modifications (Fig. 7A).

Pereopod 7. Basis and ischium elongated, sternal margin straight, with one semicircular lobe on distal portion in rostral view; merus bearing semicircular lobe in proximal portion in rostral view (Fig. 7B).

Genital papilla. Triangular ventral shield and subapical orifices (Fig. 7C).

Pleopods. Pleopod 1 (Fig. 7C) exopod ovoid, with semicircular apex; endopod about twice as long as exopod and bent outwards, apex acute and bearing small setae along inner margin. Pleopod 2 (Fig. 7D) exopod triangular, outer margin concave with one seta; endopod flagelliform, longer than exopod. Pleopod 3–4 exopods as in Fig. 7E–F, respectively. Pleopod 5 (Fig. 7G) exopod triangular, outer margin almost straight with one tiny seta, inner margin covered with small setae, apex short and acute.

**Taxonomic remarks**

*Circoniscus xikrin* sp. nov. is clearly distinguishable from *C. buckupi*, *C. carajasensis*, and *C. mendesi* sp. nov. in the semicircular lobe on the rostral surface of the male pereopod 7 ischium and merus, and telson with acute apex.

**Ecological remarks**

The specimens were collected in the aphotic zone, inhabiting very moist soil. This species is considered to be a troglobitic due to the absence of body pigments and eyes, and elongated pereopods.

**Distribution**

Presently known only from SB_0049 cave in PARNA dos Campos Ferruginosos, Canaã dos Carajás, and N3_0026 cave system, Parauapebas, Pará, Brazil (Fig. 1).

Family Armadillidae Brandt, 1831

Genus ***Ctenorillo*** Verhoeff, 1942

**Type species**

*Ctenorillo buddelundi* Verhoeff, 1942, by monotypy [= *Cubaris regulus* 893 Van Name, 1920], by monotypy (see Schmidt & Leistikow 2004).

***Ctenorillo ferrarai*** Campos-Filho, Araujo & Taiti, 2014
Figs 8B–D

*Ctenorillo ferrarai* Campos-Filho, Araujo & Taiti in Campos-Filho *et al*., 2014: 412, figs 37–40, table 1.

*Ctenorillo ferrarai* – Fernandes *et al*. 2019: 1119. — Campos-Filho *et al*. 2023: 560, figs 22–23.

**Material examined**

BRAZIL – **Pará, Canaã dos Carajás** • 1 ♂, 1 ♀; SB_0049 caves (also registered as GEM 1460 and known as Samuel II by local people); 6°18′58.4″ S, 49°53′41.1″ W; 629 m a.s.l.; 16 Feb. 2022; J.E. Gallão,

J.S. Gallo, D.F. Torres and V.F. Sperandei leg.; LES 0028774. – **Parauapebas** • 1 ♂; CAV-N1-0174; 6°01′27.20″ S, 50°17′54.73″ W; 649 m a.s.l.; 12 Feb. 2022; J.E. Gallão, J.S. Gallo, D.F. Torres and V.F. Sperandei leg.; LES 0028775 • 3 ♂♂, 1 ♀; same collection data as for preceding; LES 0028776 • 2 ♂♂, 1 ♀; same collection data as for preceding; LES 0028777.

### Ecological remarks

The specimens were collected in the aphotic and twilight zones, living under rocks and among roots in moist soil (Fig. 8B–D).

### Distribution

*Ctenorillo ferrarai* has been recorded in caves of the FLONA de Carajás, in the municipalities of Canaã dos Carajás and Curionópolis, Pará (Campos-Filho *et al*. 2014, 2023). This is the first record in Parauapebas (Fig. 1).

## Discussion

As mentioned, the genus *Circoniscus* has a distribution restricted to South America, with the majority of records in the Brazilian territory. Campos-Filho *et al*. (2011) described *Circoniscus buckupi* and *C. carajasensis*, and Ferreira *et al*. (2015) recorded *Circoniscus* sp., all from iron ore caves in FLONA de Carajás. Campos-Filho *et al*. (2014) recorded the epigean species *C. bezzi* Arcangeli, 1931, *C. intermedius*

