

RESEARCH ARTICLE

# Contribution to the knowledge of Brazilian troglobitic Pseudoscorpiones (Arachnida): description of *Pseudochthonius lubueno* sp. nov. (Chthoniidae) from Serra do Ramalho karst area, state of Bahia, Brazil

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**ABSTRACT.** *Pseudochthonius lubueno* **sp. nov.**, a new obligatory cave-dwelling pseudoscorpion species is described from Gruna da Altina cave, the fifth species of the genus in the region of Serra do Ramalho karst area, southwestern Bahia, Brazil. This genus occurs in South and Central America, sub-Saharan central Africa, and in the Arabian Peninsula. The new species can be identified by the following combination of characters: eyes or eyespots absent, coxa I with two and coxa II with 4–5 coxal spines, without microdenticles on the fixed pedipalpal finger, rallum with five blades, ratio ist–est/ist–esb = 1.9. With this new description, the genus now includes 15 species from Brazil: *P. biseriatus* Mahnert, 2001, *P. brasiliensis* Beier, 1970, *P. diamachi* Prado & Ferreira, 2023, *P. gracilimanus* Mahnert, 2001, *P. heterodentatus* Hoff, 1946, *P. homodentatus* Chamberlin, 1929, *P. koinopoliteia* Prado & Ferreira, 2023, *P. lubueno* sp. nov., *P. orthodactylus* Muchmore, 1970, *P. olegario* Schimonsky, 2022, *P. pali* Prado & Ferreira, 2023, *P. ramalho* Assis, Schimonsky & Bichuette, 2021, *P. ricardo* Mahnert, 2001, *P. strinatii* Beier, 1969 and *P. tuxeni* Mahnert, 1979. The new species shows troglomorphic characteristics such as the depigmentation of the carapace and the absence of eyes. In addition, illustrations, diagnoses, an identification key for cave-dwelling species of the genus, and distribution maps for all Brazilian species of *Pseudochthonius* are provided.

**KEY WORDS.** Caves, northeastern Brazil, subterranean, taxonomy, troglomorphic.

## INTRODUCTION

Brazilian pseudoscorpion fauna is remarkable with 183 species distributed in 15 families (Harvey 2013, Schimonsky and Bichuette 2019, Assis et al. 2021, Schimonsky et al. 2022, World Pseudoscorpiones Catalog 2022, Prado and Ferreira 2023). Chthoniidae is the most diverse family, with 881 species and 54 genera. It is distributed worldwide except in Antarctica, with its greatest diversity occurring in the USA (150 species), Spain (98), Italy (91), China (57), Croatia (43), Australia (36), France (35), and Greece (35) (World Pseudoscorpiones Catalog 2022, Hou et al. 2023). In Brazil, Chthoniidae is represented by 34 species in 11 genera: *Heterolophus* Tömösváry, 1884 (2), *Tridenchthonius* Balzan, 1887

(2), *Lechthyia* Balzan, 1892 (1), *Pseudochthonius* Balzan, 1892 (14), *Compsaditha* Chamberlin, 1929 (1), *Tyrannochthonius* Chamberlin, 1929 (4), *Austrochthonius* Chamberlin, 1929 (4), *Soroditha* Chamberlin & Chamberlin, 1945 (1), *Neoditha* Feio, 1945 (1), *Cryptoditha* Chamberlin & Chamberlin, 1945 (2) and *Lagynochthonius* Beier, 1951 (2) (World Pseudoscorpiones Catalog 2022).

*Pseudochthonius* is characterized by the absence of an intercoxal tubercle, the presence of coxal spines on coxae I and II, and in most cases, having strongly sigmoid palpal chelal fingers (Muchmore 1986, Mahnert and Adis 2002). To date, *Pseudochthonius* includes 34 extant species distributed in America Central – six living species of which two are troglobites: *P. troglobius* Muchmore, 1986 from Mexico

(Muchmore 1986) and *P. arubensis* Wagenaar-Hummelinck, 1948, from the Netherlands Antilles (Wagenaar-Hummelinck 1948) and one fossil species (Schawaller 1980) – and of South (with 14 species are from Brazil), sub-Saharan central Africa (five species distributed in the Republic of Congo and Ivory Coast), and the Middle East in the Arabian Peninsula, with one species (World Pseudoscorpiones Catalog 2022).

The known diversity of *Pseudochthonius*, as well as that of Chthoniidae, has been recently increased with the description of five troglobitic species from Brazilian caves (already added to the general numbers herein presented); *P. ramalho*, from a single cave in the Serra do Ramalho karst area, state of Bahia, *Pseudochthonius diamachi* Prado & Ferreira, 2023, *Pseudochthonius koinopoliteia* Prado & Ferreira, 2023, *Pseudochthonius pali* Prado & Ferreira, 2023, also from Serra do Ramalho karst area, and *P. olegario* from a single cave in municipality of Presidente Olegário, state of Minas Gerais (Assis et al. 2021, Schimonsky et al. 2022, Prado and Ferreira 2023). All areas belong to the Bambuí geomorphological group, the largest geomorphological unit in Brazil. Of the 14 *Pseudochthonius* from Brazil, nine occur inside caves, of which seven are considered troglobites: *P. biseriatus*, *P. strinatii*, *P. ramalho*, *P. olegario*, *P. diamachi*, *P. koinopoliteia*, and *P. pali* (Mahnert 2001, Harvey 2013, Assis et al. 2021, Schimonsky et al. 2022, Prado and Ferreira 2023). The present study provides the description of a new troglobitic *Pseudochthonius* species found in a single cave in municipality of Serra do Ramalho, in the Serra do Ramalho karst area, southwestern Bahia, Brazil. We also provide data regarding the conservation status of the new species and the area. A discussion about troglomorphisms in the genus is also provided.

