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Stemmiulus brasiliensis n. sp., a new species of millipede from Brazilian iron ore caves (Diplopoda: Stemmiulida: Stemmiulidae)

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Abstract

A new species of *Stemmiulus* Gervais, 1844 is described from Amazonian iron ore caves located in Pará State, Brazil. The new species differs from the other Brazilian species by gonopod morphology, especially the angiocoxite and colpocoxite, and for the first pairs of legs of males. A key for the species of *Stemmiulus* found in Brazil is included.

Key words: Stemmiulida, Neotropics, Iron ore caves, Brazil

Introduction

Currently, eight extant nominate genera are recognized in the order Stemmiulida Cook, 1895: *Eostemmiulus* Mauriès, Golovatch et Geoffroy, 2010; *Diopsiulus* Silvestri, 1897; *Prostemmiulus* Silvestri, 1916; *Paurochaeturus* Silvestri, 1916; *Plusiochaeturus* Silvestri, 1916; *Nethoiulus* Brolemann, 1920; *Stemmiulus* Gervais, 1844; and *Scoliogmus* Loomis, 1941 (Shear 2011; Shelley *et al*. 2012). In addition, there is an extinct genus, *Parastemmiulus* Riquelme, Alvarado-Ortega, Ramos-Arias, Hernández, Le Dez., Lee-Whiting et Ruvalcaba-Sil, 2013 (Riquelme *et al*. 2013). However, Mauriès & Golovatch (2006) suggested the synonymization of the genera *Diopsiulus*, *Prostemmiulus*, *Paurochaeturus*, *Plusiochaeturus* and *Nethoiulus* with *Stemmiulus*, which thus becomes a quite diverse genus. Nevertheless, according to Shear (2011), this alteration would require a more robust argumentation in order to be confirmed.

The Stemmiulida is considered typically pantropical (Hoffman *et al*. 1996; Mauriès *et al*. 2010; Shelley *et al*. 2012). Its distribution covers New Guinea, Indonesia, Southeast Asia, Central Africa and Central and South America (Chamberlin 1952; Loomis 1964; Hoffman 1977; Mauriés 1979, 1984, 1989; Mauriès & Golovatch 2006; Mauriès *et al*. 2010; Shelley *et al*. 2012). In the Americas, there are around 75 known species (Mauriés 1984) which range from Peru in the south to Mexico in the north (Silvestri 1916; Shelley *et al*. 2012). Recently, a supposed introduction of Stemmiulida to southern Florida, USA was recorded (Shelley *et al*. 2012). In Brazil, only three species are currently known: *Stemmiulus adisi* (Mauriès, 1984), *S. amazonicus* (Mauriès, 1984) and *S. wellingtoni* (Mauriès 1984), all from Amazonian forests near Manaus (Mauriès 1984).

In this paper, we describe a new species of *Stemmiulus* found in iron ore caves in the Amazonian region, Pará State, Brazil. In addition, we prepared a key to the Brazilian species based on gonopod structure.

Material and methods

Collection and preservation: The type specimens were collected during 2010 and 2011 and are deposited in the Zoology Collection, Seção de Invertebrados Subterrâneos (ISLA) at the Universidade Federal de Lavras, Campus Universitário de Lavras, Minas Gerais, Brazil. All specimens were captured with a brush and fixed in vials containing 70% ethanol. The collections were made in fifteen iron ore caves in the municipality of Curionópolis, Pará State, Brazil, in the so-called "Serra Pelada" region (Fig. 1).

