



A new species of the sun-spider genus *Mummucia* (Arachnida: Solifugae: Mummucidae) from Piauí, northeastern Brazil

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Abstract

The Brazilian solifuge *Mummucia ibirapemussu* new species (Solifugae, Mummuciidae) from Serra das Confusões National Park, in the semi-arid Caatinga domain, is herein described, with illustrations and SEM pictures of the main taxonomic characters. Geometrical morphometric analyses were also performed and indicated that this new species can be accurately distinguished from *Metacleobis fulvipes* regarding the shape of propeltidium.

Key words: taxonomy, geometric morphometric analysis, solpugid, solifugid, Caatinga

Introduction

Despite the fact that the order Solifugae is less diverse than Acari, Araneae, Opiliones, Scorpiones and Pseudoscorpiones (Harvey, 2002; Rocha and Cancellato, 2002a), this group is still poorly known in South America (Rocha and Cancellato, 2002b). It is possible that the low diversity currently known to the Neotropical Region could merely reflect the lack of taxonomists currently working on the group, which resulted in a small number of species described in the current decade (Harvey, 2007). The most important studies on South American species were done by Roewer (1934) and Maury (1970, 1982, 1984, 1987, 1998). A few recent contributions have been published, extending the geographical distribution of Brazilian species (Rocha, 2003; Rocha and Cancellato, 2002a, c; Rodrigues *et al.* 2007), describing new species from Neotropical domains such as Caatinga (Xavier and Rocha, 2001) and Cerrado (Martins *et al.* 2004; Rocha and Carvalho, 2006), or redescribing species based on recent collected specimens (Rocha and Cancellato, 2002b).

The known distribution of Solifugae species in Brazil is still fragmentary, with large areas without records (see Rocha and Cancellato, 2002a). Presently, there are only two records in northeastern Brazil: a single juvenile Ammotrechidae collected at Balsas, State of Maranhão; and the type series of *Mummucia mauryi* Rocha (Mummucidae), whose type-locality is Ibiraba, State of Bahia (Rocha and Cancellato, 2002a; Xavier and Rocha, 2001).

In this paper we present the first records of Solifugae from the State of Piauí, Northeastern Brazil, describing a new species of the genus *Mummucia* from the Serra das Confusões National Park in the Caatinga domains. We also performed geometric morphometric analyses to compare the new *Mummucia* species with *Metacleobis fulvipes* Roewer 1934 (redescribed by Rocha and Cancellato, 2002b).

The individuals were collected at Serra das Confusões National Park (09°27'–09°31'S, 043°05'–043°56'W), in the municipalities of Guaribas and Caracol in the State of Piauí, northeastern Brazil. The climate is hot tropical semi-arid, with temperatures ranging from 18°C to 38°C (average 25°C) (Araújo et al. 2006). The Serra das Confusões National Park is a 500,000ha reserve, covered by Caatinga phytophysionomies (arboreal Caatinga, shrubland Caatinga, and enclave forests) located on the arenitic plateaus (chapadas) and depressions of the Parnaíba River Basin (see Gregorin et al. 2008, for details).

Methods

We compared adult males of *Mummucia ibirapemussu* **n. sp.** (n=14) and *Metacleobis fulvipes* (n=10) regarding their propeltidium geometry because these species are the only mummuciids whose cheliceral dentitions are just slightly distinct. These morphometric analyses were performed only between these two species owing to difficulties in obtaining a reasonable number of specimens of other mummuciids. Digital images of the male propeltidium of both species were captured by a Leica DFC320 digital camera coupled to a Leica S6 stereoscope equipped with plain lenses which avoid image distortion. For each propeltidium, coordinates of eight landmarks (Fig. 1) were digitized and assembled into matrices.