## MATERIAL AND METHODS

### Study area

The Serra do Ramalho karst area comprises the municipalities of Coribe, Feira da Mata, Carinhanha, and Serra do Ramalho. Plateaus are made of limestone rocks belonging to the Bambuí geomorphologic group (Rubbioli et al. 2019). This region is located in southwestern Bahia and comprises extensive limestone landscapes with several caves and karst systems (Figs 1, 2). It belongs to the Sete Lagoas formation, Bambuí group, composed of dark, heterogeneous limestones, interspersed with layers of claystone, deposited approximately 750 to 600 million years ago (Rubbioli et al. 2019), and belongs to middle São Francisco River basin. The climate is tropical dry with a dry winter and the annual precipitation varies between 800 and 1000 mm (Gonçalves et al. 2018). The

region is considered a spot of subterranean fauna (Trajano et al. 2016, Gallão and Bichuette 2018) and the obligatory cave-dwelling fauna is remarkable with representatives in a large variety of taxa (e.g., Bichuette and Trajano 2004, 2005, Bichuette and Rizzato 2012, Gallão and Bichuette 2018).

### Material examined and treatment of specimens

Specimens were prepared by immersion in 85% lactic acid at room temperature for two weeks (Judson 1992). They were then examined by preparing temporary slide mounts with 10 mm coverslips supported by sections of nylon fish line (Harvey 2021). Specimens were examined with Nikon SMZ660 Stereomicroscope and Leica DMLS compound microscope and the male holotype was illustrated with the aid of a camera lucida.

Maps were produced with QuantumGis Desktop 3.10.12 (QGis Open Source Geospatial Foundation). Coordinates were obtained from field trips to the study location with a global positioning system (GPS-Garmin 60CSx).

The examined specimens are deposited in Laboratório de Estudos Subterrâneos, at Universidade Federal de São Carlos (LES, curator: Maria Elina Bichuette), and Museu de Zoologia da Universidade de São Paulo (MZUSP, curator: Ricardo Pinto-da-Rocha).

### Comparative material

Brazil – Caatinga province • *Pseudochthonius ramalho*; 1 male, Serra do Ramalho karst area, Serra do Ramalho, Bahia, Gruna do Vandercir cave; 13°38'11.40"S, 43°50'5.10"W; 31.V.2012; Bichuette ME, Gallão JE, Hattori N leg.; LES 009601. Parana Forest Province • *Pseudochthonius biseriatus*; 1 male, Itacarambi, Minas Gerais, Olhos d'Água cave, 15°7'0.10"S, 44°10'0.10"W, 24.VII.2012, Bichuette ME, Gallão JE and Rizzato PP leg.; LES 009433.

Parana Forest Province • *Pseudochthonius strinatii*; 1 male, São Paulo, Iporanga, Parque Estadual Turístico do Alto Ribeira, Sumidouro da Passoca cave; 24°33'57"S, 48°43'W; 03.XII.2013; Bichuette ME, Gallão JE, Fernandes CS, Rizzato PP, Fonseca R and Arnone I leg.; LES 009391. Atlantic province • *Pseudochthonius olegario*, 1 male, Minas Gerais, Presidente Olegário, Lapa Zé de Sidinei cave; 18.30156°S, 46.09462°W, Galena village, 16.iv.2014, Zepon T, Resende LA and Damasceno G leg.; MZSP76522.

### Terminology and measurements

The terminology and measurements mostly follow Chamberlin (1931), except for legs, pedipalps, and trichobothria follow Harvey (1992); for chelal movable finger

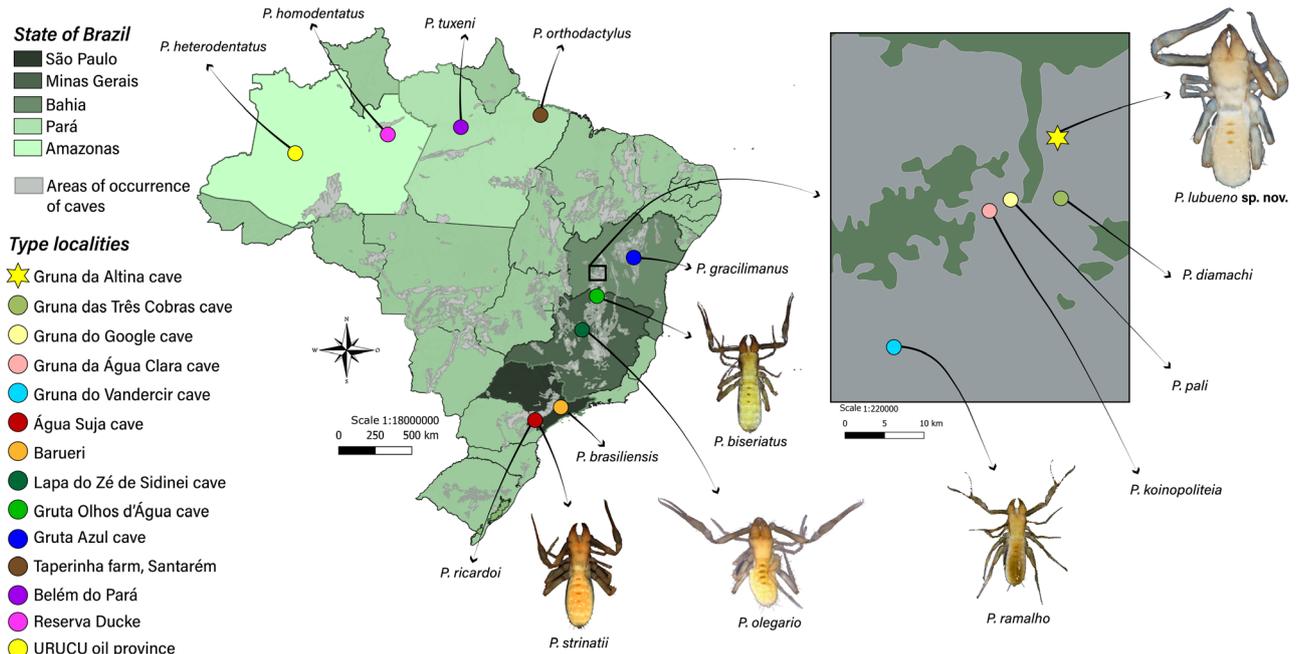


Figure 1. Map showing the distribution of *Pseudochthonius lubueno* sp. nov. in Gruna da Altina cave, located in Serra do Ramalho, Bahia, and the distribution of Brazilian epigeal and hypogean *Pseudochthonius* species, with the troglobitic representatives

