Unveiling a hidden diversity: descriptions of nine new species of *Ctenorillo* Verhoeff, 1942 (Isopoda, Armadillidae) discovered in Brazilian caves and their importance for conservation

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Habitus of the species of the genus Ctenorillo Verhoeff, 1942 discussed in the present paper.

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Unveiling a hidden diversity: descriptions of nine new species of *Ctenorillo* Verhoeff, 1942 (Isopoda, Armadillidae) discovered in Brazilian caves and their importance for conservation

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ABSTRACT

Nine species of *Ctenorillo* Verhoeff, 1942 are described from Brazil, revealing a great diversity of the genus in South America. *Ctenorillo pelado* Cardoso & Ferreira, n. sp., and *C. araguaia* Cardoso & Ferreira, n. sp. are described, and *C. ferrari* Campos-Filho, Araújo & Taiti, 2014 has the knowledge of its distribution expanded from the state of Pará (north of Brazil); *Ctenorillo intertidalis* Cardoso & Ferreira n. sp., *C. ubajarenxis* Cardoso & Ferreira, n. sp., *C. cearenxis* Cardoso & Ferreira, n. sp. and *C. quiteriensis* Cardoso & Ferreira, n. sp. are described from the state of Ceará (northeast Brazil); *C. potiguar* Cardoso & Ferreira, n. sp. from the state of Rio Grande do Norte (northeast Brazil); *C. iuiuensis* Cardoso & Ferreira, n. sp. from the state of Bahia (northeast Brazil); and *C. jequitinhonha* Cardoso & Ferreira, n. sp. from the state of Minas Gerais (southeast Brazil). Most of the newly identified species are found in protected conservation areas and are therefore legally protected. However, special attention should be paid to *C. iuiuensis* Cardoso & Ferreira, n. sp., a troglobitic species, due to its distinctive ecological features and its habitat being limited to a single cave, which is currently not protected.

KEY WORDS
Woodlice, terrestrial isopods, cave species, Brazil, Neotropics, troglobitic, new species.
BACKGROUND

The genus *Ctenorillo* Verhoeff, 1942 is distributed across Africa and South America (Taiti et al. 1998; Schmalfuss 2003; Boyko et al. 2008; Campos-Filho et al. 2014, 2017; Cifuentes & Da Silva 2023; Carpio-Díaz et al. 2023). In Brazil, three species are known: *C. mineri* (Van Name, 1936) from Brazil, Guyana and Venezuela; *C. ubajarensis* Campos-Filho, Araujo & Taiti, 2014 from Brazil; and *C. tuberosus* (Budde-Lund, 1904) from Brazil, Haiti and Germany (introduced) (Campos-Filho et al. 2018).

*Ctenorillo* is distinguished by its diminutive size and strongly convex body shape, endoantennal conglabulation and dorsal surface featuring more or less developed ribs and/or tubercles; cephalon with a subquadrangular frontal shield, and the pereonite 1 epimeron with a schisma; pereonites 1 and 2 with ventral lobes, the latter bearing a triangular lobe; telson with hour-glass shape; antenna with two articles on flagellum, with the distal article longer than the proximal one; subquadran- gular uropod with flattened protopod, with a concave medial margin and a tiny exopod inserted near the medial margin; and pleopod 1-5 exopods with monospiracular-covered lungs (Carpio-Díaz et al. 2018). As previously noted by Schma-

RÉSUMÉ

Une diversité cachée dévoilée : description de neuf nouvelles espèces de *Ctenorillo* Verhoeff, 1942 (Isopoda, Armadillidae) découvertes dans des grottes brésiliennes et leur importance pour la conservation.

Neuf espèces de *Ctenorillo* Verhoeff, 1942 sont décrites brésil, révélant une grande diversité du genre en Amérique du Sud. *Ctenorillo ubajarensis* Cardoso & Ferreira, n. sp. et *C. araguaia* Cardoso & Ferreira, n. sp. sont décrites, et *C. ferrarae* Campos-Filho, Araujo & Taiti, 2014 voit la connaissance de sa distribution étendue à l’État de Pará (nord du Brésil); *Ctenorillo intertidalis* Cardoso & Ferreira, n. sp., *C. ubajarensis* Cardoso & Ferreira, n. sp., *C. caerensii* Cardoso & Ferreira n. sp. et *C. quiteniensis* Cardoso & Ferreira, n. sp. sont décrites dans l’État de Ceará (nord-est du Brésil); *C. potiguarae* Cardoso & Ferreira, n. sp. dans l’État de Rio Grande do Norte (nord-est du Brésil); *C. iuiuensis* Cardoso & Ferreira, n. sp. dans l’État de Bahia (nord-est du Brésil); et *C. japonitobonba* Cardoso & Ferreira, n. sp. dans l’État de Minas Gerais (sud-est du Brésil). Plupart des espèces nouvellement identifiées se trouvent dans des zones de conservation protégées et sont donc légalement protégées. Toutefois, un attention particulière devrait être accordée à *C. iuiuensis* Cardoso & Ferreira, n. sp., une espèce troglobie, en raison de ses caractéristiques écologiques originales et de son habitat limité à une seule grotte, qui n’est pas protégée à l’heure actuelle.

MATERIAL AND METHODS

Specimens were collected using brushes and fixed in 70% ethanol. In the Center of Studies on Subterranean Biology at the Federal University of Lavras (CEBS/UFLA), located in Lavras, Brazil, the specimens were measured and photographed with a ZEISS Axio ZoomV16 stereomicroscope equipped with an Axio Cam 506 Color camera. After dissection, they were mounted on slides using Hoyer’s medium. Drawings were produced through a combination of photographic and dissected specimens with the aid of a camera lucida fitted to a Leica DM750 microscope. Final illustrations were created in GIMP software (v. 2.8) (Montesanto 2015, 2016) using a Wacom Cintiq drawing tablet. A subset of specimens (from some species) were investigated further using a Hitachi TM4000 scanning electron microscope. The utilization of low vacuum imaging technology allowed the examination of non-conductive samples without the need for a metal coating. All material is deposited in the Collection of Subterranean Invertebrates of Lavras (ISLA), some were collected by consulting companies that collects the material to evaluate the significance of caves, as mandated by Brazilian environmental agencies in their review of potentially environmentally impactful projects. The holotype and paratypes are deposited at ISLA. In this study, we have employed the cave fauna classification system proposed by Sket (2008).

ABBREVIATION

ISLA Collection of Subterranean Invertebrates of Lavras (ISLA), at the Ecology and Conservation Department of the Federal University of Lavras, Lavras, Minas Gerais, Brazil.

MOTS CLÉS

Cloporte, isopodes terrestres, espèces cavernicoles, Brésil, néotropiques, troglobie, espèces nouvelles.

BACKGROUND

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*Ctenorillo* is distinguished by its diminutive size and strongly convex body shape, endoantennal conglabulation and dorsal surface featuring more or less developed ribs and/or tubercles; cephalon with a subquadrangular frontal shield, and the pereonite 1 epimeron with a schisma; pereonites 1 and 2 with ventral lobes, the latter bearing a triangular lobe; telson with hour-glass shape; antenna with two articles on flagellum, with the distal article longer than the proximal one; subquadran- gular uropod with flattened protopod, with a concave medial margin and a tiny exopod inserted near the medial margin; and pleopod 1-5 exopods with monospiracular-covered lungs (Carpio-Díaz et al. 2018). As previously noted by Schmal- fuss & Ferrara (1983), Campos-Filho et al. (2014, 2017) and Taiti (2018), species of *Ctenorillo* are often similar and can be distinguished by the shape, number, and disposition of dorsal tubercles.

This manuscript presents the taxonomic descriptions of nine newly discovered species (Figs 1-27), expanding the known diversity of the genus and its distribution within the Neotropical Region. Of these newly described species, two were found in Northern Brazil (Pará state), six in northeastern Brazil (Ceará, Rio Grande do Norte and Bahia states), and one in southeastern Brazil (Minas Gerais state). A notable finding is the discovery of the first troglobitic species within the genus, which was found in a cave located in Iuiu municipality, Bahia state. Additionally, this manuscript pro-
Descriptions of nine new species of *Ctenorillo* discovered in Brazilian caves

ZOOSYSTEMA • 2024 • 46 (5)
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

ZOOSYSTEMA • 2024 • 46 (5)

50°9'5"W; 17.VII-4.VIII.2014; ISLA 30635 • 1 ♀; N8_0020 cave; GEM_549; 6°10'16"S, 50°9'30"W; 24.II-13.III.2015; ISLA 30393 • 1 ♂; N8_0020 cave; GEM_830; 17.VII-4.VIII.2014; ISLA 30655 • 1 ♀; 2 ♀; N8_0022 cave; GEM_545; 6°10'32"S, 50°9'28"W; 17.VII-4.VIII.2014; ISLA 30606 • 1 ♀; N8_0022 cave; GEM_814; 17.VII-4.VIII.2015; ISLA 30640 • 1 ♀; N8_0023 cave; GEM_553; 6°10'31"S, 50°9'3"W; 2-29.IV.2015; ISLA 30630 • 1 ♀; N8_0023 cave; GEM_554; 6°10'6"S, 50°9'33"W; 2-29.IV.2015; ISLA 30650 • 1 ♀; N8_0023 cave; GEM_917; 4.IX-6.X.2014; ISLA 30737 • 1 ♀; N8_0023 cave; GEM_940; 4.IX-6.X.2014; ISLA 30755 • 1 ♀; N8_0025 cave; GEM_582; 6°10'6"S, 50°9'31"W; 2-29.IV.2015; ISLA 30426 • 1 ♂; N8_0026 cave; GEM_797; 6°10'25"S, 50°8'50"W; 17.VII-4.VIII.2016; ISLA 30628 • 1 ♂; N8_0026 cave; GEM_815; 17.VII-4.VIII.2016; ISLA 30641 • 1 ♂; 2 ♀; N8_0028 cave; GEM_580; 6°10'7"S, 50°9'28"W; 2-29.IV.2015; ISLA 30424 • 1 ♀; N8_0029 cave; GEM_802; 6°10'6"S, 50°9'35"W; 17.VII-4.VIII.2014; ISLA 30633 • 1 ♀; N8_0038 cave; GEM_554; 6°10'6"S, 50°9'33"W; 2-29.IV.2015; ISLA 30398 • 1 ♀; N8_0038 cave; GEM_799; 17.VII-4.VIII.2014; ISLA 30630 • 3 juven; N8_0038 cave; GEM_825; 17.VII-4.VIII.2014; ISLA 30650 • 1 ♀; N8_0038

Fig. 1.— Ctenorillo ferrarai Campos-Filho, Araújo & Taiti, 2014: A, Serra Norte Mountain range in the Carajás National Forest; B, entrance of an iron ore cave in the Serra Norte region where specimens are found; C, inner portion of an iron ore cave where specimens are found; D, habitus in natural condition; E, lateral view; F, cephalon and epimeron 1, lateral view; G, dorsal tubercle with nodulus lateralis. Scale bar: 1 mm.
Cardoso G. M. et al.