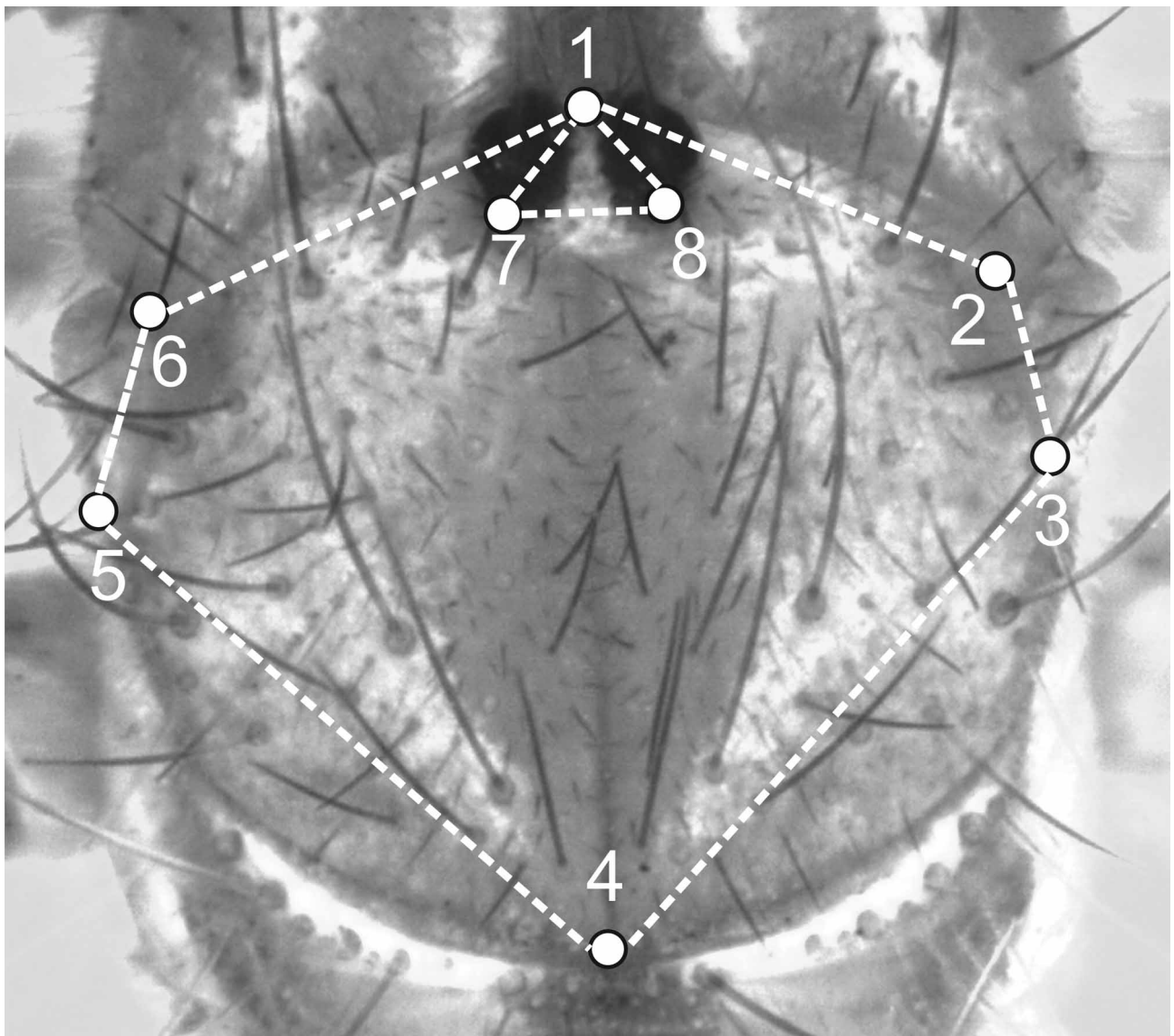


FIGURE 1. Propeltidium of *Mummucia ibirapemussu* **n. sp.** (male) with the eight landmarks chosen for geometric morphometrics.

Geometric morphometrical analyses were performed in general accordance to Rohlf (1999) and are summarized as follows. Propeltidium shape was assessed after discarding isometric size variation and following that, its relative warps (principal components) were graphically plotted describing the morphospace of the comparison between both species. Consensus configurations of propeltidium were built from shape coordinates after translating, scaling and rotating each specimen and were used to compare both species.

To test the accuracy of the morphometric classification, each individual was reclassified according to its propeltidium similarity to the average shape of each species. Mahalanobis distances (Mahalanobis, 1936) were used to estimate metric distance in this discriminant analysis. Landmark (LM) digitizing, data analyses and graphs were done using software packages BAC and PAD (Dujardin, 2010) and TPS software package (Rohlf, 2001).

The sampling at Serra das Confusões National Park occurred in October 2006 and July 2007, with large pit-fall traps (four 60L plastic buckets, connected by 60 cm plastic drift fences in a Y-shaped design – composed of one central bucket and one at the end of each arm). A total of 30 arrays were installed and each one was inspected daily (samples of 24 hours).

The specimens are deposited in the following collections: Museu Paraense Emílio Goeldi (MPEG, A.B. Bonaldo), Instituto Butantan (IBSP, A.D. Brescovit), and Museu de Zoologia da Universidade Estadual de Feira de Santana (MZUEFS, F. Bravo). The formulae of cheliceral dentition followed Muma (1951) and leg spination terminology and abbreviation followed Rower (1934), Muma (1951) and Maury (1970). All measurements are given in millimeters (except propeltidium length/width ratio). Scanning Electronic micrographs were obtained with a Zeiss LEO (1450 VP) scanning electron microscope (SEM) from the Laboratório Institucional de Microscopia Eletrônica de Varredura from MPEG.

Taxonomy

Family Mummuciidae

Genus *Mummucia* Simon, 1879

Mummucia ibirapemussu, new species

Figs. 2–31.

Type material. Holotype: Male from Serra das Confusões National Park (S09°03'85'', W043°46'31''), Guaribas and Caracol, Piauí, Brazil, VI–VII.2007, P.R.R. Silva et al. leg., MPEG 0005. **Paratypes:** fifteen males and three females, same data as holotype, MPEG 0006–0015, IBSP and MZUEFS.

Etymology: From Tupi, an ancient Indian language, by agglutination of *ibirapema* = indigenous weapon used to kill a prey and *uassu* = large. This name makes reference to the large chelicerae of Solifugae.

Diagnosis: *Mummucia ibirapemussu* **n. sp.** resembles *M. mauryi* by the pleurite coloration but differ to that species by its movable finger teeth, graded in size from distal to proximal II, III and I (Figs. 9–10; 13–14). Besides, *Mummucia ibirapemussu* **n. sp.** resembles *Metacleobis fulvipes* concerning the overall cheliceral dentition. In *Mummucia ibirapemussu* **n. sp.**, the fourth distal tooth of fixed finger is smaller than the second (males and females) whereas in *Metacleobis fulvipes* the size of those teeth are similar. Total body length is smaller in *Mummucia ibirapemussu* **n. sp.** Pleurite coloration is different between these two species.

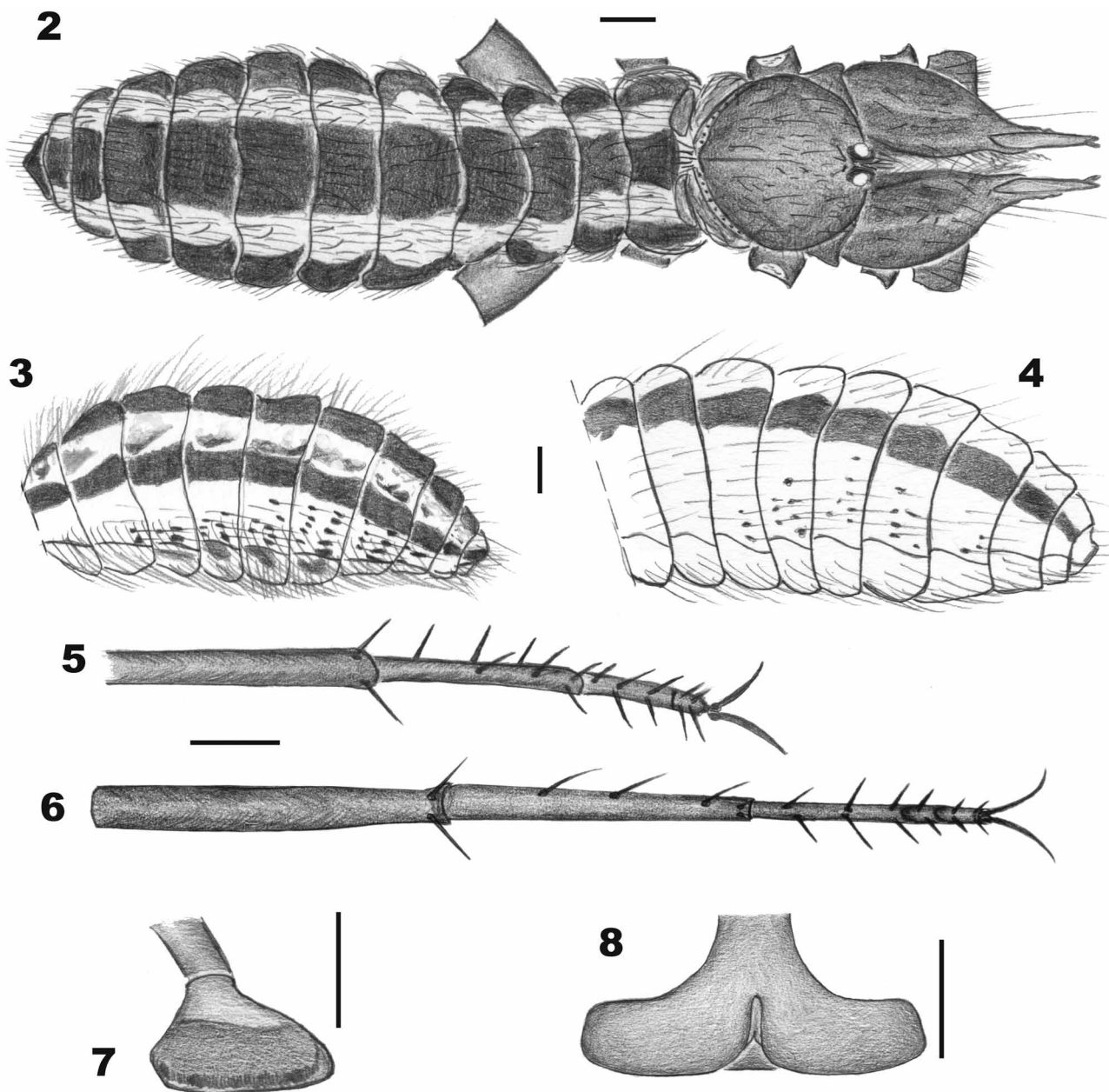
Description. Male holotype (MPEG 0005).