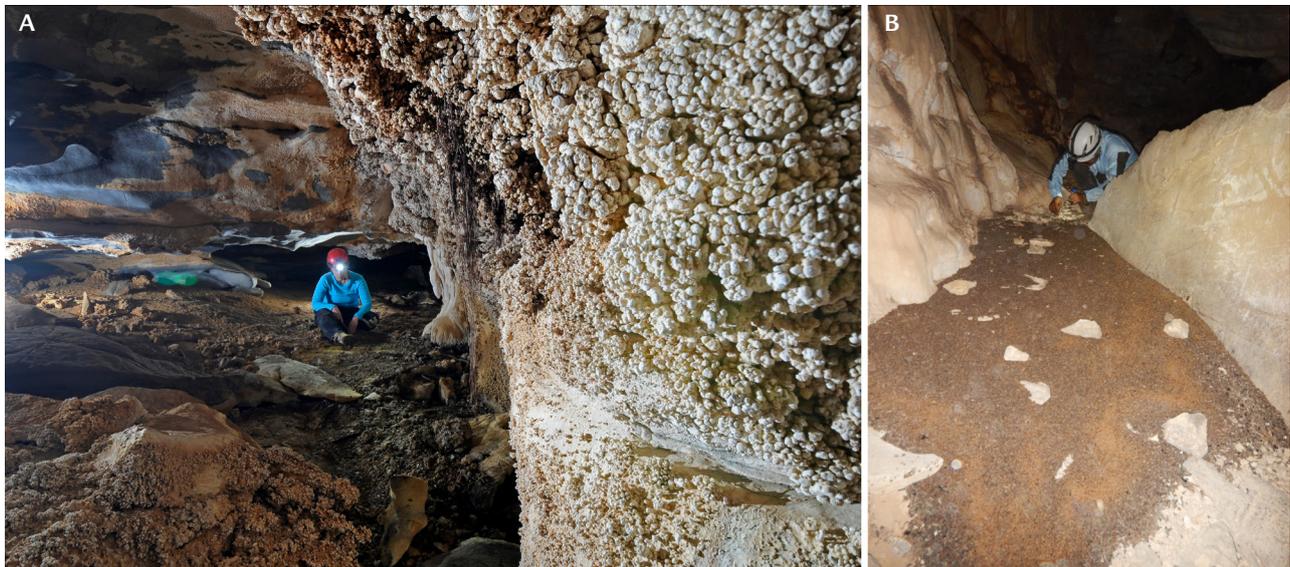


Figure 2. Gruna da Altina cave: (A) details of the microhabitat of *P. lubueno* sp. nov., Photo A. Gambarini; (B) Guano piles, a typical substrate of occurrence of the new species, Photo: M.E. Bichuette.

follow Mahnert et al. (2014); and for chelicera Judson (2007). The chaetotactic formulae of chelicera follow Gabbutt and Vachon (1963) and the duplex trichobothria follow Judson

(2018). Abbreviations. Chelal trichobothria: (b) basal, sb sub-basal, (st) sub-terminal, (t) terminal, (ib) interior basal, (isb) interior sub-basal, (ist) interior sub-terminal, (it) interior

terminal, (eb) exterior basal, (esb) exterior sub-basal, (est) exterior sub-terminal, (et) exterior terminal, (dx) duplicate trichobothria. Cheliceral setae: (gl) galeal, (dt) dorsal terminal, (dst) dorsal sub-terminal, (db) dorsal basal, (vt) ventral terminal, (vb) ventral basal, (di) isolated subapical tooth.

### TAXONOMY

Chthoniidae Daday, 1889

Chthoniinae Daday, 1889

Chthoniini Daday, 1889

*Pseudochthonius* Balzan, 1892

*Pseudochthonius lubueno* sp. nov.

Fig. 3

<https://zoobank.org/01864229-28C0-4FB4-B705-02A200D8AD89>

Type material. Holotype male. BRAZIL: Bahia, Catinga province, Serra do Ramalho karst area, Serra do Ramalho, Gruna da Altina cave; 13°33'39.2"S, 43°45'10.3"W; 27.XI.2015; Bichuette ME, Gallão JE leg.; LES 0014723. Paratype female, same data as holotype; LES 0014724.

Diagnosis. *Pseudochthonius lubueno* sp. nov. bears similarities to the troglotic species of *Pseudochthonius*, *P. strinatii*, *P. biseriatus*, *P. ramalho*, *P. olegario*, *P. diamachi*, *P. koinopoliteia* and *P. pali*, due to it is a moderately sized troglomorphic species with elongate appendages and absence of body pigmentation. However, it differs in other characters and can be identified by the following combination: *P. lubueno* sp. nov. has the rallum with five blades (nine in *P. biseriatus*, 7 in *P. olegario*, seven in *P. diamachi*, seven in *P. koinopoliteia*, and seven in *P. pali*); one distal isolate teeth in movable finger of chelicera (isolated teeth in booth fingers in *P. diamachi*); has epistome with anterior margin slightly serrate on the sides and distinctly serrate with median denticles in the middle (in *P. ramalho*, the anterior margin distinctly serrate with median denticles larger than lateral ones); 1.10 male, 1.24 female body length (1.55 male, 1.45 female in *P. ramalho*, 1.20 male, 1.58–1.60 female in *P. olegario*, 2.02–2.33 female in *P. diamachi*, 1.69 male, 1.7–1.95 female in *P. koinopoliteia* and 1.33 male, 1.70 female in *P. pali*); eyes or eyespots absent (eyespots present in *P. strinatii* and *P. ramalho*); posteriorly constricted carapace (in *P. koinopoliteia* carapace rectangular practically without posterior constriction); without microdenticles on the fixed pedipalpal finger (2 present in *P. ramalho*), 30–31 teeth on the fixed chelal finger (41 in *P. diamachi*, 38 in *P. koinopoliteia*, and 34–39 in *P. pali*, and heterodentate chelal teeth on the fixed finger (homodentate in *P. strinatii*); trichobothrium et near