**Habitat**

*Ctenorillo ferrarai* were originally found in two caves in the Carajás region, located in eastern Pará state, in the Amazon Forest. Unfortunately, data on their habitats were not provided in the original description (Campos-Filho et al. 2014). Herein we add additional occurrences for this species and some notes on their habitats, along with the first photographs of living specimens (Fig. 1). The Carajás region presents massive iron ore reserves (among other metals) thus being strategically important for the Brazilian economy. However, due to the accelerated growth of iron ore exploitation, the natural landscapes, including both external (forests) and subterranean (caves) components are under unprecedented threat. A considerable part of the iron ore plateaus in the Carajás region is located in the conservation unit of the Carajás National Forest. This National Forest embraces parts of the municipalities of Paraúna, Canoás do Carajás, and Água Azul do Norte and is composed by a mosaic of protected areas that adds up to 1.31 million hectares of preserved forests (Rolim et al. 2006) surrounded by severely impacted areas especially covered by pastures (Campos & Castilho 2012; Martins et al. 2012). This conservation unit preserves bionomic or seasonal forest formations (Fig. 1A), with 5% consisting of laterite plateaux, which outcrop on the high areas of the region (Campos & Castilho 2012). Despite the status of a conservation unit, the Carajás National Forest, is highly altered by mining, farming and illegal deforestation (Mertens et al. 2002; Souza-Filho et al. 2016; Oliveira et al. 2020; Rizzo et al. 2020). The current climate classification of the region is Aw according to Köppen’s system (Álvares et al. 2013). It is characterized by a high annual precipitation, which follows a unimodal pattern, with the rainy season peaking between January and March. The region receives an annual total precipitation of approximately 2,033 millimeters, with three-quarters of this occurring during the three wettest months. Monthly average temperatures range from 25.1°C to 26.3°C, with minimums between 15.6°C and 18.3°C (from July to October) and maximums between 34.3°C and 38.1°C, in the remaining months. The region maintains consistently high humidity levels throughout the year, with monthly average relative air humidity varying between 76.8% and 88.5%.

In Serra Norte Mountain Range samples were made in around 900 iron ore caves. Specimens of *C. ferrarai* (Fig. 1D) were found in 114 caves (which corresponds to approximately 12.7% of the caves in the area). Additionally, specimens were also found in 34 caves in the Serra do Tarzan region, in an area close to the Serra Sul complex (Fig. 1B, C). Hence, its wide distribution in caves located at different iron ore plateaux indicates that this species certainly occurs outside caves, and is considered a troglobiphic species. The caves where the specimens were found are extremely variable in their geological traits, such as the number and size of their entrances, the total length, and the position on the plateaux, among other characteristics, thus indicating that the species seems to be a generalist cave inhabitant, apparently not demanding specific habitat traits. It is important to mention, however, that the quarries expansion in the last years may represent a significant threat, thus monitoring plans should include this species to evaluate any changes in its distributional patterns and population attributes.
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

Remarks

*Ctenorillo ferrarai* was initially documented in two distinct locations of Serra Norte within the Carajás National Forest. Additional surveys conducted in both Serra Norte and Serra do Tarzan provided evidence of similar configurations of dorsal tubercles, which suggests that these specimens are conspecific with the initial discovery. *Ctenorillo ferrarai* is distinguished by its well-defined tubercles present on both the pereon and pleon segments, as well as a singular rib comprising the first lateral tubercle on epimeron 1 (Fig. 1D-G). This trait is of particular interest and will be further examined in other species within this genus.

*Ctenorillo pelado* Cardoso & Ferreira, n. sp. (Figs 2-4; 27B; 28A-D)

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_type material._ — *Holotype.* Brazil. Pará state; Curionópolis municipality; Serra Leste plateau • ♂ (4.5 mm); SL_0001 cave; 5°57’58”S, 49°38’57”W; 14.I.2011; ISLA96773.

*Paratypes.* Brazil • 1 ♀ (parts in slide); same data as holotype; ISLA96774 • 4 ♂, 3 ♀; SL_0001 cave; same data as holotype; ISLA15135 • 2 juv.; same data as holotype; 4.VII.2010; ISLA15926 • 5 ♂, 5 ♀; same data as holotype; 4.VII.2010; ISLA15969.

Fig. 2. — Ctenorillo pelado Cardoso & Ferreira, n. sp. paratype (male, 5 mm, ISLA96774): A, habitus, lateral view; B, disposition of dorsal tubercles; C, cephalon and pereonite 1, dorsal view; D, epimera 1-3 ventral view; E, pleonites 3-5, uropods and telson, dorsal view; F, antennula; G, antenna; H, right mandible; I, left mandible; J, maxillula; K, maxilla; L, maxilliped. Scale bar: 0.5 mm.
OTHER MATERIAL. — Brazil. Pará: Curionópolis municipality; Serra Leste plateau • 4♂, 5♀; SL_0002 cave; 5°52′57″S, 49°38′57″W; 13.I.2011; ISLA15136 • 8♂, 2♀; SL_0002 cave; 3.VII.2010; ISLA15970 • 2♂; SL_0003 cave; 12.I.2011; ISLA15971 • 2♂, 5♀; SL_0004 cave; 5°57′49″S, 49°38′59″W; 13.I.2011; ISLA15137 • 2♂, 2♀; SL_0004 cave; 3.VII.2010; ISLA15972 • 1♂, 2♀; SL_0006 cave; 5°57′48″S, 49°38′59″W; 13.I.2011; ISLA15138 • 3♀; SL_0006 cave; 28.VI.2010; ISLA15902 • 1♂, 6♀; SL_0007 cave; 5°57′58″S, 49°38′58″W; 3.XII.-2011; ISLA15872 • 1♂, 2♀; SL_0007 cave; 4.VII.2010; ISLA15939 • 3♀, 3juven.; SL_0008 cave; 5°58′37″S, 49°38′58″W; 14.I.2012; ISLA15139 • 4♂, 3♀; SL_0008 cave; 5°58′15″S, 49°38′47″W; 12.I.2011; ISLA15145 • 2♀; SL_0002 cave; 5°57′49″S, 49°38′59″W; 13.I.2011; ISLA15973 • 1♀, 1juven.; SL_0011 cave; 5°58′44″S, 49°38′59″W; 12.I.2011; ISLA15140 • 1♀; SL_0012 cave; 5°57′52″S, 49°38′59″W; 4.VII.2016; ISLA15974 • 2♀; SL_0013 cave; 5°57′47″S, 49°38′59″W; 13.I.2011; ISLA15141 • 1♀; SL_0014 cave; 5°57′46″S, 49°39′00″W; 13.I.2011; ISLA15878 • 1♀; SL_0015 cave; 5°57′44″S, 49°39′00″W; 2.II.2011; ISLA15938 • 1♂, 1♀; SL_0016 cave; 5°58′12″S, 49°38′51″W; 12.I.2011; ISLA6211 • 2♂, 6♀; SL_0016 cave; 12.I.2011; ISLA15143 • 1♀; SL_0016 cave; 6.VI.2010; ISLA16588 • 1♂; SL_0017 cave; 5°58′16″S, 49°38′48″W; SL_0011; ISLA15144 • 3♀; SL_0019 cave; 5°58′15″S, 49°38′47″W; 12.I.2011; ISLA15145 • 1juven.; SL_0020 cave; 5°58′15″S, 49°38′47″W; 12.I.2011; ISLA15146 • 2♂; SL_0022 cave; 5°58′17″S, 49°38′46″W; 29.I.2011; ISLA15147 • 1♀, 3juven.; SL_0023 cave; 5°58′18″S, 49°38′46″W; 12.I.2011; ISLA15985 • 3♂, 6♀; SL_0024 cave; 5°58′19″S, 49°38′41″W; 9.VI.2010; ISLA15929 • 2♂, 4♀; SL_0026 cave; 5°58′21″S, 49°38′41″W; 12.I.2011; ISLA15976 • 2♂, 1♀; SL_0026 cave; 9.VI.2010; ISLA16589 • 2♂; SL_0030 cave; 5°58′20″S, 49°38′37″W; 8.VI.2010; ISLA15954 • 1♀; SL_0032 cave; 5°58′7″S, 49°38′40″W; 27.VII.2010; ISLA15942 • 1♂, 3♀; SL_0035 cave; 5°58′32″S, 49°38′16″W; 31.I.2011; ISLA15148 • 1♂, 2♀; SL_0036 cave; 5°58′31″S, 49°38′15″W; 23.VII.2010; ISLA15931 • 1♀; SL_0037 cave; 5°58′40″S, 49°37′54″W; 27.I.2011; ISLA15855 • 1♀; SL_0037 cave; 8.VII.2010; ISLA15935 • 1♂; SL_0042 cave; 5°58′14″S, 49°38′47″W; 2.II.2011; ISLA15149 • 2♂; SL_0042 cave; 8.VII.2010; ISLA16590 • 1♀; SL_0047; 30.VI.2010; ISLA16591 • 1♀; SL_0048 cave; 5°58′58″S, 49°37′52″W; 29.I.2011; ISLA15860 • 2♂, 1♀; SL_0049 cave; 5°58′58″S, 49°37′51″W; 29.I.2011; ISLA15980 • 2♂, 1♀; SL_0049; 27.VI.2010; ISLA16592 • 1♂, 2♀; SL_0057 cave; 5°58′36″S, 49°37′32″W; 11.II.2011; ISLA15151 • 1♀; SL_0058 cave; 5°58′34″S, 49°37′28″W; 29.I.2011; ISLA15150 • 1♂, 3♀; SL_0058 cave; 27.VI.2010; ISLA16593 • 3♂, 5♀; SL_0060 cave; 5°58′46″S, 49°37′22″W; 10.II.2011; ISLA15152 • 4♂, 5♀; SL_0060 cave; 10.VI.2010; ISLA16594 • 1♂; SL_0064 cave; 5°58′44″S, 49°37′17″W; 10.VI.2010; ISLA15924 • 1♀, SL_0065 cave; 5°58′53″S, 49°37′11″W; 2.XII.-2011; ISLA15154 • 2♂, 1♀; SL_0065; 3.XII.-2011; ISLA15155 • 2♂, 8♀; SL_0065 cave;
The new species name is a noun in apposition that refers to the region where the species was collected, also known as “Serra Pelada”, which means “naked mountains”, in reference to the presence of the metallophilic vegetation, that is considerably reduced (in size) when compared to the surrounding Amazon Forest.