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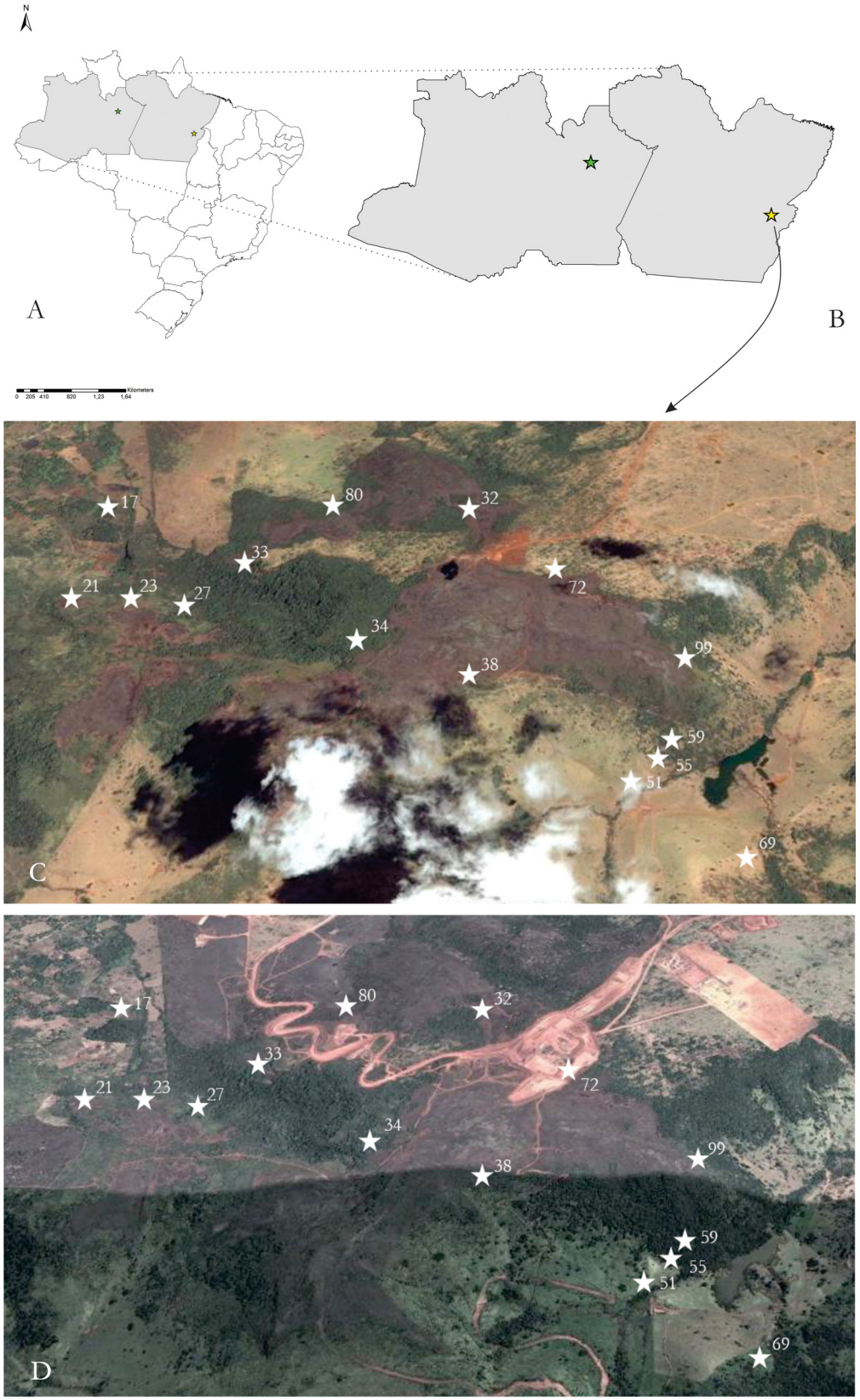

FIGURE 1. Distribution map of *Stemmiulus brasiliensis* **sp. nov.** A) map of Brazil; B) Amazonas and Pará State. Green star refers to the species *S. adisi*, *S. amazonicus*, *S. wellingtoni*, all from near Manaus city, Amazonas State, and yellow star referes to *S. brasiliensis* **sp. nov.** (Curionópolis, Pará State); C) the "Serra Pelada" region where the species was observed in the year 2006, showing the progress of industrial impacts on the region; C) the same region in the year 2013. The location of the caves is given as white stars.

Taxonomic comments. In this paper, we consider the genera *Diopsiulus*, *Prostemmiulus*, *Paurochaeturus*, *Plusiochaeturus* and *Nethoiulus* as synonyms of *Stemmiulus*, as suggested by Mauriès & Golovatch (2006). Therefore, the Brazilian species *Prostemmiulus adisi*, *P. wellingtoni* and *P. amazonicus* are considered here as belonging to the genus *Stemmiulus*. However, agreeing with Shear (2011), this assignment is bound to remain provisional until a broad and robust revision of the Stemmiulida has been assessed.

Systematics

Order Stemmiulida Cook, 1895

Family Stemmiulidae Pocock, 1894

Genus *Stemmiulus* Gervais, 1844

Stemmiulus Gervais 1844. Annales de la Société Entomologique de France, 2 (2): 28. Type species: *Iulus* (*recte: Julus*) *bioculatus*, 1844, by monotypy. Online publication: Sierwald, P. (ed.). 2006. *Nomenclator Generum Diplopodorum*, version 2.

Stemmiulus brasiliensis Iniesta & Ferreira, sp. nov.

(Figs 2–5)

Type. Holotype male (ISLA 5681), SL22 cave (Serra Leste 5°57'39.14''S, 49°38'03.51''N), Curionópolis/PA, Brazil, 2010, leg. M. P. Oliveira.

Paratypes: 2 males (ISLA 3701, 5682), SL51 and SL22 caves, Curionópolis/PA, Brazil, 2010; 2 females (ISLA 5683), SL22 cave, Curionópolis/PA, Brazil, 2010, all leg. M. P. Oliveira.

Name. To emphasize Brazil, the *terra typica*.

FIGURE 2. *Stemmiulus brasiliensis* **sp. nov.**, A) live paratype female; B) anterior part of body, a fixed paratype female.