Coloration in 70% ethanol. Prosoma: propeltidium whitish yellow, with central portion pale yellow larger than ocular tubercle in the median region, whitish yellow in the border of the lateral lobes. Ocular tubercle with a narrow longitudinal whitish yellow stripe between the eyes and a black ring surrounding each eye. Peltidium whitish yellow and parapeltidium white. Mesopeltidium and metapeltidium with a brown central stripe and lateral white stripes, each stripe a third of the tergite width (Fig. 27).

Chelicerae pale yellow, with three longitudinal, distally fused, white stripes on the ectal face.

Pedipalpi and legs pale yellow, with slightly darker ends. Malleollus of the trochanter II grey with large brown spots on the enlarged portion (Figs. 7, 17) and the remaining malleollus whitish.

Opisthosoma: lateral borders of the tergites white, with a wide dark brown stripe on the central half, which is darker near the posterior border of the tergites. White area of the tergites covered by brown bifid setae with brown sockets and scattered brown marks. Pleurites white on the ventral portion, dorsal portion brown. Pale brown translucent bifid bristles in the white portion have sockets shaped into brown spots. Sternites white, lateral borders brownish. Anal segment almost totally brown. First to fourth postspiracular sternites with brown spots which include the sockets of some bifid bristles. All covering bristles and bifid bristles are translucent yellowish.



FIGURES 2–8. *Mummucia ibirapemussu* n. sp. 2. Male habitus, dorsal view. 3. Male opisthosoma, left lateral view. 4. Female opisthosoma, left lateral view. 5. Male leg III. 6. Male leg IV. 7. Right malleolus V of male holotype. 8. Genital operculum of female. Scale bars: Figs. 2–6, 0.5 mm. Figs. 7–8, 0.25 mm.

Morphology and chaetotaxy. Prosoma: propeltidium wider than long (Table 1) with some scattered bifid setae, and separated from lateral lobes by dorsal grooves. Ocular tubercle prominent with one transversal row of anteriorly oriented bifid setae and two longitudinal rows between the eyes. Distance between two eyes

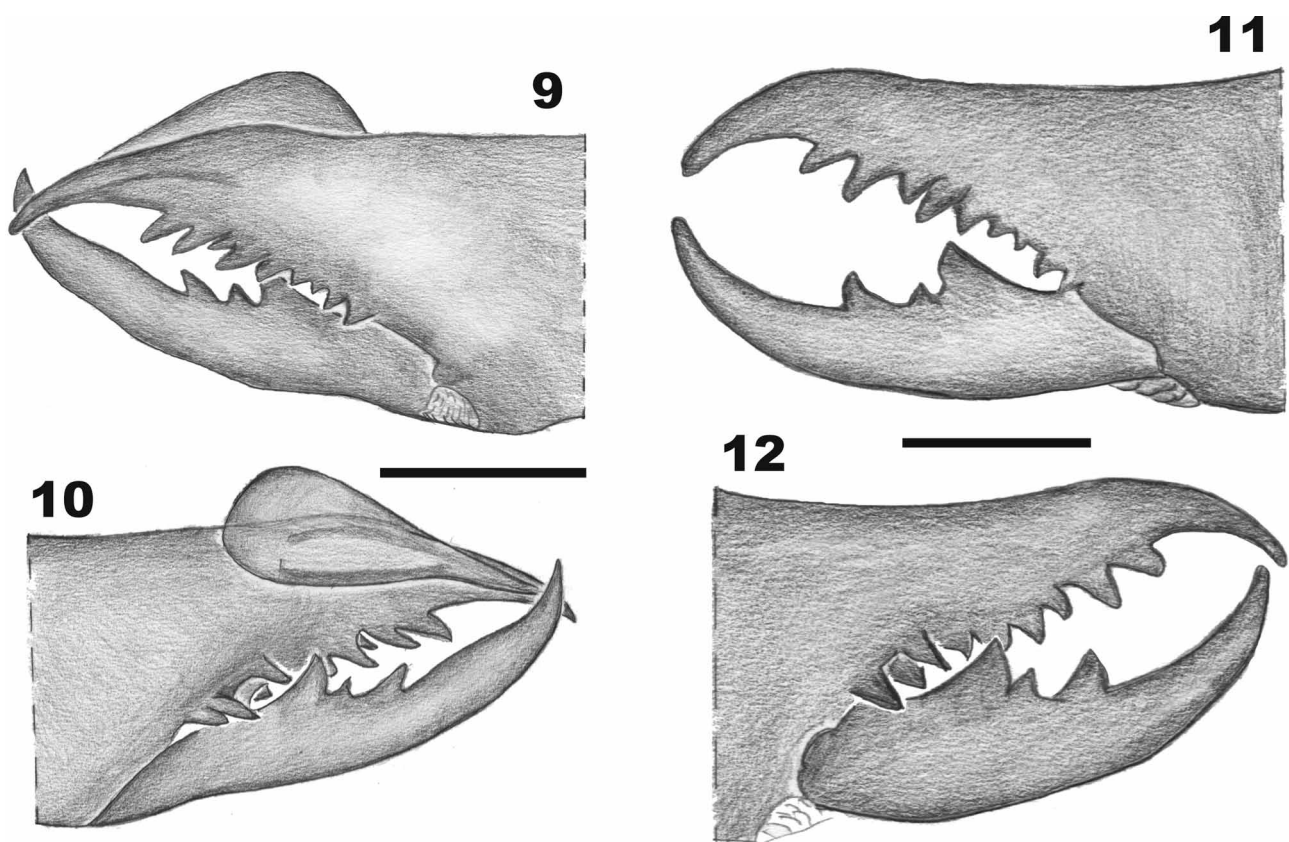
about 1.5 times eye diameter. Peltidium narrow, with a transverse row of different sized bifid setae. Parapeltidium smooth. Mesopeltidium trapezoidal-shaped, 2.5 times wider than long, with one row of bifid setae on posterior margin. Metapeltidium 1.6 times wider than long.