**Diagnosis.** — Dorsum covered with conical tubercles and lateral ribs with three rows on cephalon (4, 2, 6); three rows on pereonite 1 (6, 10, 8); two rows on pereonites 2-7 (6 + 6); one row of four tubercles on pleonites 3-5; two paramedian tubercles on telson. Pleopod 1 exopod wider than long, triangular with protruding distal portion, outer margin concave and crenulate; endopod with distal portion straight, slightly swollen, four times longer than exopod.

**Distribution.** — Carajás National Forest, Pará State.

**Description**

Maximum size: σ, 4.5 mm, Ψ, 6 mm. Color grey in nature, brownish in ethanol (Figs 4B; 27B). Dorsum covered with conical tubercles and lateral ribs (Figs 2A-C; 28A, B): cephalon with three rows on cephalon (4, 2, 6 from front to back of vertex); pereonite 1 with 24 in three rows (6, 10 and 8); pereonites 2-7 with 12 (6 + 6); pleonites 3-5 with one row of four tubercles on pleonites 3-5; two paramedian tubercles on telson. Pleopod 1 exopod wider than long, triangular with protruding distal portion, outer margin concave and crenulate; endopod with distal portion straight, slightly swollen, four times longer than exopod.
margin distinctly sinuous at sides; inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching epimeron posterior margin (Figs 2A, D; 28D). Pereonites 2-7 (Figs 2A; 28B) with wide quadrangular epimera slightly bent outwards. Telson (Fig. 2E) hourglass-shaped, proximal portion broader than distal portion. Antenna (Fig. 2F) of three articles, second article much shorter than first and third, third article with two apical and four subapical aesthetasc. Antenna (Fig. 2G) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about three times as long as first. Mandibles (Fig. 2H, I) with molar penicil semidichotomised, consisting of several plumose setae from common stem; right mandible with 1 + 1 and left mandible with 2 + 1 free penicils. Maxillula (Fig. 2J) with outer branch bearing 4 + 5 simple teeth. Maxilla (Fig. 2K) distally setose and bilobate, with inner lobe narrower than outer lobe. Maxilliped (Fig. 2L) endite with subapical large seta and two triangular setae on apical margin; palp with two setae on basal article. All pleopod exopods with monospiracular covered lungs (Fig. 28C). Uropod (Fig. 3A) protopod flattened, enlarged on basal portion; exopod very short, inserted dorsally close to medial margin of protopod.

Male

Pereopods without particular modifications (Fig. 3B, C). Pleopod 1 exopod (Fig. 3D) wider than long, triangular with protruding distal portion, outer margin concave and crenulate; endopod four times longer than exopod, distal portion straight, slightly swollen. Pleopod 2 endopod longer than exopod (Fig. 3E). Pleopods 3-5 exopods as in Figure 3F-H.

HABITAT

Specimens of C. pelado Cardoso & Ferreira, n. sp. were found in several caves in the Serra Leste Mountain Range (also known as Serra Pelada) which is part of the geological complex of the Carajás region, in the Carajás National Forest (Fig. 4A). The specimens were found in caves, and also in the external habitats, during external surveys (Fig. 4B). The regional climate is also classified as Aw according to the Köppen system, characterized by the same patterns of precipitation and temperature as described for the previous species (C. ferrarai). Nevertheless, given the regularity with which specimens have been observed within cave systems, it is plausible to classify this species as troglobic. Of the approximately 120 iron ore caves surveyed in the region, C. pelado Cardoso & Ferreira, n. sp. was identified in 63 of these caves (roughly 52.5% of the total caves in the area), indicating an even broader distribution within Serra Leste than C. ferrarai within the Serra Norte complex (Fig. 4C, D). It should be noted that Serra Leste is primarily comprised of a single, extensive plateau, as opposed to the multiple plateaus present in the Serra Norte complex. As with C. ferrarai, the geological characteristics of caves inhabited by C. pelado Cardoso & Ferreira, n. sp. vary significantly, suggesting that this species is not strongly reliant on specific habitat traits. Despite the wide distribution of this species in the caves of the area, a large quarry is rapidly expanding in the region, posing a significant threat to the species. Therefore, monitoring plans should include C. pelado Cardoso & Ferreira, n. sp. to assess any potential changes to its distributional patterns and population characteristics.

Remarks

As mentioned previously, the Cienorillo species are distinguished mainly by the shape, number, and disposition of dorsal tubercles. The morphology of C. pelado Cardoso & Ferreira, n. sp. and C. ferrarai is very similar, the species differ in the number of tubercles on pereonite 1 with C. pelado Cardoso & Ferreira, n. sp. presenting 24 tubercles and C. ferrarai presenting 22; this seems to be related to the prominent lateral rib in C. ferrarai while in C. pelado Cardoso & Ferreira, n. sp. the lateral rib is present from pereonite 2 to 7 with two tubercles (instead of one rib) on pereonite 1. The disposition of tubercles on pereonite 1 differ with 6 + 10 + 8 on C. pelado Cardoso & Ferreira, n. sp. and 4 + 12 + 6 on C. ferrarai. The specimen presented by Campos-Filho et al. (2023) were also collected in the Serra Leste plateau and resembles the morphology of C. pelado Cardoso & Ferreira, n. sp. presented here; therefore, we can consider them as the same species.

Comparing C. pelado Cardoso & Ferreira, n. sp. with other Cienorillo species, on pleon, the presence of four tubercles on pleonites 3-5 is similar to C. guinensis (Schmalfuss & Ferrara, 1983), C. legai (Arcangeli, 1941), C. minori and C. ferrarai from which it differs by the shape of male pleopod 1 exopod.

Cienorillo araguaia Cardoso & Ferreira, n. sp.

(Figs 5-7; 27C; 28E)

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TYPE MATERIAL. — Holotype. Brazil • 1 ♂ (5 mm); Pará state; São Geraldo do Araguaia municipality; Serra das Andorinhas cave; 6°16’55”S, 48°32’34”W; sector 4; 17–20.II.2018; V. F. Sperandei leg.; ISLA96775.

Paratypes. Brazil • 1 ♂ in slide; same data as holotype; ISLA96784 • 6 ♀; sector 1; same data as holotype; ISLA96776 • 1 ♀; sector 1; same data as holotype; ISLA96777 • 1 ♀; sector 3; same data as holotype; ISLA96778 • 3 ♂, 8 ♀; sector 4; same data as holotype; ISLA96779 • 5 ♂; sector 5; same data as holotype; ISLA96780 • 3 ♀, 5 ♂ sector 6; same data as holotype; ISLA96781 • 1 ♀; sector 7; same data as holotype; ISLA96782 • 1 ♂, 1 ♀; same data as holotype; ISLA96783.

OTHER MATERIAL. — Brazil • 4 ♀; Pará state; São Geraldo do Araguaia municipality; Remanso dos Botos cave; 6°22’6”S, 48°23’38”W; V. F. Sperandei leg.; 20.II.2018; ISLA96785.

ETYMOLOGY. — The new species name is a noun in apposition that refers to the Araguaia River, a Brazilian environmental heritage: the type locality is within the hydrographic basin of the Araguaia river. The word Araguaia comes from the indigenous Amazonian language term arauay (or araguaí), which designates a type of macaw species.

DIAGNOSIS. — Dorsum covered with conical tubercles and lateral ribs with three rows on cephalon (6, 2, 6); four rows on pereonite 1 (4, 7, 10, 6); two rows on pereonites 2-6 (10 + 8) and on pereonite 7 (6 + 8); one row of four tubercles on pleonites 3-5; and two parame-dian tubercles on telson. Pleopod 1 exopod distal portion round, outer margin straight; endopod with distal portion slightly bent outward, slightly swollen, four times longer than exopod.
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

**Distribution.**—Serra dos Martírios/Andorinhas State Park in São Geraldo do Araguaia municipality, Pará state.

**Description**

Maximum size: ♂, 5 mm; ♀, 6 mm. Color grey with lateral margins depigmented (Fig. 27C). Dorsum covered with conical tubercles and lateral ribs (Figs 5A, B, 28E): cephalon with three rows (6, 2, and 6 from front to back of vertex); pereonite 1 with 27 in four rows (4, 7, 10 and 6); pereonites 2-6 with 18 (10 + 8); pereonite 7 with 14 (6 + 8); pleonites 3-5 with one row of four tubercles; telson with two paramedian tubercles. Dorsal cuticle (Fig. 28E) with short triangular scale setae; pereonites 1-7 bearing one line of noduli lateralis per side on outer surface of posterior tubercle of second line of tubercle. Cephalon with frontal shield directed upward; eye consisting of 16 ommatidia (Fig. 5C, D). Pereonite 1 with posterior margin sinuous at sides; inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching epimeron posterior margin (Fig. 5E). Pereonites 2-7 (Fig. 5A) with wide quadrangular epimera slightly bent outwards. Telson (Fig. 5F) hourglass-shaped, proximal portion broader than distal portion. Antennula (Fig. 5G) of three articles, second article...