to dx and it (et distal to it in *P. diamachi* and *P. koinopoliteia*). Concerning the position of trichobothrium ist, closer to esb than to est, *P. lubueno* sp. nov. has the ratio  $ist-est/ist-esb = 1.90$  (3.0 in *P. strinatii*, 1.98 in *P. ricardoii*, 1.22 in *P. gracilimanus*, 4.71 in *P. ramalho*, 1.02 in *P. diamachi*, 0.68 in *P. koinopoliteia*, 2.46 in *P. pali*, 2.37 in *P. tuxeni*, 2.34 in *P. brasiliensis* and 2.06 in *P. orthodactylus*); 3 setae on tergites I–II (2 setae in *P. biseriatus*, 2–4 in *P. diamachi*); coxa I with 2 and coxa II with 4–5 coxal spines (in *P. biseriatus*, I 5+3–4 and II 5+5–6, in *P. ramalho* I 3–5 and coxa II 5–3, in *P. diamachi* I 3–5 and II 4, in *P. koinopoliteia* I 5–6 and II 4–5, *P. pali* I 3–5 and II 5–6, in *P. olegario* I 4 and II 5). The following characters are also different from other Brazilian cave species of *Pseudochthonius*: *P. lubueno* sp. nov. absent eyes, 30–31 teeth on the fixed chelal finger (in *P. gracilimanus* due to the presence of 2 small eyes and 23–26 teeth; in *P. ricardoii* due to 2 eyespots and 43 teeth). *Pseudochthonius lubueno* sp. nov. also differ from *Pseudochthonius* of the world: differs from *P. arubensis*, by the rallum with 6 blades (5 blades in *P. lubueno* sp. nov.) and the number of chelal fixed and movable finger with 28 teeth (in *P. lubueno* sp. nov. fixed finger with 34 male/32 female and movable finger with 29 male/30 female); differ from *P. troglotus* by the rallum with 8 blades, the homodentate chelal teeth on the fixed finger, with 65 teeth and the presence of one small coxal spine on coxa III (in *P. lubueno* sp. nov. rallum with 5 blades, 30 acute teeth and coxal spines on coxa III absent). In the case of ratio trichobothrium ist,  $ist-est/ist-esb$ , (*P. lubueno* sp. nov. = 1.90), 2.4 in *P. arubensis* and 1.72 in *P. galapagensis* Beier, 1977.

There are also differences in the proportions of some body parts: *P. lubueno* sp. nov. 1.3 (1.0 female) times longer than carapace and 2.6 (2.8 female) times longer than patella, differs from the *P. strinatii* 1.3 and 2.0 (2.5 female), and *P. ramalho* 1.4 (1.2 female) and 2.2 (2.6 female); *P. lubueno* sp. nov. pedipalp femur 3.0–4.5 times longer than broad, differs from the *P. biseriatus* (6.4–6.6), *P. strinatii* (5.3–6.8), *P. homodentatus* (4.6–4.9); *P. lubueno* sp. nov. pedipalp chela 5.3 (5.4 female), differs *P. biseriatus* (7.5–8.0), *P. strinatii* (6.7–7.4), *P. diamachi* (7.7–7.8) and *P. ricardoii* (6.0); in *P. biseriatus* femur 1.89 (1.77 female) longer than patella, in *P. ricardoii* 1.72 longer than patella, differs of the *P. lubueno* sp. nov. 3.7 (2.25 female) longer than patella.

Description (male and female). Body: coloration of specimens in 70% ethanol generally pale yellow, tergites III–V with a dark median mark (Fig. 3); Male is slightly smaller than female.

Chelicera (Fig. 4C). Five setae on hand, with one seta (dt) on the basal position of the fixed finger and one seta (gl) close to the basal seta on the movable finger, with