Chelicerae (Figures 9–10; 13–15): stridulatory apparatus on mesal face with seven parallel grooves (Fig. 13–14). Ectal face with several short bristles and setae, both bifid and acuminate. Movable finger with one anterior, one intermediate, and one principal tooth, graded in size from distal to proximal II, III and I (Figs. 9–10, 14). Fixed finger with two anterior and two principal teeth graded in size from distal to proximal II, I, IV, III; five ectal fondal teeth, graded in size: I, III, V, II, IV and three mesal fondal teeth, graded in size from distal to proximal I, II, III, the first distal separated from the others by a diastema (Figs. 9–10, 14–15). Fixed finger bears, centrally on its dorsal face, one very long seta (about the length of femur III) with a prominent socket (Fig. 14).

Flagellum (Figs. 9–10, 13–16): a thin translucent drop-shaped vesicle, laterally flattened as in other mummuciids; with a long longitudinal ectal opening. The attachment of the flagellum is a sclerotized ring placed posteriorly on its ectal face; and its distal portion is irregularly brush-like (Fig. 16).

Pedipalp: tarsi immovable, without spines, densely covered by different sized bifid bristles and several short acuminate bristles, with some very long setae in tibiae and femur (about 1.1 times pedipalpal tibial length).

Legs: covered by several different sized bifid bristles and some bifid setae (see Fig. 26). Some very long setae on the dorsal surface (about 2.6 times the basitarsus IV length). Leg I: thin, without claws and spines. Legs II and III: tibiae with a distal pair of ventral spines; basitarsus with three retrolateral spines and 1.1.2 ventral spines; telotarsi two-segmented with 1.2.2/2.2 ventral spines (Fig. 5). Leg IV: tibia with a distal pair of ventral spines; basitarsus with 1.1.1.2 ventral spines; telotarsi three-segmented, with 2.2.2/2/2.2 ventral spines (Fig. 6). The three segments of the telotarsi IV with some ventral spines can be seen in Figure 26. Malleoli as in Figures 7 and 17.



FIGURES 9–12. *Mummucia ibirapemussu* n. sp., left chelicerae. 9. Male holotype, ectal view. 10. Same, mesal view. 11. Female paratype, ectal view. 12. Same, mesal view. Scale bars: 1 mm.

Opisthosoma: tergites wider than long (Figs. 2, 27), with rounded borders, covered by bifid setae and bifid bristles. Genital operculum with central longitudinal opening. Sternites wider than long, densely covered by bifid bristles. Posterior border of 2nd post-spiracular sternite with a row of about 50 ctenidia, more rigid and slightly longer than the bifid bristles in sternites (Fig. 24). Two post-spiracular sternites with several long and acuminate bristles, 1.5 times longer than other sternite bristles. Pleurites as in Figure 3.

Measurements: see Table 1.

Female paratype (MPEG 0010).

As in male, except for the following features.

Morphology and chaetotaxy. Prosoma: Eyes separated by 1.25 times their diameter. Mesopeltidium twice wider than long. Metapeltidium 1.7 times wider than long.

Chelicerae (Figs. 11–12, 19–22): Movable finger with one anterior, one intermediate, and one principal tooth, graded in size from distal to proximal II, III, I (Figs. 11–12, 20, 22). Fixed finger with two anterior and two principal teeth graded in size from distal to proximal II, I, IV, III; five ectal fondal teeth, graded in size: I, III, V, II, IV (Figs. 11–12, 20–21). Three (as in males; Fig. 12) or two mesal fondal teeth separated by a diastema.

Opisthosoma: sternites densely and uniformly covered by bifid bristles, without conspicuous sockets (Fig. 24). Genital operculum (Fig. 23) prominent, round-bordered, with central longitudinal opening. Pleurites as in Figure 4.

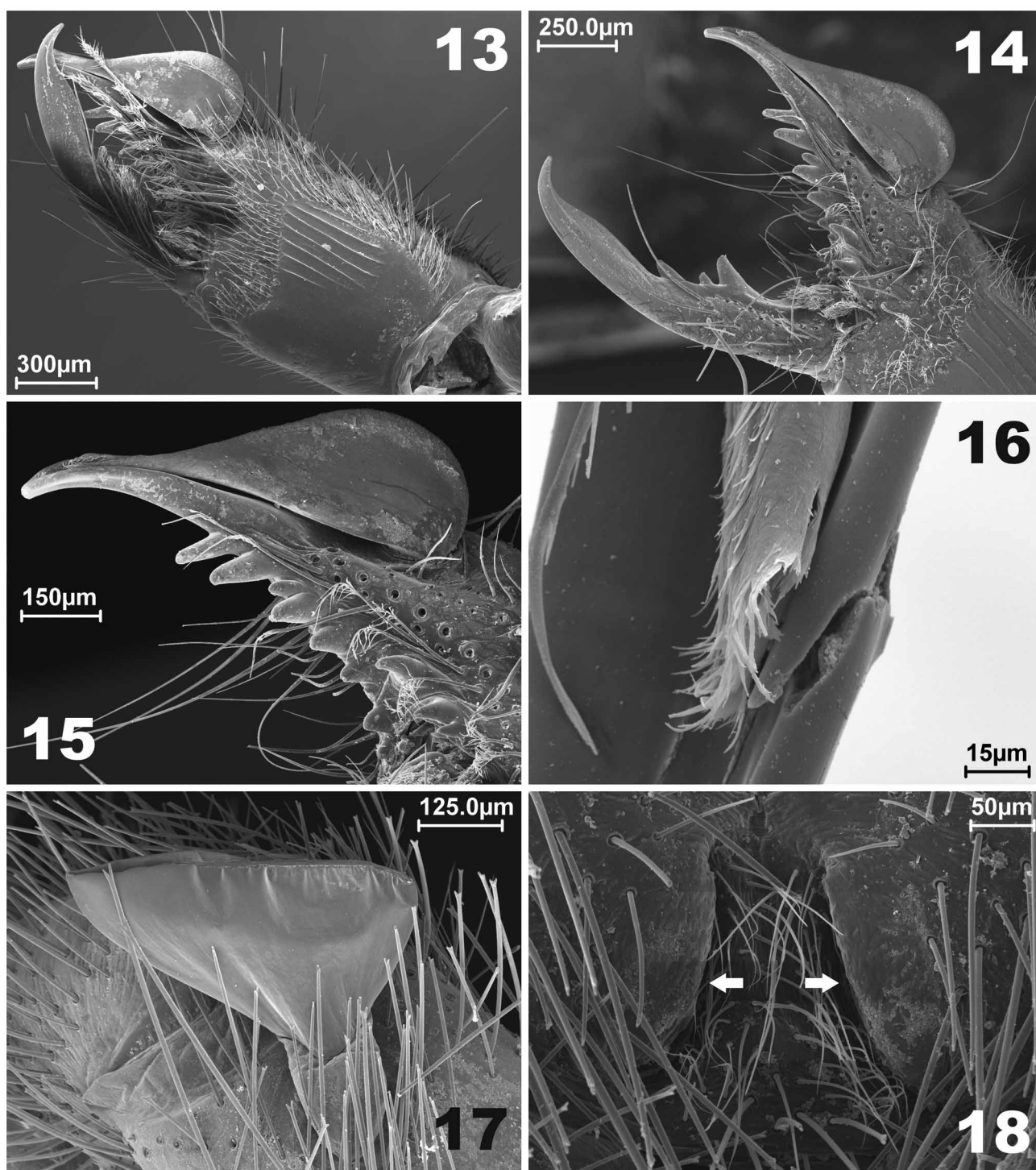
Measurements: see Table 1.