**Fig. 5.** — Ctenorillo araguaia Cardoso & Ferreira, n. sp. paratype (male, 5 mm, ISLA96784): A, habitus, lateral view; B, disposition of dorsal tubercles; C, cephalon, dorsal view; D, cephalon and pereonite 1, dorsal view; E, epimera 1-5 ventral view; F, pleonites 3-5, uropods and telson, dorsal view; G, antennula; H, antenna; I, right mandible; J, left mandible; K, maxillula; L, maxilliped. Scale bar: 0.5 mm.
shorter than first and third, third article with six apical and one subapical aesthetascs. Antenna (Fig. 5H) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about four times as long as first. Buccal pieces as *C. pelado* Cardoso & Ferreira, n. sp. (Fig. 5I-L). All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 6A) protopod flattened, enlarged on basal portion; exopod very short, inserted dorsally close to medial margin of protopod.

**Male**

Pereopods without particular modifications (Fig. 6B, C). Pleopod 1 exopod (Fig. 6D) wider than long, distal portion round, outer margin straight; endopod four times longer than exopod, distal portion slightly bent outwards, slightly swollen. Pleopod 2 endopod longer than exopod (Fig. 6E). Pleopods 3-5 exopods as in Figure 6F-H.

**Habitat**

Specimens of *C. araguaia* Cardoso & Ferreira, n. sp. were found in the Andorinhas cave and in Remanso dos Botos cave which are quartzite caves located in the Serra das Andorinhas Mountain Range (also known as Serra dos Martírios). The regional climate is classified, according to Köppen, as Aw5 (Tropical climate with dry season or Humid Equatorial), with annual rainfall between 1000 mm and 1500 mm and an average annual temperature of 26°C (22°-32°C). The relative humidity is high and varies from 25% to 90% with an average of 78% (Alvares et al. 2013).

The Andorinhas cave is 1 km long, featuring entrances on both the side cliffs covered by Amazonian Forest and the mountaintop covered by savannah vegetation (Fig. 7A, B). During the rainy season, an intermittent drainage flows through the cave. A large colony of insectivorous bats (*Pter-
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

**onotus** sp.) inhabits some inner and isolated parts of the cave, producing a massive guano piles that cover the floor of several conduits and chambers. In upper areas of the cave conduit (Fig. 7C) away from the bat colony, specimens of *C. araguaia* Cardoso & Ferreira, n. sp. were found under rocks (Fig. 7D). Given the lack of bat guano in that part of the cave, it is probable that the new species feeds on plant debris carried by floods and deposited along this conduit. In contrast, the Remanso dos Botos cave is smaller (125 m) and located at a lower altimetric level of the hill. The main organic deposits in this cave are guano produced by bats with distinct feeding habits, such as frugivory (*Carolia* sp.) and insectivory (*Peropteryx* sp. and *Natalus* sp.). Moreover, seeds transported by the bats germinate, resulting in sprouts that were also consumed by some invertebrates. Specimens of *C. araguaia* Cardoso & Ferreira, n. sp. were observed on the cave floor in deeper areas of the cave, as in the Andorinhas cave.

The caves are located in the Serra dos Martírios/Andorinhas State Park, which preserves the mountain top and cliffs. However, the surrounding landscape has been significantly impacted, particularly by deforestation for agriculture. The Andorinhas cave receives sporadic visitors, likely due to the difficult access to the cave. It is worth noting that the occurrence of *C. araguaia* Cardoso & Ferreira, n. sp. in these caves does not imply that the species is restricted to this habitat, especially considering the absence of any obvious troglomorphic traits. Therefore, further studies, including external samplings, are needed to better understand the distribution of the species.

**Remark**

*Ctenorillo araguaia* Cardoso & Ferreira, n. sp. is similar to *C. pelado* Cardoso & Ferreira, n. sp., presenting two tubercles on pereonite 1 and lateral ribs from pereonites 2 to 7, but differs in the number of tubercles on pereonite 1 (27 vs 24 in *C. pelado* Cardoso & Ferreira, n. sp.), in the number of tubercles on pereonites 2 to 7 (18 tubercles on pereonites 2 to 6 and 14 on pereonite 7 vs *C. pelado* Cardoso & Ferreira, n. sp. with 12 tubercles on pereonites 2 to 7).

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**Fig. 7.** — *Ctenorillo araguaia* Cardoso & Ferreira, n. sp.: **A**, quartzite outcrops on the Serra das Andorinhas mountain range; **B**, entrance of the Andorinhas cave, where specimens are found; **C**, inner portion of the Andorinhas cave; **D**, habitus in natural condition.
**Ctenorillo intertidalis** Cardoso & Ferreira, n. sp.  
(Figs 8-10; 27D; 28F, G)

**Type material.** — Holotype. Brazil • 1 ♂ (6 mm; parts in slide); Ceará state; Jijoca de Jeriacoara municipality; Jeri_10 cave; 2°47’12”S, 40°30’12”W; 25.IX.2019; R.L. Ferreira leg.; ISLA96786.

**Paratypes.** Brazil • 2 ♂, 9 ♀; same data as holotype; ISLA96787.

**Other material.** — Brazil. Ceará state; Jijoca de Jeriacoara municipality • 10 ♂, 12 ♀; Jeri_4 cave; 2°47’18”S, 40°30’42”W; 25.IX.2019; R.L. Ferreira leg.; ISLA96788 • 1 ♂ in slide; Jeri_4 cave; ISLA96789 • 10 ♂, 11 ♀; Jeri_7 cave; 2°47’16”S, 40°30’34”W; 24.IX.2019; R.L. Ferreira leg.; ISLA96790 • 11 ♂, 7 ♀; Jeri_8; 2°47’17”S, 40°30’32”W; 24.IX.2019; R.L. Ferreira leg.; ISLA96791 • 1 ♂ in slide; Jeri_8; 24.IX.2019; R.L. Ferreira leg.; ISLA96792 • 7 ♂, 1 ♀; Duas bocas cave; 2°47’16”S, 40°30’33”W; 24.IX.2019; R.L. Ferreira leg.; ISLA96793 • 1 juv.; Jeri Novo cave; 2°47’15”S, 40°30’33”W; 25.IX.2019; R.L. Ferreira leg.; ISLA 96800.

**Etymology.** — The new species name is a noun in apposition that refers to area in where the caves are located, close to the beach, in an intertidal area.

**Diagnosis.** — Dorsum covered with conical tubercles and lateral ribs with three rows on cephalon (4, 2, 6); four rows on pereonite 1 (4, 7, 6, 7); two rows on pereonites 2-7 (8 + 7); one row of four tubercles on pleonites 3-5; and two paramedian tubercles on telson. Pleopod 1 exopod distal portion round, sinuous outer margin; endopod with distal portion slightly bent outward, three times longer than exopod.

**Distribution.** — Jeriacoara National Park, municipality of Jijoca de Jeriacoara, North of Ceará state.

**Description.** Maximum size: ♂ and ♀, 7.5 mm. Color grey with lateral margins depigmented. Dorsum covered with conical tubercles and lateral ribs (Figs 8A, B; 28F, G): cephalon with three rows (4, 2, and 6 from front to back of vertex); pereonite 1 with 24 in four rows (4, 7, 6 and 7); pereonites 2-7...
Descriptions of nine new species of *Ctenorillo* discovered in Brazilian caves

with 15 (8 + 7); pleonites 3-5 with one row of four tubercles; telson with two paramedian tubercles. Dorsal cuticle (Fig. 28G) with short triangular scale setae, pleonites 1-7 bearing one line of *noduli lateralis* per side on outer surface of posterior tubercle of second tubercle. Cephalon with frontal shield protruding above vertex; eye consisting of 10 ommatidia (Figs 8A, C, D; 28F). Pereonite 1 with posterior margin sinuous at sides; inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching epimeron posterior margin (Fig. 8C). Pereonites 2-7 (Fig. 8A) with wide quadrangular epimera slightly bent outwards. Telson (Fig. 8E) hourglass-shaped, proximal portion broader than distal portion. Antennula (Fig. 8F) of three articles, second article shorter than first and third, third article with four apical and five subapical aesthetascs. Antenna (Fig. 8G) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about twice as long as first. Buccal pieces as *C. pelado* Cardoso & Ferreira, n. sp. (Fig. 8H-L), except maxillula (Fig. 8J) with 4 + 6 simple teeth. All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 9A) protopod flattened, enlarged on basal portion; exopod outward, short, inserted dorsally close to medial margin of protopod.

**Male**
Pereopods without particular modifications (Fig. 9B, C). Pleopod 1 exopod (Fig. 9D) wider than long, distal portion round, sinuous outer margin; endopod three times longer than exopod, distal portion slightly bent outwards. Pleopod 2 endopod longer than exopod (Fig. 9E). Pleopods 3-5 exopods as in Figure 9F-H.

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Fig. 9. — *Ctenorillo intertidalis* Cardoso & Ferreira, n. sp. paratype (male, 7.5 mm, ISLA96786): A, uropod; B, pereopod 1; C, pereopod 7; D, pleopod 1 and genital papilla; E, pleopod 2; F, pleopod 3 exopod; G, pleopod 4 exopod; H, pleopod 5 exopod.
HAbitAT
Specimens of *C. intertidalis* Cardoso & Ferreira, n. sp. were found in six caves in quartzite outcrops on the shoreline (Fig. 10A, B), near the village of Jericoacoara, in the municipality of Jijoca de Jericoacoara. The climate is classified as hot and humid (Aw’sg. Köppen), with summer rains from January to July. Temperatures range from 25°C to 35°C, and the dry season lasts about six months and is often interrupted by heavy rains in October or September (Alvares et al. 2013).

The new species was found in six out of eight sampled caves in the area. The caves are quite small, presenting, on average, 14.48 (± 7.48) meters of horizontal projection. Thus, most of them were devoid of aphotic zones. Specimens of *C. intertidalis* Cardoso & Ferreira, n. sp. were observed under rocks, sheltered from the wind off the coast (Fig. 10C). The organic matter inside the caves consisted of plant debris (brought by the wind or the tides, in caves closer to the sea) and bat guano in some caves (produced by the piscivorous *Noctilio leporinus* (Linnaeus, 1758)). In some caves, individuals of *C. intertidalis* Cardoso & Ferreira, n. sp. were observed co-occurring with another isopod species (Fig. 10D). The external environment comprises a “restinga” ecosystem dominated by herbaceous vegetation, which grows along the dunes. Thus, there are few external shelters for these organisms. As the samplings that resulted in the discovery of this new species focused specifically on caves, the actual extent of *C. intertidalis* Cardoso & Ferreira, n. sp. habitat is currently unknown, but their distribution may be much wider than that observed in this work, especially considering the lack of troglomorphic traits in this species.

