First record of *Pachychernes subrobustus* (Balzan, 1892) from the Brazilian Cerrado biome: notes on the biology of the genus and an identification key (Pseudoscorpiones)

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Abstract: During a field survey on pseudoscorpion diversity in the Brazilian Cerrado (in the central-western region of Brazil), the presence of the genus *Pachychernes* Beier, 1932 was confirmed on the basis of several individuals. Here, the pseudoscorpion of the genus *Pachychernes* Beier, 1932, *P. subrobustus* (Balzan, 1892) is formally reported for the first time from Brazil. A small population was found associated with the bark of rough trees of *Myracrodruon urundeuva* M. Allemão, 1862 (Anacardiaceae). Ecological comments and a taxonomic key for the species of this genus are included.
Key words: Pseudoscorpiones, microhabitat, taxonomy, zoogeography, Brazilian Cerrado, Brazil.

Primer registro de *Pachychernes subrobustus* (Balzan, 1892) del bioma Cerrado Brasileño: notas sobre la biología del género y clave de identificación (Pseudoscorpiones)
Resumen: Durante un estudio de la diversidad de pseudoescorpiones en el Cerrado Brasileño (región centro-occidental de Brasil), se detectó la presencia del género *Pachychernes* Beier, 1932, sobre la base de varios individuos. Se reporta por primera vez de Brasil el pseudoescorpión *Pachychernes subrobustus* (Balzan, 1892), asociado con la corteza de árboles rugosos de *Myracrodruon urundeuva* M. Allemão, 1862. Se incluyen comentarios ecológicos.
Palabras clave: Pseudoscorpiones, microhábitat, taxonomía, zoogeografía, Cerrado Brasileño, Brasil.

The genus *Pachychernes* Beier, 1932, was established by Beier (1932) for the type species *Chelifer* (?*Atemnus*) *subrobustus* Balzan, 1892, from Venezuela (Balzan, 1892; Beier, 1932; Muchmore, 1997; Harvey, 2013). Currently, the genus is represented by ten extant species distributed from North America (southwestern region of USA) to South America (reaching Argentina region), noted here as *P. attenuatus* Muchmore, 1991 from Mexico, *P. baileyi* Feio, 1945, *P. corticalis* Tooren, 2008 from Aruba (Netherlands Antilles), *P. gracilis* Ellingsen, 1902 from Ecuador, *P. robustus* (Balzan, 1888), *P. shelfordi* Hoff 1946 from Mexico and USA, *P. subgracilis* (With, 1908) from Brazil, *P. subrobustus* (Balzan, 1892) from Argentina, Colombia, Paraguay and Venezuela, *P. tamaulipensis* Villegas–Guzman and Pérez (2007) from Mexico, *P. zehorum* Muchmore (1997) from Mexico and Panama, and an extinct species of Dominican amber from the Miocene, *P. effossus* Schawaller, 1980 (Schawaller, 1980; Ellingsen, 1902; Beier, 1932; Roewer, 1936, Hoff, 1946; Villegas–Guzman & Pérez, 2007; Muchmore, 1975, 1997; Harvey, 2013).

The pseudoscorpions fauna of Brazil is currently represented by 15 families and 174 species (Lira *et al*., 2020). An important portion of these species are considered endemic (121 species) (Harvey, 2013; Mendes, 2020). Previous species records are mostly from northern and southern regions of Brazil (Harvey, 2013; Mendes, 2020; Lira *et al*., 2020). However, the Central region of Brazil remains poorly documented (Mendes, 2020). Additionally, the species composition and taxonomy status from majority regions of Brazil remains little understood (Marques & Lamas, 2006; von Schimonsky & Bichuette, 2019). Consequently, the reports of pseudoscorpions are scarce from the Brazilian Cerrado Domain. For this reason, it is convenient to stimulate the augmentation of the investigation efforts on the fauna of pseudoscorpions in the Brazilian Cerrado. Thus, in this study we report the first population of *Pachychernes subrobustus* from the Brazilian savanna.

The study was conducted in the Antônio Marmo Canedo Park (16°18'34,33" S, 48°57'16,56" W), located in Anápolis City, Goiás State, Brazil. The samples occurred in trees of the family Fabaceae, which known to harbor corticolous pseudoscorpions (Ribeiro *et al*., 2018), during the months January and February in 2020. We used tweezers to remove bark from the trees, and small brushes to induce the pseudoscorpions to grasp the bristles and collect them without damaging them. Applying this methodology, we were able to collect five specimens, of which eight were females and two males.