Intraspecific variation. The white area of the tergites of most of the male paratypes lack the brown scattered marks present on the holotype, probably owing to degradations of the tissue caused by poor preservation of the specimen. The female used for SEM pictures had only four ectal fondal teeth, while the remaining female paratypes have five ectal fondal teeth.

TABLE 1. Morphometric characters of *Mummucia ibirapemussu* **n. sp.**. Measurements are in millimeters (except propeltidium length/width ratio).

Morphometric character	Male holotype (MPEG 0005)	Males paratypes (n=10)	Female paratype (MPEG 0010)	Other female paratype (MPEG 0012)
Total length	7.8	6.1–8.8	8.8	8.0
Cheliceral length	2.4	2.0–2.7	2.7	2.6
Cheliceral width	0.8	0.7–0.9	0.9	0.9
Propeltidium length	1.6	1.3–1.8	1.7	1.4
Propeltidium width	1.8	1.3–2.1	2.1	2.1
Propeltidium length/width ratio	0.9	0.8–1.1	0.8	0.7
Pedipalp length	6.2	5.1–6.3	5.2	5.15
Leg I length	5.0	4.7–5.2	4.7	-
Leg IV length	8.7	7.1–9.5	7.8	7.6

Remarks. The new species herein described, *Mummucia ibirapemussu* **n. sp.**, is assigned to the type genus *Mummucia*, because at the present time it is impossible to reliably distinguish the genera of Mummuciidae, as pointed out by Maury (1998). The same decision was taken by Xavier and Rocha (2001), Martins *et al.* (2004) and Rocha and Carvalho (2006). The family Mummuciidae still requires an entire taxonomic and phylogenetic revision to better understand the generic limits and define the most useful characters for species definition. However, one character appears to be constant in the family: the longitudinal ectal opening of the flagellum, which was already reported only for *Mummucia coaraciandu*, *M. mauryi*, *M. taiete* Rocha and Carvalho, 2006 (Rocha and Carvalho, 2006: 165, fig. 5) and *Metacleobis fulvipes* (Xavier and Rocha, 2001; Martins *et al.* 2004; Rocha and Cancellato 2002b; Rocha and Carvalho, 2006).



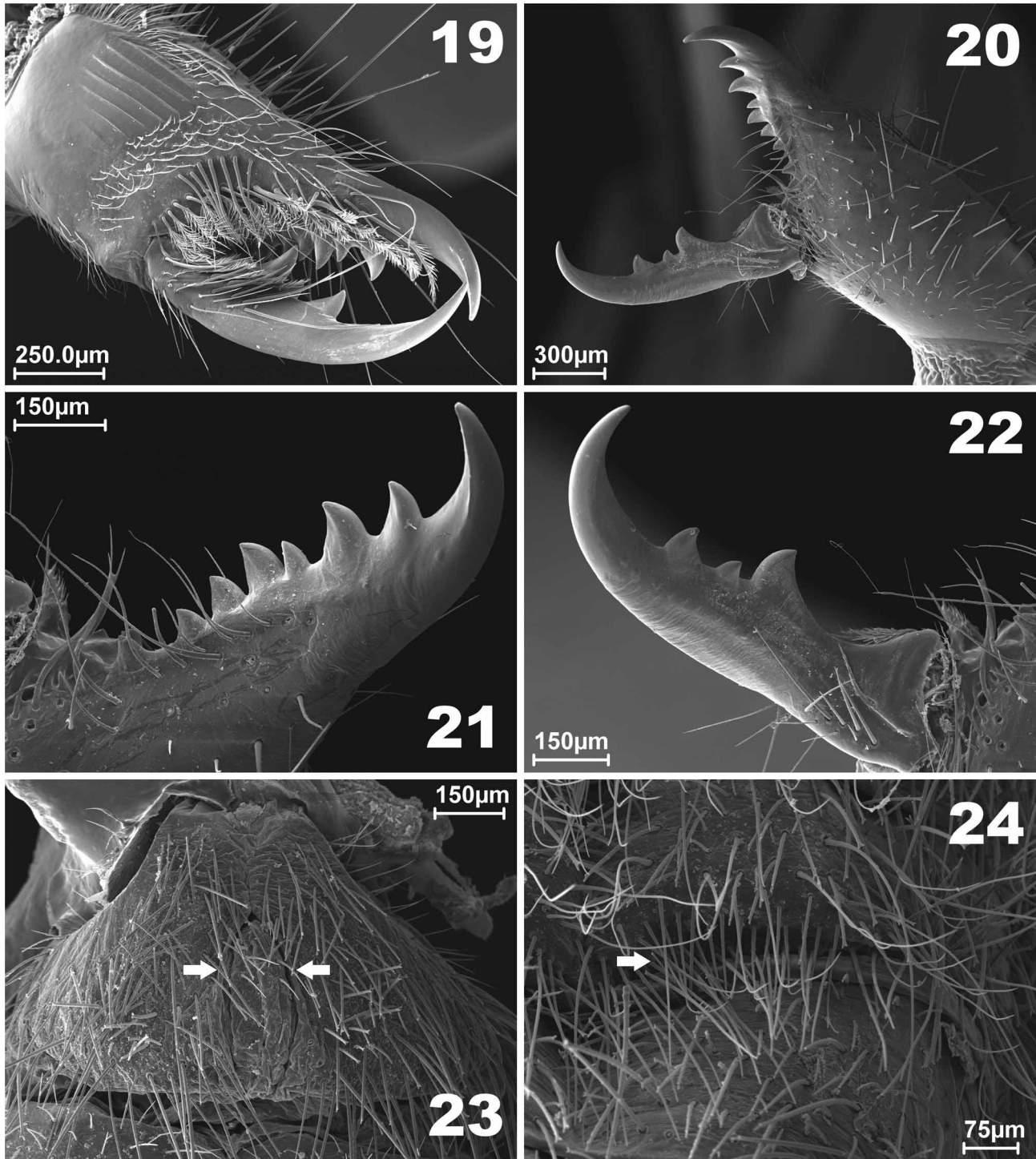
FIGURES 13–18. *Mummucia ibirapemussu* **n. sp.**. 13. Male chelicera, mesal view. 14. Opened male chelicera, mesal view. 15. Detail of the fixed finger of the male chelicera, mesal view. 16. Detail of the apical portion of the flagellum, dorsal view. 17. Right malleolus V, male individual. 18. Tracheal spiracle opening, male individual, ventral view.