The region is inserted in the Jericoacoara National Park, so the area and the caves are currently protected. Nonetheless, it is noteworthy that there is no regulation of visitor access to these caves, and due to the region’s popularity as a tourist destination, uncontrolled foot traffic may inadvertently pose a threat to the invertebrate populations, including those of the newly discovered species.

REMARK
*Ctenorillo intertidalis* Cardoso & Ferreira, n. sp. resembles *C. pelado* Cardoso & Ferreira, n. sp. in the number of tubercles on pereonite 1 (24), however the disposition with the presence of a lateral rib is similar to *C. ferrarai*, differing from both by the number of tubercles on pereonites 2 to 7 (15).
Descriptions of nine new species of *Ctenorillo* discovered in Brazilian caves

*Ctenorillo ubajarensis* Cardoso & Ferreira, n. sp.

(Figs 11-13; 27E; 28H)


**Type material.** — *Holotype. Brazil* • 1 ♂ (4 mm); Ceará state; Ubajara municipality; Urso Fóssil cave; 3°49’59”S, 40°53’32”W; 22.1.2019; R.L. Ferreira leg.; ISLA96794.

*Paratypes. Brazil* • 4 ♂, 5 ♀; same data as holotype; ISLA96795.

**Other material.** — *Brazil* • 1 ♀; Ceará state; Ubajara municipality; Macaco Fóssil cave; 3°49’45”S, 40°54’6”W; 24.1.2019; R.L. Ferreira leg.; ISLA96796; 1 ♀; Ubajara municipality; Pendurado cave; 3°50’4’’S, 40°53’35”W; 25.1.2019; R.L. Ferreira leg.; ISLA96797.

**Etymology.** — The new species name is a noun that refers to the type locality (the Ubajara National Park).

**Diagnosis.** — Dorsum covered by bosses, more developed posteriorly with three rows on cephalon (4, 2, 4); three rows on pleonite 1 (5, 2, 8); two rows on pleonites 2-6 (6 + 6) and on pleonite 7 (6 + 5);
one row of four tubercles on pleonites 3-5; and two paramedian tubercles on telson. Pleopod 1 exopod with protruding distal portion, triangular, outer margin concave and crenulate; endopod with distal portion straight, slightly swollen, five times longer than exopod.

**DISTRIBUTION.** — Ubajara National Park, Ubajara municipality, Ceará state.

**DESCRIPTION**

Maximum size: ♂, 5 mm, ♀, 6.5 mm. Color brown in nature (Figs 13C; 27E). Dorsum covered by bosses, more developed posteriorly (Figs 11A, B; 28H); cephalon with three rows (4, 2, and 4 from front to back of vertex); pereonite 1 with 15 in three rows (5, 2 and 8); pereonites 2-6 with 14 (6+6); pereonite 7 with 11 (6+5); pleonites 3-5 with one row of four tubercles; telson with two paramedian tubercles. Dorsal cuticle with short triangular scale setae; pereonites 1-7 bearing one line of *noduli lateralis* per side on the outer surface of posterior boss of second line (Fig. 28H). Cephalon with frontal shield protruding above vertex; eye consisting of eight ommatidia (Figs 11C; 28H). Pereonite 1 inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching epimeron posterior margin (Fig. 11E); pereonites 2-7 with wide quadrangular epimera (Fig. 11A). Telson (Fig. 11F) hourglass-shaped, proximal portion broader than distal portion. Antennula (Fig. 11G) of three articles, second article shorter than first and third, third article with five apical and two subapical aesthetascs. Antenna (Fig. 11H) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about twice as long as first. Buccal...
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

Pieces as *C. pelado* Cardoso & Ferreira, n. sp. (Fig. 11I-M). All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 12A) protopod flattened, enlarged on basal portion; exopod outward, short, inserted dorsally close to medial margin of protopod.

**Male**
Pereopods without particular modifications (Fig. 12B, C). Pleopod 1 exopod (Fig. 12D) wider than long, protruding distal portion, triangular, outer margin concave and crenulate; endopod with distal portion straight, slightly swollen, five times longer than exopod. Pleopod 2 endopod longer than exopod (Fig. 12E). Pleopods 3-5 exopods as in Figure 12F-H.

**Habitat**
Specimens of *C. ubajarensis* Cardoso & Ferreira, n. sp. were found in three caves located at the Ubajara National Park (Fig. 13A). These caves are associated with limestones from the Frecheirinha Formation, Ubajara karst Group (Neoproterozoic). This region experiences two distinct climatic seasons: the rainy period when 94% of rainfall occurs (from January to June), and the dry period that is practically without rain (from July to December). The average annual temperature ranges from 20°C to 22°C in Serra da Ibiapaba and around 24°C to 26°C in the peripheral depression. June and July are typically the warmest months, while October and November are the hottest (Alvares et al. 2013).

The Urso Fóssil cave, in which most of the specimens were found, extends up to 195 meters in length and has four entrances located along the cave main conduit (Fig. 13B). Most parts of the cave receive some light from the external environment, and aphotic areas are relatively few. Although this cave is located within the limits of the National Park, in which caves are important touristic attractions, tourists do not regularly visit this cave. However, it has been the target of several palaeontological excavations in recent decades, which, on the one hand, revealed the great fossiliferous importance of this cave but, on the other hand, ended up altering several of its microhabitats.

Most specimens of *C. ubajarensis* Cardoso & Ferreira, n. sp. (Fig. 13C) were found in Urso Fóssil cave, beneath fallen rocks or blocks on the cave floor. Additional specimens were observed in two other nearby caves (Pendurado and Macaco caves), with only one specimen found in each of these caves. Since external inventories were not conducted during our visit to the area, it is not possible to determine the actual distribution of this species, but it certainly occurs in external habitats in the caves’ surroundings. Since the area is legally protected, the species is apparently not under any threat.

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Fig. 13. — *Ctenorillo ubajarensis* Cardoso & Ferreira, n. sp.: A, limestone outcrops at the Ubajara National Park; B, entrance of the Urso Fóssil cave, where specimens are found; C, habitus in natural condition.
Remak

*Ctenorillo ubajarensis* Cardoso & Ferreira, n. sp., like *C. kenyensis* Schmölzer, 1974, differ from the congeneric species by the less developed tubercles, however in *C. ubajarensis* Cardoso & Ferreira, n. sp. the tubercles are more like bosses and are slightly more developed on pereonite 7, while on *C. kenyensis* they are granulated and densely distributed dorsally.

*Ctenorillo cearensis* Cardoso & Ferreira, n. sp.

(Figs 14; 15; 27F)

*type material.* — *Holotype.* Brazil • 1 ♂ (4 mm; parts in slide); Ceará state; Santa Quitéria municipality; W_04 cave; 4°33'53"S, 39°46'36"W; Carste leg.; 10-18.III.2021; ISLA96021.
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

**Other Material.** — Brazil • 1 ♂; SQ_26 cave; 4°33′38″S, 39°46′51″W; Carste leg.; 10-18.III.2021; ISLA96020 • 1 ♂; W_16 cave; 4°33′43″S, 39°46′44″W; Carste leg.; 10-18.III.2021; ISLA96026 • 1 ♂; SQ_03 cave; 4°33′53″S, 39°46′40″W; Carste leg.; 10-18.III.2021; ISLA96033 • 2 ♂; SQ_P2 cave; 4°33′37″S, 39°45′57″W; Carste leg.; 10-18.III.2021; ISLA96962 • 3 ♂; SQ_03 cave; 4°34′4″S, 39°47′0″W; Carste leg.; 10-18.III.2021; ISLA96025.

**Etymology.** — The new species name, “cearensis”, refers to the people who are born in the State of Ceará, Brazil. The word Ceará comes from the tupy language that means the macaw’s singing (o canto dajanaia in Portuguese).

**Diagnosis.** — Dorsum covered by weakly developed tubercles and ribs with three rows on cephalon (4, 4, 4); three rows on pereonite 1 (2, 8, 9); two rows on pereonites 2-6 (4 + 11) and on pereonite 7 (4 + 7); one row of four tubercles on pleonites 3-5; and two paramedian tubercles on telson. Pleopod 1 exopod with round distal portion, outer margin straight; endopod with distal portion straight, four times longer than exopod.

**Distribution.** — Santa Quitéria municipality, Ceará state.

**Description.** — Maximum size: ♂ and ♀; 4 mm. Color grey (Fig. 27F). Dorsum covered by weakly developed tubercles and ribs (Fig. 14A, B): cephalon with three rows (4, 4, and 4 from front to back of vertex); pereonite 1 with 15 in three rows (2, 8, and 9); pereonites 2-6 with 15 (4 + 11); pereonite 7 with 11 (4 + 7); pleonites 3-5 with one row of four tubercles; telson with two paramedian tubercles. Dorsal cuticle with short triangular scale setae; pereonites 1-7 bearing one line of noduli lateralis per side on outer surface of posterior tubercle of second line of tubercle. Cephalon with frontal shield protruding above vertex; eye consisting of eight ommatidia (Fig. 14C, D). Pereonite 1 inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching posterior margin of epimera (Fig. 14E); pereonites 2-7 with wide quadrangular epimera (Fig. 14A). Telson (Fig. 14F) hourglass-shaped, proximal portion broader than distal portion. Antennula (Fig. 14G) of three articles, second article shorter than first and third, third article with six apical aesthetascos. Antenna (Fig. 14H) short and stout.
flagellum shorter than fifth article of peduncle; second article of flagellum about three times as long as first. Buccal pieces as C. pelado Cardoso & Ferreira, n. sp. (Fig. 14I-M). All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 15A) protopod flattened, enlarged on basal portion; exopod outward, short, inserted dorsally close to medial margin of protopod.