The specimens were dissected with separation of a leg I and IV, a chelicera and a pedipalp, from which the chela was separated. After the examination, the dissected portions were placed in a microvial and preserved in 70% ethanol in the same vial as the rest of each specimen. The specimens were studied using temporary mounts glycerin, a process carried out in the Biodiversity Laboratory of State University of Goias, Anápolis, Brazil. The specimens were examined under a dissecting microscope (Carl Zeiss, plus Axiostar, Germany). Multifocal photographs were taken with an HD digital camera attached to the stereo microscope, using Axiostar, and then united with the image stacking software AxioVision Carl Zeiss (Rel.4.8.2. SP3). Measurements were taken using a micrometer attached to the stereomicroscope, Axiostar, in conjunction with software AxioVision Carl Zeiss (Rel.4.8.2. SP3). Genital organs were observed after immersion in lactic acid for a few hours or longer, and in some cases in 10% KOH solution.

The specimens were confirmed for the family Chernetidae and as member of the genus *Pachychernes*, using the morphological descriptions made by Balzan (1888), Beier (1932), Hoff (1946), Villegas–Guzman & Pérez (2007), Muchmore (1997), and Mahnert *et al*. (2011). Terminology and mensuration mostly following Chamberlin (1931), except for the nomenclature of the pedipalps, legs and with some minor modifications to the terminology of the trichobothria (Harvey, 1992), chelicera Harvey & Edward (2007) and Judson (2007) and face of appendages Harvey *et al*. (2012). The measurements are obtained in millimeters (mm); the width is measured dorsally, except for the legs that are measured laterally. The identified specimens were deposited in the collection of the Arachnid Behavioral Ecology Laboratory, at State University of Goias, Anápolis, Brazil.

Results

***Pachychernes subrobustus* (Balzan, 1892)**

Pachychernes subrobustus (Balzan): Balzan, 1892; With, 1908; Ellingsen, 1910; Beier, 1932: 115–116; Mello–Leitão, 1939: 120.

MATERIAL EXAMINED. BRAZIL. Goiás: Anapolis, Antônio Marmo Canedo Park, [16°18′34.53" S, 48°57′15.06" W, 1027 m.a.s.l.] 15 July, 2019, E. Bedoya–Roqueme, 3♀, (LECA–UEG; ANA–03); Antônio Marmo Canedo Park, [16°18′34.53" S, 48°57′15.06" W, 1027 m.a.s.l.] 15 July, 2019, E. Bedoya–Roqueme, 2♂, (LECA–UEG; ANA–03). BRAZIL. Goiás, Anapolis, Antônio Marmo Canedo Park, [16°18′34.53" S, 48°57′15.06" W,, 1027 m.a.s.l.] 9 January, 2020, RF Ribeiro, 5♀, (LECA–UEG; ANA–03).

DESCRIPTION (ADULTS). Female and male (Figs. 2), according to the descriptions by Balzan (1892), With (1908), Ellingsen (1910), Beier (1932) and the specialized taxonomic key by Mahnert *et al*. (2011). *Pachychernes subrobustus* (Balzan, 1892) can be easily distinguished from other species of the genus by: (a) the carapace slightly longer than wide, (b) clearly granulated; (c) without distinct transverse furrows; (d), with two eye spots and a small concavity in center of carapace; (e) the presence of 45–48 setae, including 4 on anterior margin and 6–8 on posterior margin (Fig. 3A). Additionally, all tergites divided except XI, finely granulated. Tergites I–III with 8–10 setae simple and acuminated, and 1 lateral setae, the others with 12–16 posterior setae and 1–2 lateral and 1–2 marginal medial; XI 8–10 setae (2 tactile setae, 2 setae medial on each side).

Cheliceral hand with 5 acuminate setae (Fig. 3B); rallum with 3 blades (Fig. 3C), the distal one denticulate; fixed finger with 3 teeth, movable finger with tooth–like subapical lobe; galea fairly short with 6 shorts branches (Fig. 3B); serrula exterior with 21 blades (Fig. 3B).

Female genital region with a central group of 18–28 setae, plus 10 marginal setae; spermathecae H–shaped with 4 lobes. Anterior genital operculum of male with a set of 23–25 small setae grouped on each side of operculum on the anterior region and 4 setae on margin, posterior operculum with 10–12 setae. Pedipalps (Figs. 3D–3E): femur robust, finely granulated, all setae acuminate, male 2.3 × (female 2, l–2.2 ×), patella male 2.8 × (females 2.1×).