Mummucia ibirapemussu **n. sp.** slightly resembles *M. mauryi* in the color pattern of pleurites, a character set that was proposed to be species-specific in Mummuciidae (Rocha and Carvalho, 2006). This feature appears to be convergent in these two species, as they differ in the cheliceral dentition, a character used by Maury (1984) and Rocha (2002) to support species recognition.

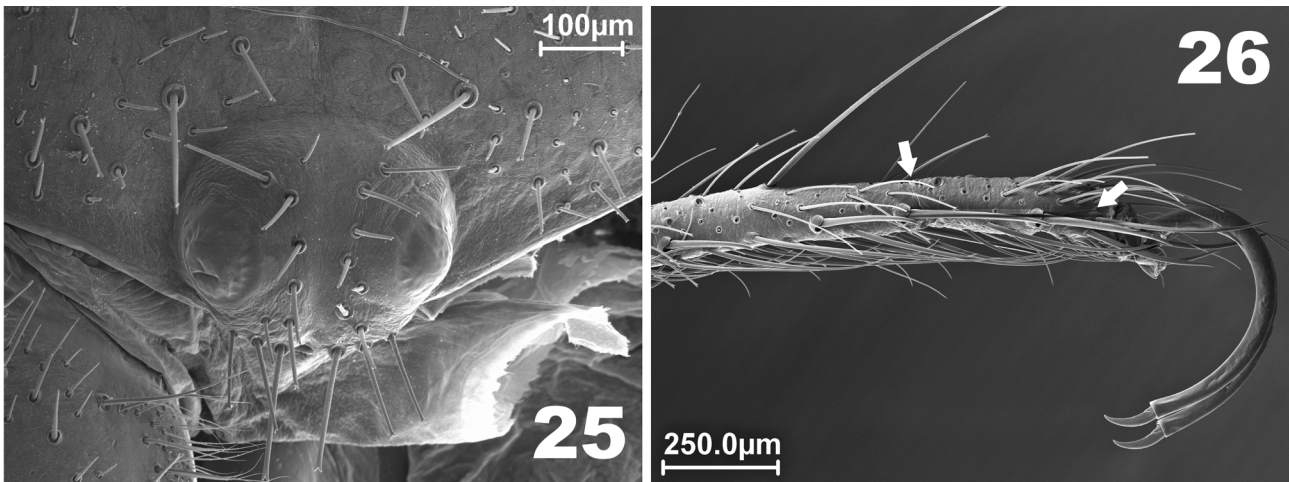
Besides, the geometry of propeltidium showed that males of *M. ibirapemussu* **n. sp.** can be biometrically distinguishable from *Metacleobis fulvipes*. Shape analyses showed the individuals arranged in distinct plot

groups at the graphical morphospace defined by principal components 1 and 2 (Fig. 28). Each group corresponded to one species, with no overlap between them. The reclassification accuracy of females based on the Mahalanobis distances was 100% for *M. ibirapemussu* **n. sp.** and 92% for *Metacleobis fulvipes*.

To help in distinguishing *M. ibirapemussu* **n. sp.** from *Metacleobis fulvipes*, the morphometric characters of propeltidium shape were examined from a multivariate point of view. Shape of propeltitium is taxonomically informative and for that reason it has been frequently addressed in species descriptions, represented by its length/width ratio (Muma, 1951; Maury, 1982, 1987; Rocha and Carvalho, 2006).



FIGURES 19–24. *Mummucia ibirapemussu* **n. sp.** 19. Female chelicera, mesal view. 20. Opened female chelicera, ectal view. 21. Detail of the fixed finger of the female chelicera, ectal view. 22. Detail of the movable finger of the female chelicera, ectal view. 23. Female genitalia, ventral view. Arrows indicates the two longitudinal openings. 24. Ctenidia (arrow), male individual, ventral view.



FIGURES 25–26. *Mummucia ibirapemussu* n. sp.. 25. Ocular tubercle. 26. Telotarsus IV, adult male, lateral view; arrows indicates the two distal tarsomeres.