Male
Pereopods without particular modifications (Fig. 15B, C). Pleopod 1 exopod (Fig. 15D) wider than long, round distal portion, outer margin straight; endopod with distal portion straight, four times longer than exopod. Pleopod 2 endopod longer than exopod (Fig. 15E). Pleopods 3-5 exopods as in Figure 15F-H.

HABITAT
Specimens of C. cearensis Cardoso & Ferreira, n. sp. were found in six limestone caves inventoried in the caatinga biome in northern Ceará state. The region experiences a Tropical Hot Semi-arid climate (BSH according to Koppen), with an average annual rainfall of 799.8 mm concentrated between February and April (Álvares et al. 2013). Average temperatures in the region hover around 27°C, with approximately 3°C of thermal amplitude (IPECE 2011). The area features three types of vegetation: Tropical Steppe, located in both the residual massifs and dissected areas of the Sertaneja Depression; Thorny Deciduous Forest and Tropical Rainforest. Unfortunately, the biologists who collected the specimens did not provide any data on the caves or the conservation status of the surrounding region. However, at least 74 caves were inventoried in the region, and specimens of C. cearensis Cardoso & Ferreira, n. sp. were found only in six of them. As mentioned for other species herein described, external inventories were not conducted, hence it is not possible to determine the actual distribution of this species. Nonetheless, the species does not present any troglomorphic traits, which would suggest its restriction to subterranean habitats. Importantly, the cave inventories were conducted to rank the importance of the caves in the area, as required by Brazilian environmental agencies for evaluating projects that may impact the environment. The potential installation of quarries in the area is a cause for concern since the limestone caves in the region are located close to uranium deposits (Júnior & Carste et al. 2021). Carste leg.; ISLA96095.

ETYMOLOGY
— The new species name is a noun in apposition that refers to the people who are born in the municipality where the specimens were found (Santa Quitéria).

DIAGNOSIS
— Dorsum covered with conical tubercles and lateral ribs with three rows on cephalon (4, 2, 6); four rows on pereonite 1 (4, 5, 10, 7); two rows on pereonite 2-4 (8 + 7) and on pereonites 5-7 (10 + 7); one row of four tubercles on pleonites 3-5; and two paramedian tubercles telson. Pleopod 1 exopod with protruding distal portion, triangular, outer margin straight; endopod with distal portion straight, slightly swollen, three times longer than exopod.

DISTRIBUTION
— Santa Quitéria municipality, Ceará state.

DESCRIPTION
Maximum size: ♂ and ♀, 7 mm. Color brown with lateral margin depigmented (Fig. 27G). Dorsum covered with conical tubercles and lateral ribs (Fig. 16A-C): cephalon with three rows (4, 2, and 6 from front to back of vertex); pereonite 1 with 26 in four rows (4, 5, 10 and 7); pereonites 2-4 with 15 (8 + 7); pereonites 5-7 with 17 (10 + 7); pleonites 3-5 with one row of four tubercles; telson with two paramedian tubercles. Dorsal cuticle with short triangular scale setae; pleonites 1-7 bearing one line of noduli lateralis per side on outer surface of posterior tubercle of second line of tubercles. Cephalon with frontal shield protruding above vertex; eye consisting of eight ommatidia (Fig. 16A, D). Pereonite 1 with postero-marginal spine distinctly sinuous at sides; inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching posterior margin of epimera (Fig. 16E). Pereonites 2-7 (Fig. 16A) with wide quadrangular epimera slightly bent outwards. Telson (Fig. 16F) hourglass-shaped, proximal portion broader than distal portion. Antennula (Fig. 16G) of three articles, second article shorter than first and third, third article with three apical and five subapical aesthetascas. Antenna (Fig. 16H) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about three times as long as first. Buccal pieces as C. pelado Cardoso & Ferreira, n. sp. (Fig. 16I-K). All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 17A) protopod flattened, enlarged on basal portion; exopod very short, inserted dorsally close to medial margin of protopod.

Male
Pereopods without particular modifications (Fig. 17B, C). Pleopod 1 exopod (Fig. 17D) wider than long, protruding distal portion, triangular, outer margin straight; endopod with...
Descriptions of nine new species of *Ctenorillo* discovered in Brazilian caves

**Habitat**

Specimens of *C. quiteriensis* Cardoso & Ferreira, n. sp. were found in two limestone caves inserted in the caatinga biome in northern Ceará state. The regional climate is also classified as BSh according to the Köppen system, characterized by the same patterns of precipitation and temperature as described for *C. cearensis* Cardoso & Ferreira, n. sp. Also, no data were available about the caves or the conservation status of the surrounding region. Regrettably, external inventories were not conducted during the sampling process in the area, making it difficult to determine the precise distribution of this species. It is likely that *C. quiteriensis* Cardoso & Ferreira, n. sp. occurs in external habitats surrounding the caves, as observed in other species described here. As with *C. cearensis* Cardoso & Ferreira, n. sp., the establishment of quarries for uranium extraction in the future could pose a significant threat to the habitats of this newly discovered species. It is essential to undertake further studies to determine the extent of its distribution and the potential impacts of anthropogenic activities in the region to develop conservation strategies to safeguard this species.

**Remarks**

*Ctenorillo quiteriensis* Cardoso & Ferreira, n. sp. occur in the same region as *C. cearensis* Cardoso & Ferreira, n. sp. and they clearly differ in the shape and number of tubercles, being more developed in *C. quiteriensis* Cardoso & Ferreira, n. sp. On pereonite 1, *C. quiteriensis* Cardoso & Ferreira, n. sp. presents 26 tubercles, resembling *C. ferranii* in the presence of a lateral rib on the pereonites that are more developed posteriorly.

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**Fig. 16.** — *Ctenorillo quiteriensis* Cardoso & Ferreira, n. sp., holotype (male, 7 mm, ISLA96038): A, habitus, lateral view; B, disposition of dorsal tubercles; C, cephalon and epimeron 1, dorsal view; D, cephalon, frontal view; E, epimerae 1-3, ventral view; F, pleonites 3-5, uropods and telson, dorsal view; G, antennula; H, antenna; I, right mandible; J, maxillula; K, maxilliped. Scale bar: 0.5 mm.

distal portion straight, slightly swollen, three times longer than exopod. Pleopod 2 endopod longer than exopod (Fig. 17E). Pleopods 3-5 exopods as in Figure 17F-H.
**Ctenorillo potiguar** Cardoso & Ferreira, n. sp. (Figs 18-20; 27H; 28I)

**Type Material.** — Holotype. Brazil • 1 ♂ (3 mm, parts in slide); Rio Grande do Norte state; Baraúna municipality; Furna Nova cave; 5°2’3”S, 37°34’16”W; 12.VI.2008; D.M. Bento leg.; ISLA96798. Paratypes. Brazil • 2 ♀; same data as holotype; ISLA96799.

**Other Material.** — Brazil. Rio Grande do Norte; Baraúna municipality • 1 ♂, 2 ♀; Furna Feia cave; 5°2’12”S, 37°33’36”W; 31.VII.2010; D.M. Bento leg.; ISLA59267 • 2 ♂; Esquecida cave; 5°2’16”S, 37°33’40”W; 12.VI.2010; D.M. Bento leg.; ISLA59283 • 1 ♀; same collection data as for preceding; ISLA59333 • 1 ♀; Britador cave; 11.VI.2010; D.M. Bento leg.; ISLA59263.

**Brazil.** Rio Grande do Norte; Felipe Guerra municipality • 1 ♂, 1 ♀; Crotes cave; 5°33’37”S, 37°39’30”W; 4.VI.2010; D.M. Bento leg.; ISLA59330 • 2 ♂; same collection data as for preceding; ISLA59282 • 1 ♂; Trapiá cave; 5°33’45”S, 37°37’15”W; 4.VIII.2010; D.M. Bento leg.; ISLA59270.

**Etymology.** — The new species name is a noun in reference to people who are born in the State of Rio Grande do Norte, Brazil.

**Diagnosis.** — Dorsum covered with round tubercles and ribs with three rows on cephalon (4, 4, 6); four rows on pereonite 1 (4, 5, 8, 9); two rows on pereonites 2-7 (8 + 7); one row of four tubercles on pleonites 3-5 with; two paramedian tubercles on telson. Pleopod 1 exopod with round distal portion, outer margin straight; endopod with distal portion bent outward, four times longer than exopod.
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

**DISTRIBUTION.** — Baraúna and Felipe Guerra municipalities, west of the Rio Grande do Norte state.

**DESCRIPTION**

Maximum size: \( \sigma \), 3 mm, \( \varphi \), 4 mm. Color brown with lateral margins depigmented in nature (Figs 20D; 27H). Dorsum covered with round tubercles and ribs (Fig. 18A, B): cephalon with three rows (4, 4, and 6 from front to back of vertex); pereonite 1 with 26 in four rows (4, 5, 8 and 9); pereonites 2-7 with 15 (8 + 7); pleonites 3-5 with one row of four tubercles; telson with two paramedian tubercles. Dorsal cuticle with short triangular scale setae; pereonites 1-7 bearing one line of noduli lateralis per side on outer surface of posterior tubercle of second tubercles (Fig. 28I). Cephalon with frontal shield protruding above vertex; eye consisting of five ommatidia (Figs 18C, D; 28I). Pereonite 1 with posterior margin sinuous at sides; inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching posterior margin of epimera (Fig. 18E). Pereonites 2-7 (Fig. 18A) with wide quadrangular epimera slightly bent outwards. Telson (Fig. 18F) hourglass-shaped, proximal portion broader than...
distal portion. Antennula (Fig. 18G) of three articles, second article shorter than first and third, third article with seven apical aesthetascas. Antenna (Fig. 18H) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about three times as long as first. Buccal pieces as *C. pelado* Cardoso & Ferreira, n. sp. (Fig. 18I-M). All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 19A) protopod flattened, enlarged on basal portion; exopod outward, short, inserted dorsally close to medial margin of protopod.

**Male**

Pereopods without particular modifications (Fig. 19B, C). Pleopod 1 exopod (Fig. 19D) wider than long, round distal portion, outer margin straight; endopod with distal portion bent outward, four times longer than exopod. Pleopod 2 endopod longer than exopod (Fig. 19E). Pleopods 3-5 exopods as in Figure 19F-H.