Male chelal hand with slight excavation and quite densely covered with longer setae on prolateral margin, female chelal hand not modified (Fig. 3D–3G). Chelal fingers of the male almost as long as the fingers of the female, but clearly shorter than the hand without pedicel. fixed chelal of both male and female with approximately 38–42 teeth and 12 retrolateral accessory teeth, movable finger chelal with approximately 36–38 teeth and eight retrolateral accessory teeth each; distribution of trichobothria as in (Fig. 3F), Trichobothria *isb*, *ib*, *ist* and *it* forming a group near the base of the fixed finger, trichobothrium *est* distal of *et*, clearly closer and at the same level of *esb* (Fig. 3F).

All legs light yellow, robust, setae acuminate, tactile setae of tarsus IV located at the midpoint (Fig. 3H). Arolium not divided, shorter than the claws.

MEASUREMENTS (MM): males (females in parenthesis), body length 2.93–3.1 (3.93–4.1); carapace 1.21–1.23/0.83–0.85 (1.22–1.23/0.87–0.89). Chelicera 1.09–1.21/0.83–0.85 (0.25–0.27/0.15–0.17). Pedipalp: trochanter 0.46–0.48/0.32–0.34 (0.58/0.32); femur 0.78–0.80/0.34–0.36 (0.75–0.76/0.33); patela 0.78–0.79/0.40–0.42 (0.79–0.81/0.42–0.43); hand (with pedicel) 0.95–0.97/0.65–0.66 (0.90–0.91/0.50–0.53); chela (with pedicel) 1.65–1.67/0.65–0.66 (1.75–1.77/0.50–0.53); chela (without pedicel) 1.57–1.59/0.65–0.66 (1.70–1.75/0.50–0.53); movable finger length 0.76–0.78 (0.65–0.70). Leg I: trochanter 0.19–0.20/0.12–0.13 (0.22–0.23/0.13–0.14); femur 0.24–0.25/0.12–0.13 (femur 0.25–0.26/0.14–0.16); patella 0.28–0.29/0.14–0.15 (0.31–0.33/0.14–0.15); tibia 0.30–0.31/0.09–0.10(0.33–0.34/0.10–0.11); tarsus 0.27–0.29/0.07–0.09 (0.30–0.32/0.07–0.09). Leg IV: trochanter 0.27–0.29/0.15–0.17 (0.31–0.33/0.17–0.19); femur + patella: 0.80–0.82/0.19–0.21 (0.83–0.84/0.22–0.23); tibia 0.44/0.16(0.44–0.45/0.15–0.16); tarsus 0.40–0.41/0.13–0.14 (0.42–0.44/0.09–0.11).

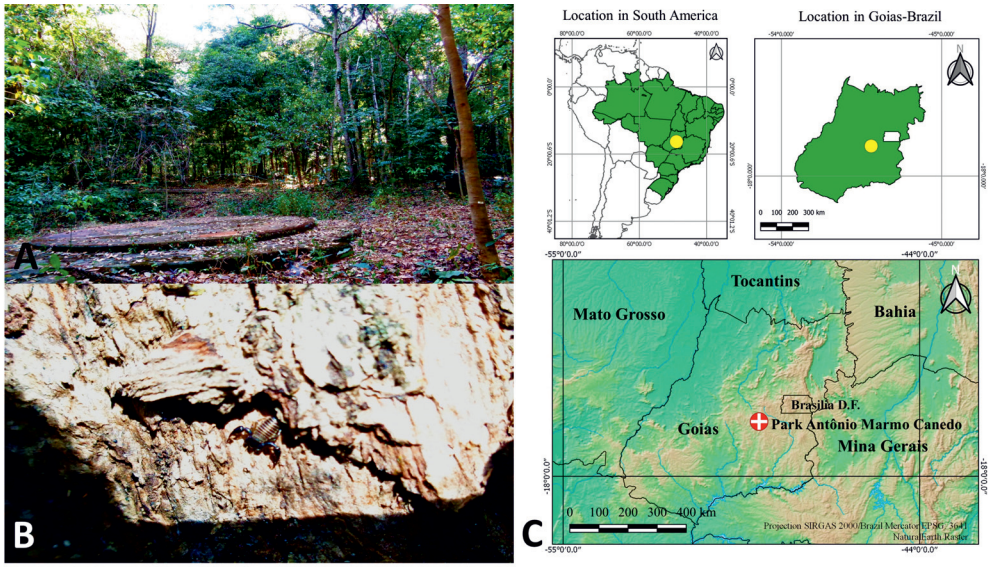
DISTRIBUTION. Argentina, Brazil*, Colombia, Paraguay, Venezuela (Fig. 1C).