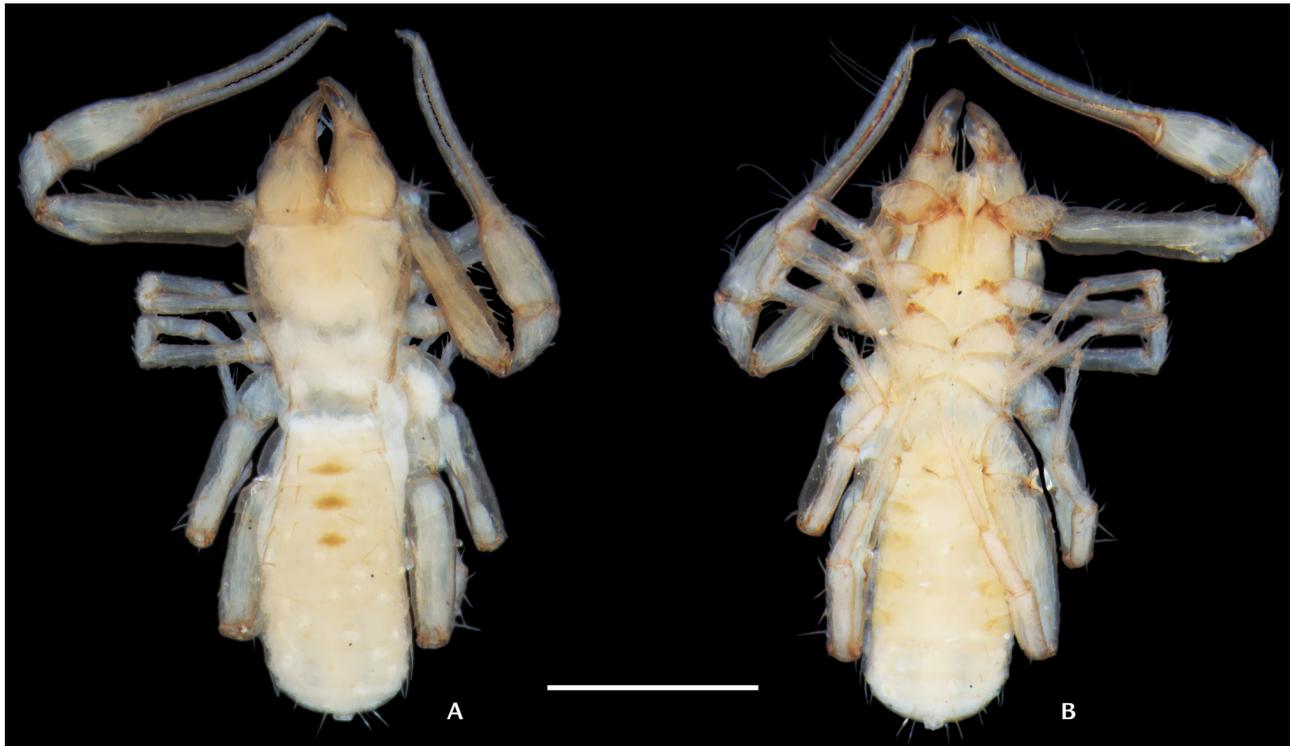


Figure 3. *Pseudochthonius lubueno* sp. nov. Paratype female, habitus: (A) dorsal view; (B) ventral view. Scale bar: 0.5 mm. Photo: Luciana Bueno dos R. Fernandes.

lateral microsetae (vb); All setae acuminate; Fixed finger with 7 (male)/8 (female) teeth proximally reduced in size; Movable finger with 8 (male)/9 (female) teeth proximally reduced in size with subapical isolated tooth (di); Serrula exterior with 12 (male), 13 (female) lamellae; Rallum with 5 blades pectinated (Fig. 4D); Dorsal face of cheliceral palm with 4 lyrifissures, 2 situated near setae it and vb, 1 lyrifissure positioned anteriorly on the fixed finger.

Carapace (Fig. 4A). Anterior margin slightly serrated on the sides and distinctly serrate with median denticles in the middle; Epistome prominent and dentate; without any traces of eyes; posteriorly constricted; Chaetotaxy 6:4:4:2:2 (18), of which one pair are preocular microseta; 2 lyrifissures anteriorly and 1 posteriorly.

Pedipalp (Fig. 5AB). 1.4 (male), 1.2 (female)  $\times$  longer than carapace and 2.2 (male), 2.6 (female)  $\times$  longer than patella; movable finger 1.6 (male), 1.9 (female)  $\times$  longer than hand; fixed finger 1.65 (male), 1.72 (female)  $\times$  longer than hand. Fixed chelal finger long and strongly sigmoid in its distal half. Fixed finger with 34(male)/32(female) acute teeth, distinctly separated from each other, but paired and in each pair, one tooth is slightly directed retrolaterally and

the other prolaterally. Movable finger with 29(male)/32(female) flattened and separated teeth. Trichobothria. ib and isb situated close to each other sub-medially in the dorsal region of the chelal hand; eb closer to esb than to ist, forming a straight oblique row at the base of the fixed chelal finger; ist closer to esb than to the est (ratio ist-est/ist-esb = 1.9); et slightly near the tip of the fixed finger, near to the chelal teeth; dx, located near to the end of the fixed finger; t closer to st and situated at the same level as est.

Abdomen. Chaetotaxy of tergites I–XI: male, 3: 3: 4: 3: 5: 4: 4: 3: 4: 4: 3; female, 4: 4: 4: 4: 5: 6: 6: 6: 5: 3. Chaetotaxy of sternites III–XI: (male/female) 12: 13: 8: 8: 8: 8: 6: 5: 2, anal cone 0/2 setae.

Genital area (Fig. 4F, G): Anterior genital operculum with 9(male)/8(female) marginal and discal setae, genital opening slit-like triangular in male, with 10 marginal setae on each side; posterior operculum with 8 setae in female.

Coxae (Fig. 4E): Manducatory process distally acute, with 2 setae; Pedipalpal coxa with 3 setae; Coxa I with 2 setae on anterior margin and coxa II with 4–5 highly dented coxal spines in decreasing size distally, Coxa III with 6 setae and coxa IV with 8 setae; Intercoxal tubercle absent.