**Habitat**

Specimens of *Ctenorillo potiguar* Cardoso & Ferreira, n. sp. were found in six caves located in the west of the Rio Grande do Norte state. This region has more than 1000 currently known caves (CANIE/CECAV 2022), but only about 48 have been inventoried (Ferreira et al. 2010; Bento et al. 2021). The caves are inserted in the limestones of the Janaíra Formation, deposited during the Upper Cretaceous, which corresponds to a carbonate ramp that emerged along the emersed portion of the Potiguar Basin (Bezerra et al. 2007). The region is in the Caatinga Biome, with a hot and semiarid climate (BSh on the Köppen climate classification) (Alvares et al. 2013). The average temperature is constant over the year, ranging from 25° to 30°C, with average annual precipitation around 800 mm (concentrated from February to June, but 70% can fall in a single month) (Silva et al. 2017).

Three caves, Furna Feia (Fig. 20A, B), Furna Nova (Fig. 20C) and Macacos/Esquecida, are located in the Furna Feia Na-
Descriptions of nine new species of *Ctenorillo* discovered in Brazilian caves

ZOOSYSTEMA • 2024 • 46 (5)

...national Park (FFNP) in the municipality of Baraúna. Specimens were also found in the Britador cave, near FFNP, in Baraúna. Other specimens were found in Trapiá and Crotes caves, in the municipality of Felipe Guerra (RN), 60 km from the first ones. These caves exhibit varied morphology, dimensions, and environmental conditions, ranging from small photic caves spanning a few tens of meters (e.g. Britador cave) to large aphytic caves covering hundreds of meters and characterized by more stable climatic conditions (e.g. Furna Feia, Furna Nova, and Trapiá caves). Despite this distribution, individuals (Fig. 20D) were mainly found in aphytic and humid areas within the caves, often sheltered under rocks. This observation suggests that the species may have a specific habitat preference.

No samplings were conducted outside caves in the area, and it is likely that the species also occurs in surface habitats (especially considering the absence of any obvious troglomorphic traits). Therefore, further studies including external samplings are needed to better understand the species distribution. Although only part of the distribution of the new species occurs within a conservation unit, the other caves are found in relatively conserved areas, without direct anthropic impacts. Three caves (Furna Feia, Furna Nova, and Crotes Caves) are visited by tourists in an orderly manner. Thus, the conservation status of the species can be considered of less concern.

**Remark**

*Ctenorillo potiguar* Cardoso & Ferreira, n. sp. resembles *C. ubajarenensis* Cardoso & Ferreira, n. sp. by the less developed tubercles, however they are more prominent on *Ctenorillo potiguar* Cardoso & Ferreira, n. sp. By the number of tubercles on pereonite 1, *Ctenorillo potiguar* Cardoso & Ferreira, n. sp. resembles *C. quitieriensis* Cardoso & Ferreira, n. sp. with 26 tubercles, differing by the shape.

*Ctenorillo iuiuensis* Cardoso & Ferreira, n. sp.

(Figs 21-23; 27I)

**Type Material.** — Holotype. Brazil • 1 ♂ (4 mm, parts in slide), Bahia state, Iuiu municipality, Lapa do Matias cave; 14°28′46″S, 43°36′50″W; R.L. Ferreira leg., 22.VII.2022; ISLA96802.

Paratypes. Brazil • 2 ♀; same data as holotype; ISLA96803.

**Etymology.** — The new species name “iuiuensis” refers to the municipality where the species inhabits.

**Diagnosis.** — Dorsum covered with conical tubercles three rows on cephalon (2, 2, 2); three rows on pereonite 1 (4, 4, 11); two rows on pereonites 2-6 (6 + 7) and on pereonite 7 (6 + 5); and two paramedian tubercles on pleonites 3-5 and on telson. Pleopod 1 exopod with round distal portion, outer margin straight; endopod with distal portion slightly bent outward, five times longer than exopod.
Cardoso G. M. et al.  

**DISTRIBUTION.** — Serra do Iuiu mountain range, Iuiu municipality, Bahia state.

**DESCRIPTION**

Maximum size: ♂ and ♀, 4 mm. Color pale (Fig. 27I). Dorsum covered with conical tubercles (Fig. 21A, B); cephalon with three rows (2, 2, and 2 from front to back of vertex); pereonite 1 with 19 in three rows (4, 4 and 11); pereonites 2-6 with 13 (6 + 7); pereonite 7 with 11 (6 + 5); pleonites 3-5 and telson with two paramedian tubercles. Cephalon with frontal shield protruding above vertex; eye consisting of 11 ommatidia (Fig. 21C, D). Pereonite 1 with posterior margin sinuous at sides; inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching posterior margin epimera (Fig. 21A). Pereonites 2-7 (Fig. 21A) with wide quadrangular epimera slightly bent outwards. Telson (Fig. 21E) hourglass-shaped, proximal portion broader than distal portion. Antennula (Fig. 21F) of three articles, second article much shorter than first and third, third article with seven apical aesthetasc. Antenna (Fig. 21G) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about three times as long as first. Buccal pieces as *C. pelado* Cardoso & Ferreira, n. sp. (Fig. 21H-L). All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 22A) protopod flattened, enlarged on basal portion; exopod very short, inserted dorsally very close to medial margin of protopod.

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Fig. 21. — *Ctenorillo iuiuensis* Cardoso & Ferreira, n. sp., holotype (male, 4 mm, ISLA96802): A, habitus, lateral view; B, disposition of dorsal tubercles; C, cephalon, frontal view; D, cephalon and pereonite 1, dorsal view; E, pleonites 3-5; uropods and telson, dorsal view; F, antennula; G, antenna; H, right mandible; I, left mandible; J, maxillula; K, maxilla; L, maxilliped. Scale bar: 0.5 mm.
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

Male
Pereopods without particular modifications (Fig. 22B, C). Pleopod 1 exopod (Fig. 22D) wider than long, round distal portion, outer margin straight; endopod five times longer than exopod, distal portion slightly bent outward. Pleopod 2 endopod longer than exopod (Fig. 22E). Pleopods 3-5 exopods as in Figure 22F-H.

Habitat
The Lapa do Matias cave, located in the Iuiú region, is the only place where specimens of C. iuiuensis Cardoso & Ferreira, n. sp. have been found, despite the extensive sampling of multiple caves in the region. The Iuiú region (northeastern Brazil) presents a significant karst area, known for its numerous caves and the occurrence of dozens of endemic species restricted to caves (Cardoso et al. 2021). This limestone formation is part of the Bambuí Group, the largest carbonate formation in South America. The landscape is situated within the Caatinga domain, with a seasonally dry tropical forest mostly found in the limestone outcrops due to past intensive land use. As per the Köppen-Geiger classification system, the climate in the area is semi-arid tropical (Bsh), with an annual precipitation of 788 mm and an average temperature of 24°C. The rainy season is from November to February while the dry season lasts from March to October.

The Lapa do Matias cave is located at the top of the outcrop at Serra do Iuiú, in a quite anthropized region (Fig. 23A). The cave is in a heavily human-impacted area with pastures and exposed soil, which increases erosion. Despite its small single entrance (Fig. 23B), the cave is voluminous and has two main conduits (Fig. 23C, D). A thorough search was carried out but only three specimens of C. iuiuensis Cardoso & Ferreira, n. sp. were found under limestone blocks in aphytic areas (Fig. 23E). It is worth noting that C. iuiuensis
Cardoso & Ferreira, n. sp. displays some troglomorphic traits, including a lack of pigmentation in both the body integument and eyes. As this condition was observed in all collected specimens, and none of them appeared to have a soft exoskeleton (teneral aspect), it is likely that this species is troglobitic. However, as no samplings were conducted outside caves in the area, future research is needed to confirm or refute this diagnosis.

The luuí karst area has been facing severe threats, particularly due to changes in the surrounding environments, which have intensified over the last few decades. According to Cardoso et al. (2022), the land cover and land use practices surrounding the caves in this region have significantly influenced the subterranean environments, affecting both microhabitat features and terrestrial invertebrate communities. The authors have demonstrated that deforested areas have had adverse effects on subterranean invertebrate richness, mainly by altering the fauna composition and reducing subterranean microhabitat diversity. Additionally, this region is home to several endemic cave species (Ratton et al. 2012; Souza et al. 2015; Hoch & Ferreira 2016; Souza & Ferreira 2018; Cardoso et al. 2020), making it imperative for Brazilian environmental agencies to take urgent action to protect these caves in this important Brazilian karst area.

**Remark**

*Ctenorillo iuiuensis* Cardoso & Ferreira, n. sp. differs from the Brazilian species by the presence of two paramedian tubercles on pleonites 3-5 and on telson.

**Ctenorillo jequitinhonha** Cardoso & Ferreira, n. sp.  
(Figs 24-26; 27J; 28J, K)

*urn:lsid:zoobank.org:act:5CF8B003-88B7-465B-84EF-040FEC4FB7F2*

**Type Material.** — **Holotype.** Brazil • 1 ♂ (7 mm, parts in slide), Minas Gerais state, Jequitinhonha municipality, Toca Juparanã cave; 16°25’3”S, 40°55’23”W; R.L. Ferreira leg., 7.IV .2017; ISLA96804.  
**Paratypes.** Brazil • 1 ♂ in slide; same data as holotype; ISLA96806 • 3 ♂, 8 ♀; same data as holotype; ISLA96805.
ETYMOLOGY. — The new species name is a noun in apposition that refers to the city and the Jequitinhonha River, one of the most important rivers in the north of Minas Gerais state; the type locality is within the drainage basin of the Jequitinhonha river. The word Jequitinhonha is of indigenous origin and means "wide river full of fish".

DIAGNOSIS. — Dorsum covered with round tubercles with three rows on cephalon (4, 4, 4); three rows on pereonite 1 (2, 4, 7); two rows on pereonites 2-7 (6 + 4); and two paramedian tubercles on pleonites 3-5 and on telson. Pleopod 1 exopod with protruding distal portion, triangular, outer margin sinuous; endopod distal portion straight, twice longer than exopod.