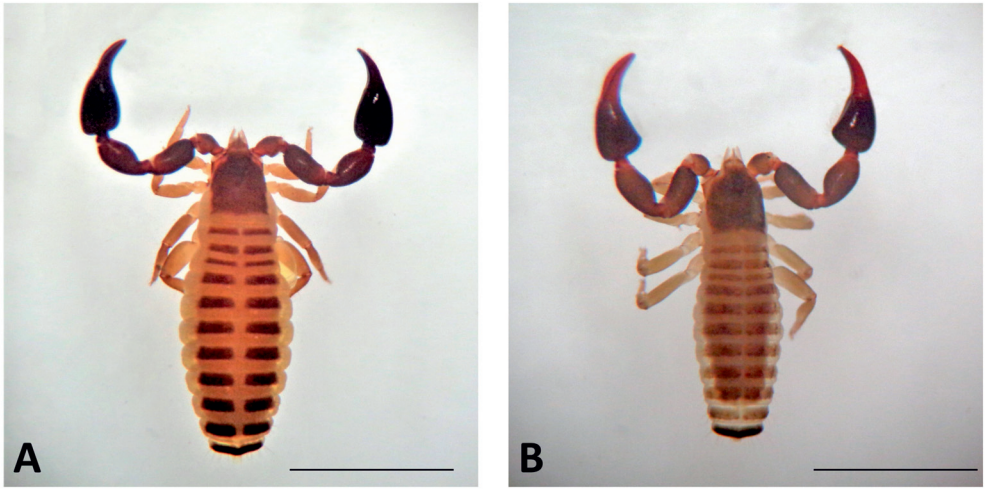
COMMENTS. *Pachychernes subrobustus* (Balzan, 1892) was collected under bark of rough trees of Aroeira (*Myracrodruon urundeuva* M. Allemão, 1862 (Anacardiaceae)) in environmental park Antônio Marmo Canedo, Anápolis, Goiás, Brazil, which has vegetation typical of the Brazilian Cerrado domain (Fig. 1A–1B). Other species of the genus *Pachychernes* has been collected under tree bark, such as *Pachychernes zehorum* Muchmore, 1997, which was collected from bark in Panama and Mexico (Muchmore, 1997). The specimens collected from Antônio Marmo Canedo Park (3♀ and 2♂) represent the first record of *P. subrobustus* from Brazil, having been found in Argentina, Colombia, Paraguay and Venezuela. The pseudoscorpion fauna in Brazil is now represented by 174 species distributed in the different biomes and regions of this country.

Identification key to the species of *Pachychernes*

Updated from the original taxonomic keys provides by Beier (1932) and Feio (1945)

1. Pedipalp slender, with femur of more than 4× (male), 3.5× (female) longer than broad..... *P. attenuatus* Muchmore.
– Pedipalp not as slender, with femur less than 3.5 × (male and female)..... 2
2. Hand pedipalpal 1.2 × longer than the patella or shorter; carapace finely granulate..... 3
– Hand pedipalpal 1.5 × longer than the patela; carapace almost smooth..... *P. gracilis* (Ellingsen)
3. Femur pedipalpal 2.4×, patella 2.1 × longer than broad 4
– Femur pedipalpal 2.7 ×, patella 2.3 × longer than broad ..... *P. robustus* (Balzan)
4. Chela (with pedicel) 3 × longer than broad..... 5
– Chela with pedicel 3.5 × longer than broad..... *P. subgracilis* (With)
5. Female spermathecae H–shaped, with thickened or elongated tubes; tibia I without modified setae; tarsus without modifications..... 6
– Female spermathecae with thin tubes, sometimes difficult to observe (see Muchmore 1997, fig.1); tibia I of male with both long and short modified setae; tarsus with dorsal depression (see Muchmore 1997, fig.4)..... *P. zehorum* Muchmore
6. Serrula exterior with 22–28 blades..... 7
– Serrula exterior with 21 blades; male chelal hand slightly excavated prolaterally and quite dense covered with longer setae; leg IV with tibia 3.2 and tarsus 3 × longer than broad..... *P. subrobustus* (Balzan)
7. Spermathecae H–shaped, consisting of elongated and thin tubes 8
– Spermathecae H–shaped, consisting of short, thickened tubes (see Muchmore, 1975; fig. 9) ..... *P. shelfordi* Hoff, 1946
8. Pedipalpal femur more than 2.2 × times longer than broad; patella 2.1× times longer than broad; spermathecae with thick tubes, folded and terminated in globose expanded sacks..... 9
– Pedipalpal femur 1.96–2.12 × times longer than broad; pedipalpal patella 1.83–1.96 × times longer than broad; spermathecae with very thin tubes terminating in very thin sacs (see Tooren, 2008; fig.3b)..... *P. corticalis* Tooren
9. Carapace with single faint transverse furrow; smaller, e.g. pedipalpal femur length 0.78–0.83 mm (female), 0.97–0.99 mm (male); carapace length 0.76mm (female), 0.88 mm (male); spermathecae terminating in two sacs, anterior pair without folding (see Villegas–Guzman & Pérez 2007; fig. 5)..... *P. tamaulipensis* Villegas-Guzman & Pérez
– Carapace with 2 distinct furrows; larger, e.g. pedipalpal femur length 1.10 (female), 0.80-0.97 mm (male); carapace length 1.02 mm (female), 0.93-1.24 (male); spermathecae terminating in two sacks, anterior pair with folding (see Mahnert, 1979; fig. 118) ..... *P. baileyi* Feio