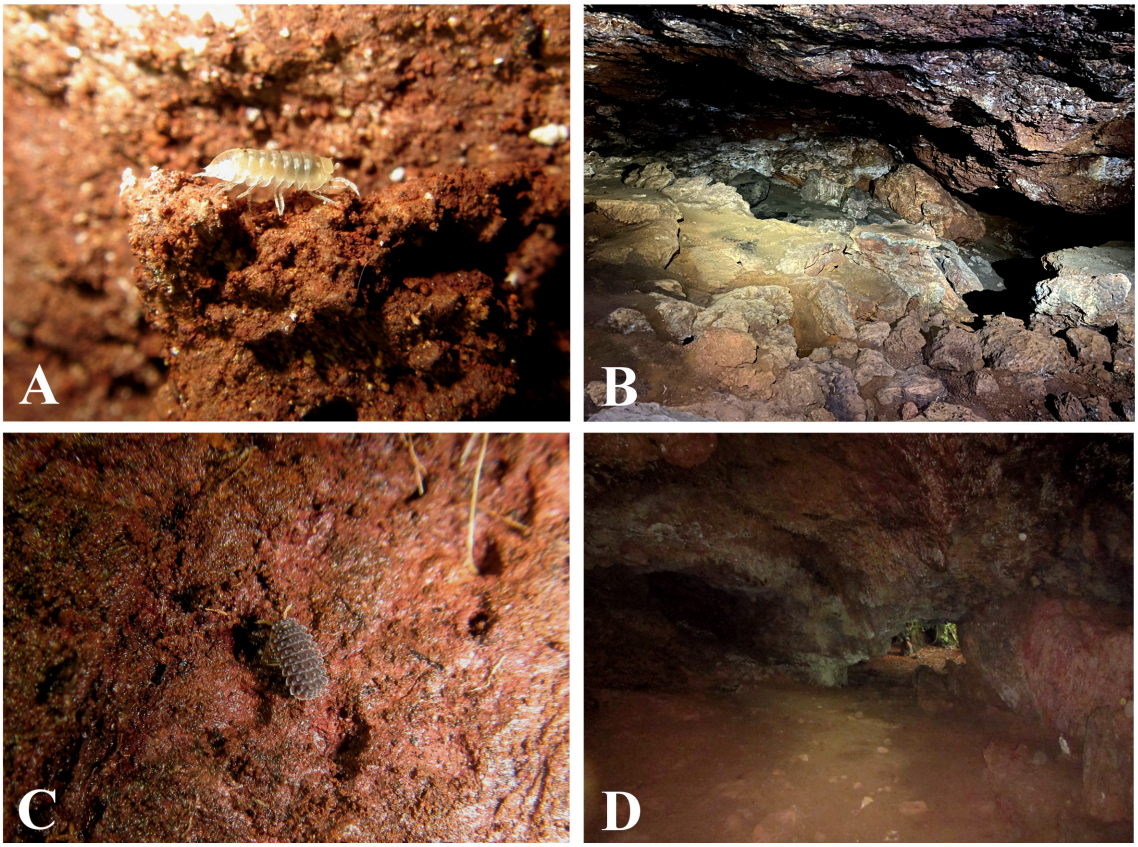


**Fig. 8. A**. *Circoniscus mendesi* López-Orozco, Campos-Filho & Bichuette sp. nov., specimen from CAV-N1-0174. **B**. Parauapebas, Pará, in moist soil. **C**. *Ctenorillo ferrarai* Campos-Filho, Araujo & Taiti, 2014, specimen from CAV-SB-0049 (also known as Samuel II by local people). **D**. Canaã dos Carajás, Pará, in moist soil.

Souza & Lemos de Castro, 1991, and *C. incisus* Souza & Lemos de Castro, 1991 from the states Pará, Mato Grosso do Sul, and Minas Gerais, all in Brazilian caves. Moreover, Campos-Filho *et al*. (2019, 2023) described several epigean species from several karstic areas in Brazil. Taking into account the above, it is clear that the subterranean habitat plays an important role in the conservation of the Oniscidea.

According to the CECAV/ICMbio database (CECAV 2020), Brazil has more than 22 000 caves, which hold a high taxonomic diversity (Gnaspini & Trajano 1994; Pinto-da-Rocha 1995; Gallão & Bichuette 2015, 2018; Trajano *et al*. 2016; Chagas-Jr & Bichuette 2018; Bichuette & Gallão 2021). Thus, our knowledge of the diversity of the terrestrial isopods from Brazilian caves is still far from complete. As mentioned by Campos-Filho *et al*. (2014), the taxonomic impediment is the primary reason for the delay in the assessment of the biodiversity of Oniscidea, both outside and inside caves. Moreover, it delays the progress in the knowledge of various other groups of invertebrates in subterranean ecosystems. Considering the national heritage of scientific collections, allied with works in development, it is important to emphasize the need to encourage the formation of more taxonomists to process the amount of material redeposited in these collections. In addition, it is worth mentioning that the iron ore caves from the Parauapebas region and surroundings suffer from iron mining for exportation. The FLONA de Carajás holds the largest mining project in Brazil (Fig. 1C). The impact of mining may be the worst to subterranean habitats due to the irreversible destruction, obliterating all the subterranean fauna. Knowing and describing our subterranean diversity are the first steps toward the conservation of our biological subterranean heritage.

The present work describes two new species of terrestrial isopods, *C. mendesi* sp. nov. and *C. xikrin* sp. nov., which belong to the troglobitic inventory of the iron ore cave diversity within the Amazonian domain. Moreover, it expands the knowledge of the distribution of *B. tarzan* and *C. ferrarai*. The diversity of terrestrial isopods associated with subterranean habitats from Brazil is increased to 80 species. Lastly, this information might be used in management and conservation plans both for this group as well as for Brazilian subterranean ecosystems.

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