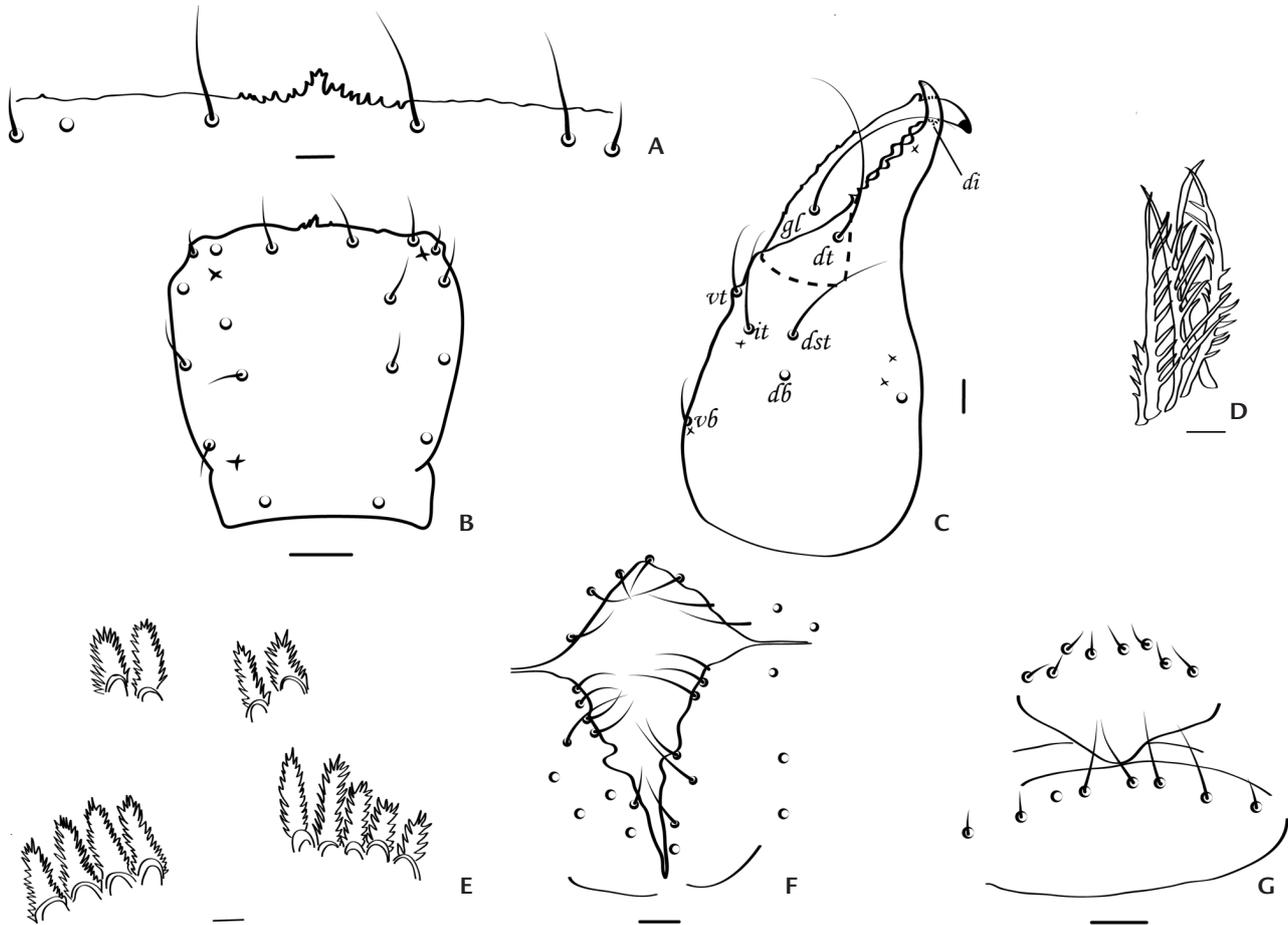


Figure 4. *Pseudochthonius lubueno* sp. nov., male holotype (A-F) and female paratype (G): (A) carapace dorsal view; (B) detail of the anterior margin, with the epistome; (C) left chelicera; (D) rallum; (E) coxal spines of coxae I–II; (F) genital opening; (G) genital opening, paratype. Scale bars: A, C, E, F–G = 0.05 mm, B = 0.2 mm, D = 0.02 mm.

Legs (Fig. 5C, D): Leg I (Fig. 5C): femur 5.9 (male)/7.2 (female) times longer than deep and 1.94 (male)/2.25 (female) longer than patella, patella 3.6 (male)/3.2 (female) times longer than deep, tibia 5.2 (male)/3.8 (female) times longer than deep, tarsus 11 (male)/9.6 (female) times longer than deep, tarsus 1.6 (male)/1 (female) times longer than tibia. Leg IV (Fig. 5D): Trochanter 1.1 (male)/1.2 (female) times longer than broad, femur + patella 2.7 (male)/5.8 (female); Tibia 4.8 (male)/3.2 (female) times longer than deep; basitarsus 4.3 (male)/3.6 (female) times longer than deep; telotarsus 10.5 (male)/14 (female) times longer than deep.

Measurements and ratios: see Table 1.

**Etymology.** The specific epithet is a combination in honor of Luciana Bueno dos Reis Fernandes, technician of Departamento de Ecologia e Biologia Evolutiva, Universidade

Federal de São Carlos, an excellent photographer, illustrator, and enthusiast of cave fauna; it is a noun in apposition.

#### Key to cave-dwelling *Pseudochthonius*

1. Eyeless, eyespots present; trichobothrium ist at least 3× further away from est than from esb (ratio ist-est/ist-esb  $\geq$  3.0)..... 2
- 1<sup>1</sup>. Eyeless, eyespots absent; trichobothrium ist less than 2.8× further away from est than from esb (ratio ist-est/ist-esb  $\leq$  2.8)..... 3
2. Ratio ist-est/ist-esb = 4.71; chelal length = 0.82–0.90; pedipalpal patella larger (4.1), pedipalpal femur smaller (4.1); endemic to Gruna do Vandercir cave, Bahia, Brazil.....  
..... *P. ramalho* Assis, Schimonsky & Bichuette, 2021