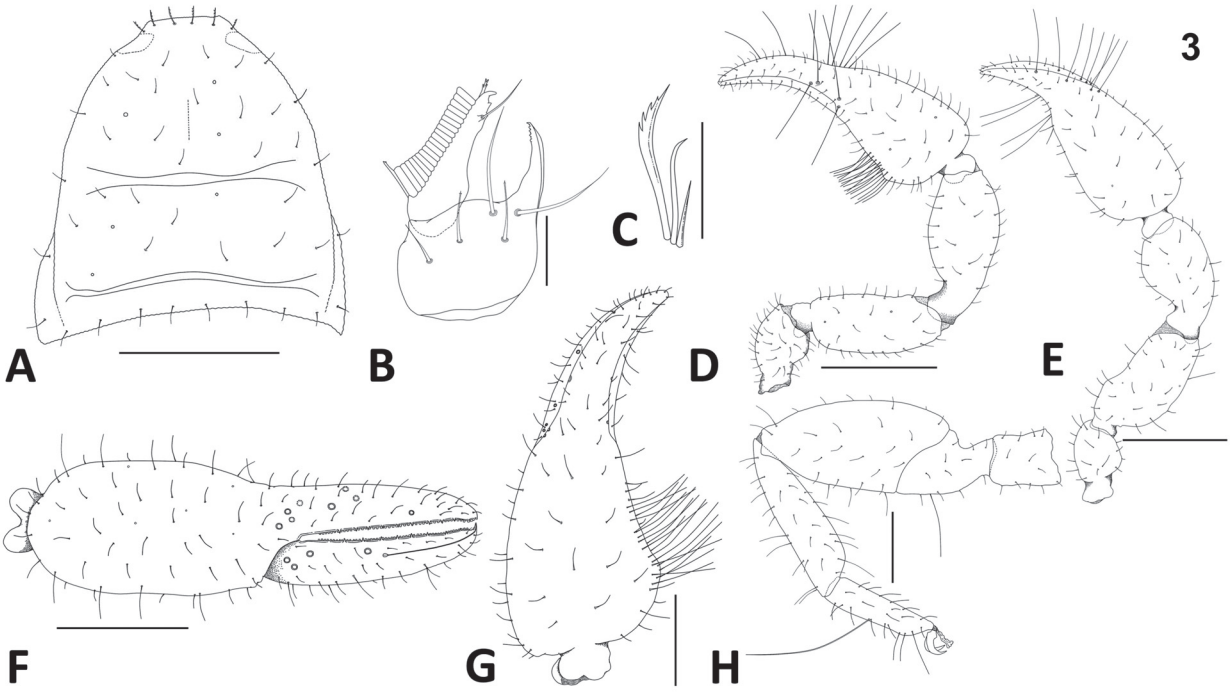


Fig. 1. *Pachychernes subrobustus* (Balzan, 1892): **A**, Antônio Marmo Canedo Environmental Park, Anapolis, Brazil. **B**, Habitus, live specimen. **C**, Location study area in Brazil. **Fig. 2.** *Pachychernes subrobustus* (Balzan, 1892), Habitus: **A**, female, dorsal view. **B**, male, dorsal view. Scale line= Figs 2A–2B: 1 mm; Figs 2C–2D: 0.05 mm. **Fig. 3.** *Pachychernes subrobustus* (Balzan, 1892): **A**, carapace, dorsal view. **B**, left chelicera, dorsal view. **C**, left rallum, lateral view. **D**, male, right pedipalp. **E**, female, right pedipalp aspect. **F**, right chela, lateral view. G, Left chela. **H**, left leg IV, lateral view. Scale lines = Figs. 3A: 0.5 mm; Fig. 3B: 0.1 mm; Fig. 3C: 0.05 mm; Figs. 3D–3H: 0.2 mm.

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