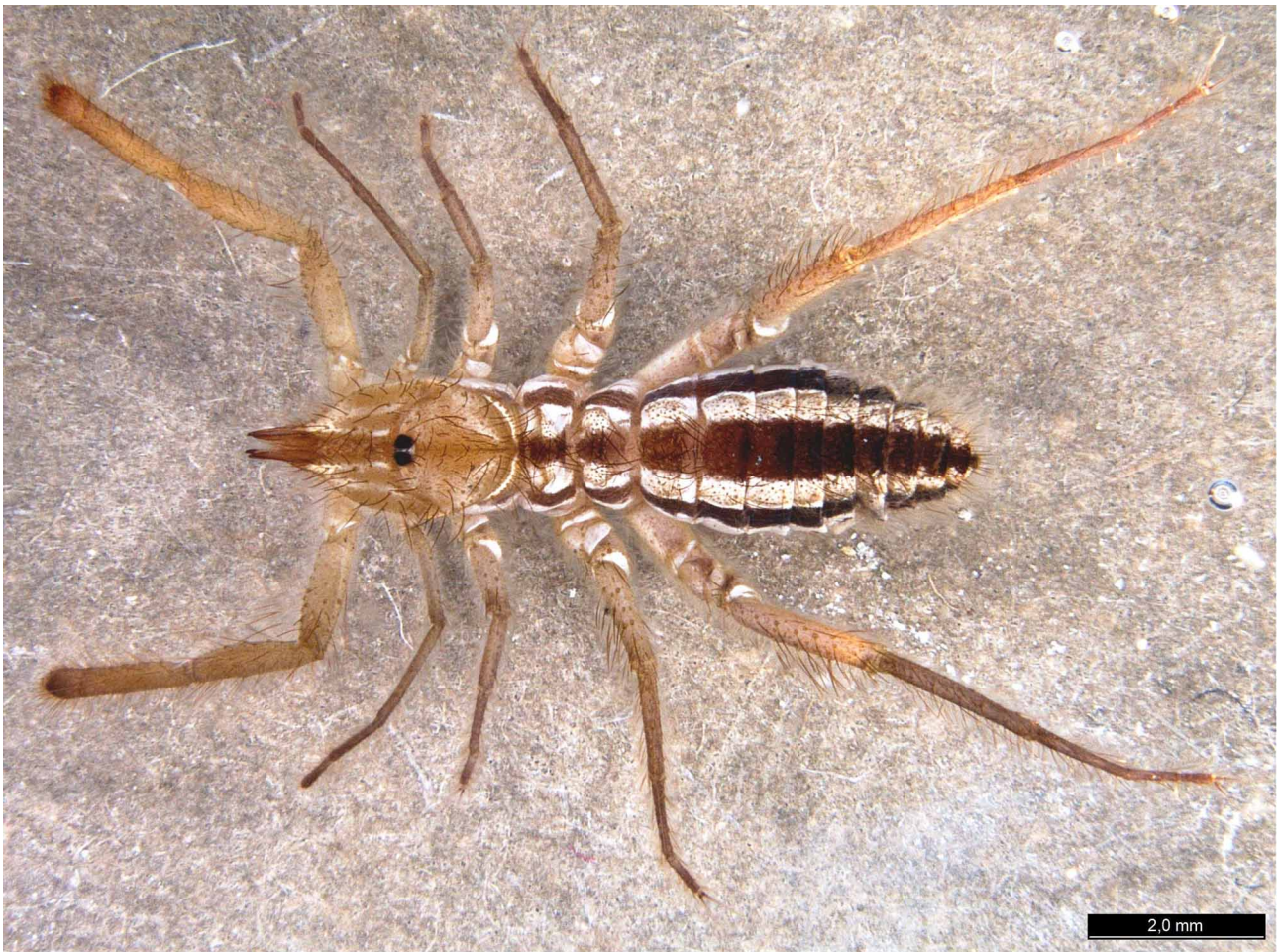


FIGURE 27. *Mummucia ibirapemussu* n. sp., habitus of preserved adult male, dorsal view.

Superimposition of consensus configurations showed that LMs 2–8 positioning are distinct between both species (Fig. 29). Mean values of ratio propeltidium length/width were: *M. ibirapemussu* n. sp. =0.90; *Metacleobis fulvipes* =0.81. Another morphometric character that appears to be diagnostic for these species is the ratio obtained through the division of propeltidium length by the arithmetic mean of the distances LM1-LM7 and LM1-LM8. Such ratio for each species was: *M. ibirapemussu* n. sp. =6.31; *Metacleobis fulvipes* =5.34.

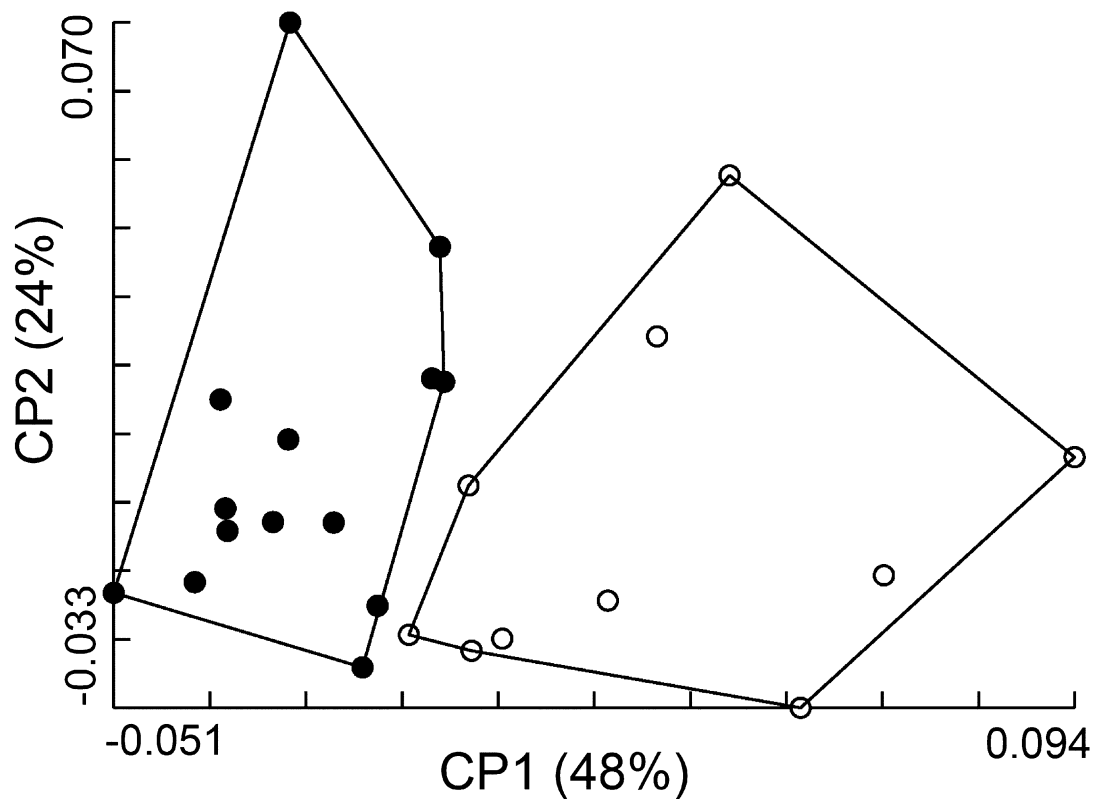


FIGURE 28. Morphospace of principal components (CPs) 1 and 2 resulting from multivariate comparison between *Mummucia ibirapemussu* **n.sp.** (white circles) and *Metacleobis fulvipes* (black circles). Score ranges of each principal component are in its respective axis and its relative contribution to the total variability are between brackets.