DISTRIBUTION. — Jequitinhonha municipality, Minas Gerais state.

DESCRIPTION

Maximum size: ♂, 7 mm, ♀, 9 mm. Color grey with lateral margins depigmented (Fig. 26C, D). Dorsum covered with round tubercles (Fig. 24A, B): cephalon with three rows (4, 4, and 4 from front to back of vertex); pereonite 1 with 13 in three rows (2, 4 and 7); pereonites 2-7 with 10 (6 + 4); pleonites 3-5 and telson with two paramedian tubercles. Dorsal cuticle (Fig. 28J, K) with short triangular scale setae, pereonites 1-7 bearing one line of noduli lateralis per side on outer surface of posterior tubercle of second tubercle. Cephalon with frontal shield protruding above vertex; eye consisting of 16 ommatidia (Figs 24C; 28J). Pereonite 1 with posterior margin sinuous at sides; inner lobe of schisma rounded, extending beyond posterior margin of outer lobe; pereonite 2 with triangular ventral tooth reaching epimeron posterior margin (Fig. 24D). Pereonites 2-7 (Fig. 24A) with wide quadrangular epimera slightly bent outwards. Telson (Fig. 24E) hourglass-shaped, proximal portion broader than distal portion. Antennula (Fig. 24F) of three articles, second article shorter than...
first and third, third article with seven apical aesthetascs. Antenna (Fig. 24G) short and stout, flagellum shorter than fifth article of peduncle; second article of flagellum about three times as long as first. Buccal pieces as C. pela-
do Cardoso & Ferreira, n. sp. (Fig. 24H-L). All pleopod exopods with monospiracular covered lungs. Uropod (Fig. 25A) protopod flattened, enlarged on basal portion; exopod outward, short, inserted dorsally close to medial margin of protopod.

Male
Pereopods without particular modifications (Fig. 25B, C). Pleopod 1 exopod (Fig. 25D) as wide as long, protruding distal portion, triangular, outer margin sinuous; endopod twice longer than exopod, distal portion straight. Pleopod 2 endopod as long as exopod (Fig. 25E). Pleopods 3-5 exopods as in Figure 25F-H.

HABITAT
Specimens of C. jequitinhonha Cardoso & Ferreira, n. sp. were found in Toca Juparanã, a granite cave located in Jequitinhonha municipality, in northeastern Minas Gerais state, Brazil. The average annual temperature is around 25°C, with the minimum temperature of approximately 15°C and the maximum of 38°C. The rainy season lasts from October to April, with December being the wettest month (140 mm of precipitation). The dry season lasts from May to September, with July being the driest month (average of 3 mm of precipitation) (Álvares et al. 2013).

The Toca Juparanã cave is a granitic talus cave that was formed by water removal of smaller sediments between large collapsed granitic blocks. The cave has two entrances of irregular shape, delineated by the contact of boulders (Fig. 26A). The main chamber of the cave has an irregular floor made up of collapsed boulders (Fig. 26B) and is euphotic/disphotic.
Descriptions of nine new species of *Ctenorillo* discovered in Brazilian caves

due to the presence of two entrances located on either side of the chamber. There is a descending aphytic conduit from this chamber, which is crossed by a small hypogenic drainage. Specimens of *C. jequitinhonha* Cardoso & Ferreira, n. sp. were found under fallen rocks in this conduit trespassed by the small drainage, although the specimens were not observed close to the mainstream passage. The only visible organic resource in this area was plant debris brought by water, indicating that the isopods were likely feeding on this resource (Fig. 26 C, D).

The vegetation surrounding the cave represents a well-preserved secondary forest, although many areas in the region are deforested for pastures and monocultures, especially near the Jequitinhonha River floodplain (Fig. 26E). The cave receives no visitors and is unknown to most of the local population. As for other *Ctenorillo* herein described, no samplings were conducted outside caves in the area, thus *C. jequitinhonha* Cardoso & Ferreira, n. sp. is likely to occur in external habitats. Therefore, it is advisable that further studies including external samplings be conducted to better understand the species distribution.

**Remark**

*Ctenorillo jequitinhonha* Cardoso & Ferreira, n. sp. differs from the Brazilian species by the round shape of tubercles, resembling *C. iuiuensis* Cardoso & Ferreira, n. sp. by the presence of two paramedian tubercles on pleonites 3-5 and on telson.
DISCUSSION

TAXONOMY

Currently, the genus is composed by 22 species, 11 of which are from Africa, seven are from Colombia, three are from Brazil, and one is from the Democratic Republic of São Tomé and Príncipe (Taitt et al. 1998; Campos-Filho et al. 2014, 2017, 2018; Cifuentes & Da Silva 2023; Carpio-Díaz et al. 2023). Hence, the current manuscript contributes significantly to the knowledge of this genus, especially in Brazil, as nine new species are described, bringing the total number of species known in the country to 12 and the total number of species in the genus to 31.

As previously mentioned, Ctenorillo is typically identified by the shape, number, and arrangement of the dorsal tubercles. In this study, we have identified three distinct shapes of tubercles in the Brazilian species. The first group of species, including C. ubajarense Cardoso & Ferreira, n. sp., C. cearensis Cardoso & Ferreira, n. sp. and Ctenorillo potiguar Cardoso & Ferreira, n. sp. display bosses or weakly developed tubercles. The second group of species, consisting of C. pelado Cardoso & Ferreira, n. sp., C. araguaia Cardoso & Ferreira, n. sp., C. intertidalis Cardoso & Ferreira, n. sp., C. quiteriensis Cardoso & Ferreira, n. sp., C. iuiuensis Cardoso & Ferreira, n. sp., C. minerí and C. tuberosus, possess conical tubercles. Finally, the third group, represented by C. jequitinhonha Cardoso & Ferreira, n. sp. exhibits round tubercles.

The number and arrangement of tubercles differed significantly among the species, and each species displayed a unique combination of these features. In most species, except for C. jequitinhonha Cardoso & Ferreira, n. sp., the tubercles developed in a lateral rib, which became increasingly prominent towards the posterior end of the last pereonites. In C. ferrairai, the first epimeron presented a single lateral rib that appeared to be the result of the fusion of two tubercles, which could be observed separately in C. tuberosus, C. minerí, C. pelado Cardoso & Ferreira, n. sp., and C. araguaia Cardoso & Ferreira, n. sp. With respect to the pleon, there was little variation among species, with most species displaying four tubercles on pleonites 3 to 5. However, C. tuberosus exhibits four tubercles on pleonites 3 and 4, and two on pleonite 5, while C. iuiuensis Cardoso & Ferreira, n. sp. and C. jequitinhonha...
Descriptions of nine new species of Ctenorillo discovered in Brazilian caves

Cardoso & Ferreira, n. sp. presented only two tubercles on pleonites 3 to 5.

Regarding the shape of the male pleopod 1, variations were observed in the presence of a distal projection on exopod, which is present in C. tuberosus, C. ferrarii, C. pelado Cardoso & Ferreira, n. sp., C. quiteriensis Cardoso & Ferreira, n. sp. and C. jequitinhonha Cardoso & Ferreira, n. sp.

The morphological similarities among the species are generally consistent with their geographical distribution. The state of Pará, in northern Brazil, host C. ferrarii, C. pelado Cardoso & Ferreira, n. sp. and C. araguaia Cardoso & Ferreira, n. sp., which exhibit well-developed, conical-shaped tubercles. In contrast, the three species occurring in the northeast of Brazil, namely C. ubajarensis Cardoso & Ferreira, n. sp., C. cearense Cardoso & Ferreira, n. sp. and Ctenorillo potiguar Cardoso & Ferreira, n. sp., display weakly developed tubercles. Notably, the most morphologically distinct species, C. iuiuensis Cardoso & Ferreira, n. sp. and C. jequitinhonha Cardoso & Ferreira, n. sp., inhabit Bahia and Minas Gerais states, respectively, the former being troglobitic, as previously mentioned.

**CONSERVATION**

The new species described here were found in highly heterogeneous regions, with some areas being well preserved while...
others significantly altered, leading to increased threats to the species. Notably, five out of the nine new species were found in conservation units: Carajás National Forest (C. pelado Cardoso & Ferreira, n. sp.); Serra dos Martírios/Andorinhas State Park (C. araguaia Cardoso & Ferreira, n. sp.); Jericoacoara National Park (C. intertidalis Cardoso & Ferreira, n. sp.); Ubajara National Park (C. ubajarensis Cardoso & Ferreira, n. sp.) and the Furna Feia National Park (FFNP) (Ctenorillo potiguar Cardoso & Ferreira, n. sp.). As such, these species could be considered relatively well protected. However, it is important to note that some of these protected areas, particularly the national parks, feature caves as a key tourist attraction, which may pose a potential threat to the species in the event of unregulated tourist activity.

From a conservation standpoint, the primary concern centers around species inhabiting regions lacking legal protection. Among the newly described species are C. cearensis Cardoso & Ferreira, n. sp., C. quiteriensis Cardoso & Ferreira, n. sp., C. iuiuensis Cardoso & Ferreira, n. sp., and C. jequitinhonha Cardoso & Ferreira, n. sp. which are at a significant risk due to deforestation caused by agricultural and livestock expansion. Since these species are not entirely reliant on caves, the loss of forest cover can severely impact critical parts of these species habitat ranges, except for C. iuiuensis Cardoso & Ferreira, n. sp., which is exclusively found in one cave. Moreover, while the fact that these species inhabit caves suggests the possibility of shelter in these environments, the caves themselves are facing an unprecedented threat in Brazil (Ferreira et al. 2022; Cardoso et al. 2023).

Finally, of all the newly described species, particular attention must be given to C. iuiuensis Cardoso & Ferreira, n. sp. due to its unique ecological characteristics. This species is not only troglobitic but also confined to a single cave, making it especially vulnerable to habitat destruction. Furthermore, as previously mentioned, the landscape surrounding the cave where C. iuiuensis Cardoso & Ferreira, n. sp. is found has been significantly modified. Consequently, it is imperative that competent environmental agencies implement protective measures to guarantee the survival of this species.
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Authors’ contributions
GMC performed the morphological description. All authors drafted the manuscript, read, and approved the final manuscript.

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