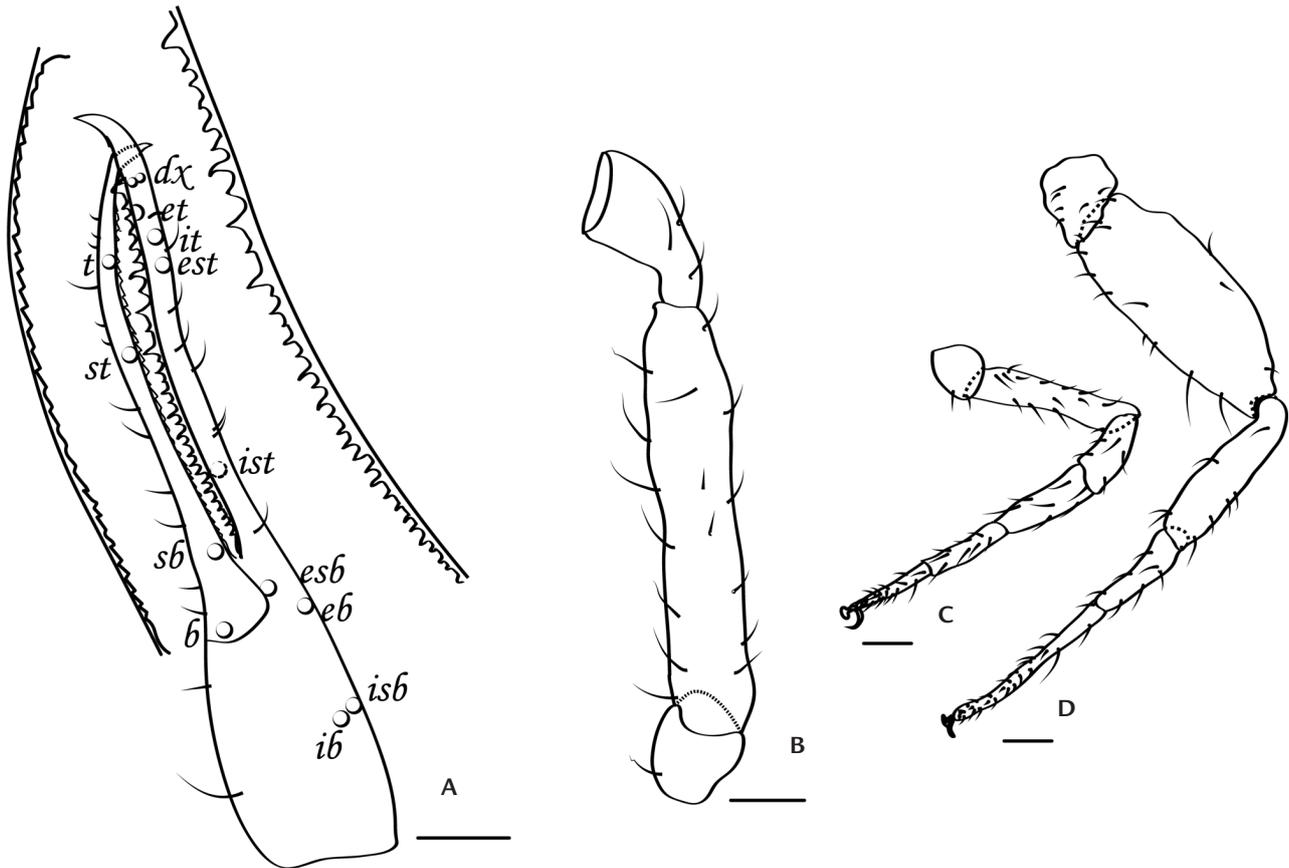


Figure 5. *Pseudochthonius lubueno* sp. nov., male holotype: (A) left chela, lateral view; (B) left palpal trochanter, femur, and patella; (C) leg I, lateral view; (D) leg IV, lateral view. Scale bars: 0.2 mm.

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|---|--|
| <p>2. Ratio ist-est/ist-esb = 3.0; chelal length = 0.82–1.06; pedipalpal patella smaller (2.0), pedipalpal femur larger (5.3–6.1); occurrence in São Paulo, Minas Gerais and Paraná, Brazil..... <i>P. strinatii</i> Beier, 1969</p> <p>3. Tergite I with 2 setae and tergite II with 4 setae ..... 4</p> <p>3'. Setae configuration other than the step above ..... 5</p> <p>4. Ratio ist-est/ist-esb = 1.02–1.11; coxa II with 4 coxal spines; chelal length = 1.43–1.59 pedipalpal femur larger (6.8)..... <i>P. diamachi</i> Prado &amp; Ferreira, 2023</p> <p>4'. Ratio ist-est/ist-esb = 2.46–2.77; coxa II with 5–6 coxal spines; chelal length = 0.87–0.98, pedipalpal femur smaller (5.7) .....<i>P. pali</i> Prado &amp; Ferreira, 2023</p> <p>5. Tergite I and II each with 2 setae ..... 6</p> <p>5'. Tergite I and II each with 4 setae ..... 7</p> <p>6. Ratio ist-est/ist-esb = 1.78–2.10; chelal length = 1.24–1.39; pedipalpal femur smaller (6.3–6.6); endemic to Olhos d'Água cave, Minas Gerais, Brazil.....<br/>..... <i>P. biseriatus</i> Mahnert, 2001</p> | <p>6'. Ratio ist-est/ist-esb = 0.68–0.85; chelal length = 1.04–1.16, pedipalpal femur larger (6.8).....<br/>.....<i>P. koinopoliteia</i> Prado &amp; Ferreira, 2023</p> <p>7. Carapace with 20 setae, including four on posterior margin; coxal spines numerous and varied on coxae I and II and including one small spine on coxa III; ist-est/ist-esb = 1.0; chelal length= 1.73; occurrence at Cueva del Cenote Xtolok, Chichkn Itza, Yucatan, Mexico..<br/>..... <i>P. troglobius</i> Muchmore, 1986</p> <p>7'. Carapace with 18 setae, including two on posterior margin; coxal spines present on coxae I and II, but absent from coxa III; trichobothrium ist closer to esb than to est (<math>2.40 \leq \text{ist-est/ist-esb} \leq 2.49</math>)..... 8</p> <p>8. Rallum with five blades; ist-est/ist-esb = 1.9; chelal length = 0.53–0.76; coxa I with 2 spines, coxa II with 4–5 spines; pedipalpal fixed finger with 30–32 teeth, movable finger with 29–30 teeth; endemic to Gruna da Altina cave, Bahia, Brazil .....<i>P. lubueno</i> sp. nov.</p> |
|---|--|

- 8' Rallum with six or more blades;  $2.40 \leq \text{ist-est/ist-esb} \leq 2.49$ ..... 9
9. Coxa I with 2–3 spines, coxa II with 3–4 spines;  $\text{ist-est/ist-esb} = 2.40$ ; chelal length = 0.7; rallum with six blades; occurrence at the cave of Quadirikiri, Aruba...  
 .....*P. arubensis* Wagenaar-Hummelinck, 1948
- 9' Coxa I with 4 spines, coxa II with 5 spines;  $\text{ist-est/ist-esb} = 2.49$ ; chelal length = 0.89–0.99; rallum with seven blades; occurrence at Zé de Sidinei cave, Minas Gerais, Brazil..... *P. olegario* Schimonsky, 2022

## DISCUSSION

### Distribution of *Pseudochthonius* in Brazil

The Chthoniidae are characterized by the intercoxal tubercle (when present) with the existence of two setae (bisetosis) and transverse spiracles (Harvey 1992). The family is distributed in most regions of the world in both epigeal and hypogean habitats (Harvey 2013, Schimonsky and Bichuette 2019). In Brazil, the family is now represented by 35 valid species (World Pseudoscorpiones Catalog 2022), with a higher incidence in the center of the country, being considered the second with the most described species, 11%

of the total for the country (second only to the family Chernetidae, with 39%) and occurring in high expressiveness in caves (Schimonsky and Bichuette 2019).