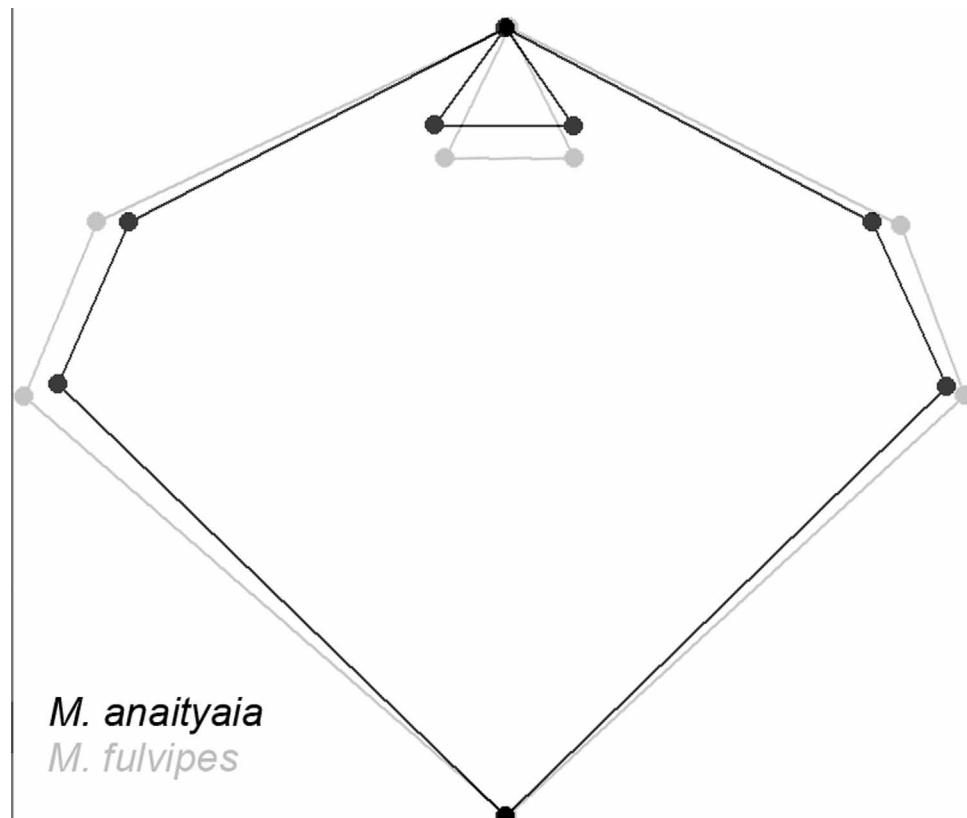
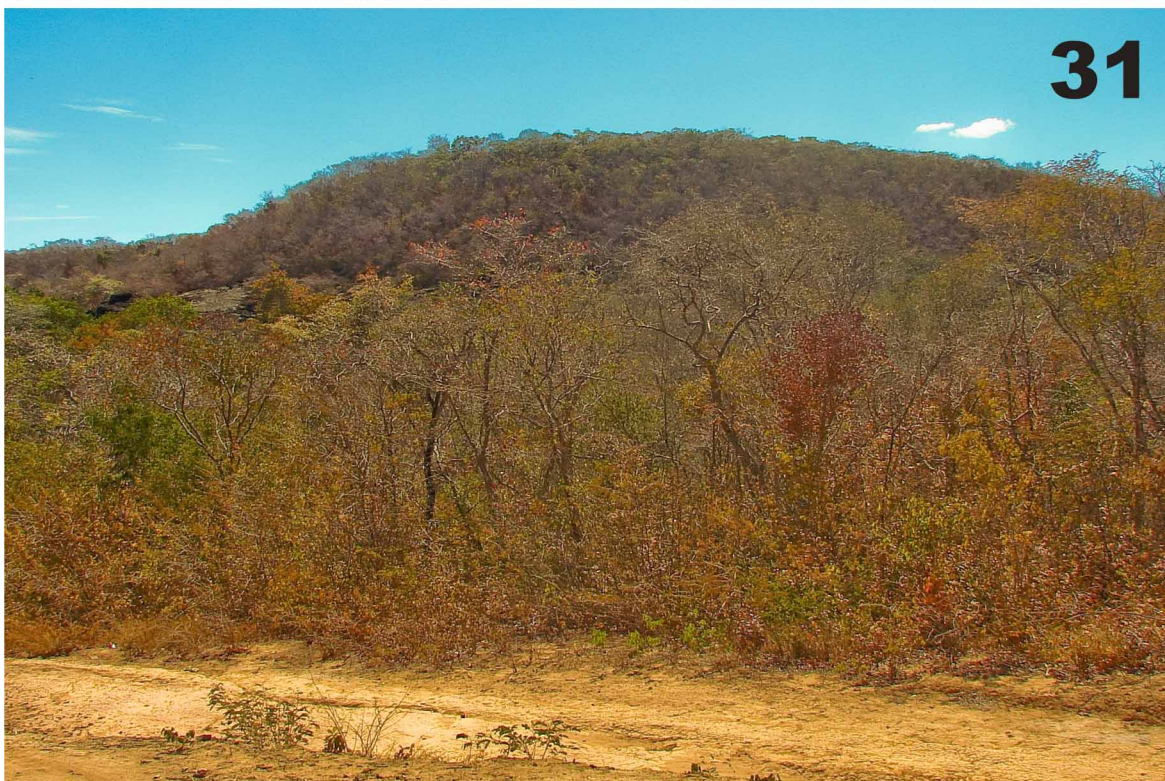


FIGURE 29. Superimposition of consensus configurations of landmarks of *Mummucia tyaiassu* **n.sp.** and *Metacleobis fulvipes*.



FIGURES 30–31. Phytophysiognomies in the type locality, Serra das Confusões National Park, where Solifugae were collected. 30. Arboreal Caatinga. 31. Shrubland Caatinga. (Photographs by Marcélia B. Silva).

Geometric morphometrics was accurate to diagnose two species Solifugae, similarly as observed in Insecta, a group in which several cryptic species has been characterized by such method (Dujardin, 2008). Arguably, morphometrics could be helpful for distinguishing other species or genus of Solifugae when larger taxonomic samples are available.

Habitat preference. We collected fourteen specimens (eleven males and three females), all in July 2007, when the enclave (humid area formed between hills) was not sampled. A total of twelve individuals were collected in arboreal Caatinga (Fig. 30) and seven individuals in shrubland Caatinga (Fig. 31). The low number of individuals sampled and the punctual sampling events prevent us to infer about habitat selection for *Mummucia ibirapemussu* n.sp.

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