The species of *Pseudochthonius* occur in five Brazilian states (Fig. 1): in the state of São Paulo (southeastern Brazil) with representatives of *P. strinatii* and *P. ricardo* (Alto Ribeira karst area), and *P. brasiliensis* (in the region of Barueri); in state of Minas Gerais (southeastern Brazil), with the troglotic species *P. biseriatus* endemic to the cave Olhos d'Água and *P. olegario* endemic to Lapa Zé de Sidinei cave; in the state of Bahia (northeastern Brazil), with the species herein described *P. lubueno* sp. nov., troglotic and endemic to Gruna da Altina cave, *P. ramalho* endemic of the Gruna do Vandercir cave, *P. diamachi* found in Gruna das Três Cobras cave, *P. koinopoliteia* uncovered in Gruna da Água Clara and Pedro Cassiano caves, *P. pali* found Gruna do Google cave and also *P. gracilimanus* found in Gruta Azul cave; in the state of Pará (northern Brazil) with representatives *P. orthodactylus* and *P. tuxeni*; and in the state of Amazonas (northern Brazil) the species *P. homodentatus* has been found in the Ducke Reserve, and *P. heterodentatus* in the Urucu Oil Province. However, recently, this genus was recorded in other karst areas and biogeographical provinces, increasing

Table 1. Measurements in millimeters and proportions (l/b, length/breadth; l/d, length/depth) of the holotype male and paratype female of *Pseudochthonius lubueno* sp. nov.

	Holotype (Paratype)	Holotype (Paratype) l/b; l/d
Body	1.10 (1.24)	
Carapace	0.30/0.26 (0.47/0.39) narrower part posteriorly	0.19 (0.28)
Pedipalpal trochanter	0.11/0.07 (0.12/0.08)	1.6 (1.5) l/b
Pedipalpal femur	0.34/0.11 (0.50/0.11)	3.0 (4.5) l/b
Pedipalpal patella	0.13/0.08 (0.18/0.10)	1.6 (1.8) l/b
Pedipalpal chela	0.53/0.10 (0.76/0.14)	5.3 (5.4) l/d
Pedipalpal hand	0.16/0.10 (0.26/0.14)	1.6 (1.8) l/d
Pedipalpal fixed finger	0.38/0.02 (0.54/0.03)	
Pedipalpal movable finger	0.34/0.01 (0.53/0.02)	
Chelicera	0.22/0.10 (0.36/0.18)	2.2 (2.0) l/b
Chelicera movable finger	0.10 (0.17)	
Leg I femur	0.30/0.04 (0.36/0.05)	7.5 (7.2) l/d
Leg I patella	0.10/0.05 (0.16/0.05)	2.0 (3.2) l/d
Leg I tibia	0.12/0.04 (0.15/0.04)	3.0 (3.8) l/d
Leg I tarsus	0.19/0.02 (0.29/0.03)	9.5 (9.7) l/d
Leg IV trochanter	0.18/0.16 (0.16/0.13)	1.1 (1.2) l/b
Leg IV femur + patella	0.43/0.18 (0.70/0.12)	2.4 (5.8) l/d
Leg IV tibia	0.24/0.05 (0.16/0.05)	4.8 (3.2) l/d
Leg IV basitarsus	0.13/0.03 (0.18/0.05)	4.3 (3.6) l/d
Leg IV telotarsus	0.21/0.02 (0.28/0.02)	10.5 (14) l/d

its distribution to 37 more caves (Schimonsky and Bichuette 2019). *Pseudochthonius lubueno* sp. nov. is the 24 troglobitic pseudoscorpion from Brazil (Schimonsky et al. 2022).

### Conservation remarks

Serra do Ramalho karst area emerges as one of the most important karst regions with obligatory cave-dwelling fauna in Brazil (Trajano et al. 2016, Gallão and Bichuette 2018). Up to now, there are troglobitic representatives in many groups such as collembolas, coleopterans, amblypygids, opilionids, amphipods, isopods, diplopods, gastropods, planarians, fishes and pseudoscorpions, and many more are waiting for formal description. Indeed, the description of obligatory cave-dwelling species is one of the most important acts for the conservation of caves (Gallão and Bichuette 2012, 2018).

Gruna da Altina cave is the type locality of *Loxosceles cardosoi* Bertani, von Schimonsky & Gallão, 2018, a troglophile Sicariidae more related to the Amazonian brown recluse spider, as well as *Loxosceles carinhanha* Bertani, von Schimonsky & Gallão, 2018, from another cave in the same region (Bertani et al. 2018). Bertani et al. (2018) pointed out Serra do Ramalho karst area as an important center of *Loxosceles* distribution. The same is observed for pseudoscorpions. In addition to the remarkable troglobitic fauna, Serra do Ramalho karst area also presents a high diversity of troglophilic species. In this way, conservation acts are extremely urgent for the extraordinary Serra do Ramalho karst area.

*Pseudochthonius lubueno* sp. nov. is possibly endemic to Gruna da Altina cave since specimens were collected in only one of several collections in this cave. Also, we sampled more than 10 caves close to Gruna da Altina cave with no records of *P. lubueno* sp. nov. Up to now, there is no legal protection for Serra do Ramalho karst area, a spot of subterranean biodiversity that suffers with non-sustainable activities as deforestation (Gallão and Bichuette 2018). Official and legal protection in addition to long-term studies is needed to effectively protect this unique and fragile species from Serra do Ramalho karst area.

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