Comparative diagnosis. *Stemmiulus brasiliensis* **sp. nov.** is distinguished from the other Brazilian species by the peculiar cephalic chaetotaxy pattern of the male and the different gonopod structure (cf. Mauriès 1984). The species *S. adisi*, *S. amazonicus* and *S. wellingtoni* all show complex gonopod conformations compared to *S. brasiliensis* **sp. nov.** The differences are especially clear in angiocoxite (**Ag**) and colpocoxite (**K**) structure. The species *S. wellingtoni* has a trifurcate **Ag** tip while the latter in the other species is either bifid or, like in *S. brasiliensis* **sp. nov.**, unipartite. In *S. adisi*, the tip of **Ag** is wider distally and shortened laterally while *S. amazonicus* has a diagonal/digitiform tip and a wider apex. In *S. brasiliensis* **sp. nov.**, **Ag** is highly distinctive, being tiny and devoid of a differentiated tip. **K** in the new species is also different, elongated, irregular in shape and membranous at apex, versus wide and with some apical projections in *S. adisi*, rounded and thin in *S. amazonicus* or thin and more strongly curved mesad in *S. wellingtoni*.

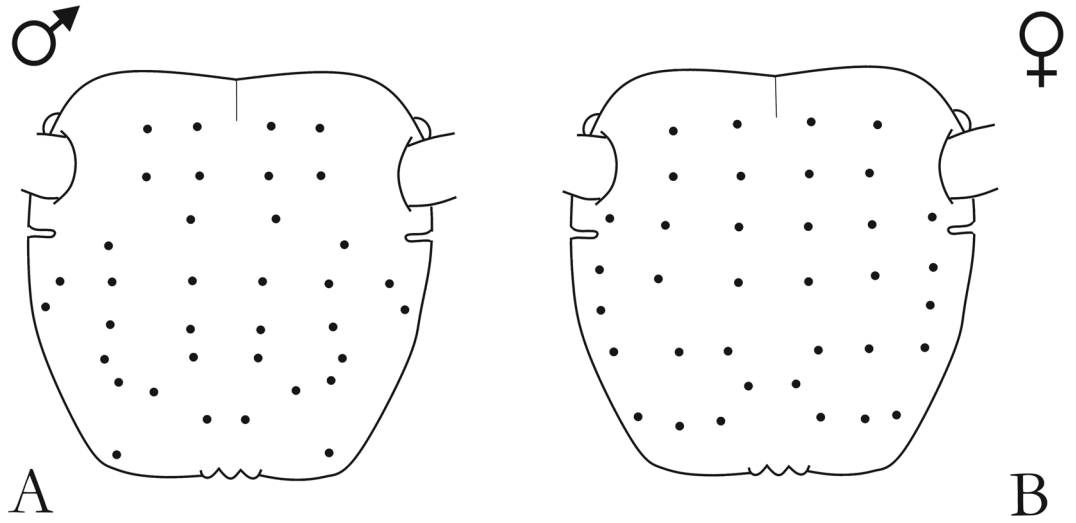

FIGURE 3. Schematic drawings of head of *Stemmiulus brasiliensis* **sp. nov.** A) Male paratype; B) Female paratype.

Measurements. Length from 8.33 to 12.15 mm; maximum midbody diameter between 0.68 to 0.92 mm; body with 35–41 rings, plus 1–2 apodous before telson.

Description of adults. *General characteristics*: Head and body brownish. Head with different chaetotaxy patterns in male (Fig. 3A) and female (Fig. 3B). One large ocellus on each side of head. In length, antennomere $1 < 3 = 4 \approx 5 = 6 < 2$. Ozopores located dorsolaterally and starting with fifth body ring. Lateral region of tergites with parallel striations, including above ozopore. Telson with 3+3 evident spinnerets. Gnatochilarium rounded in male: stipes enlarged and curved, mentum triangular, lamellae linguales striated, with 1+1 setae; females with a square gnatochilarium: stipes straight, mentum subtriangular, lamellae linguales non-striate. Trunk with a dorsal axial suture and line; a clear lateral line on each side.

Male characteristics: First to third pairs of legs modified. Legs 1 with enlarged coxae, these apparently fused to prefemur, also beset with long ventral setae; femur elongated, with short ventral setae and one especially long seta; postfemur and tibia similar, with long ventral setae; tarsus elongated, with a ventral row of short setae reaching the claw. Legs 2 (Fig. 4A, B) with a coxosternal lobe (**Lcs**) beset with short setae; **Lcs** rounded and supporting some long distal setae in oral view; telopodite (**1°, 2° Tp**) elongated and digitiform, beset with short setae; coxosternal process (**Pcs**) acute and elongated. Legs 3 (Fig. 4C, D) with a non-enlarged **Cx**; **Pf**, **F**, **Psf** and **Tb** with long ventral setae and square in shape; **T** with long dorsal setae, nine ventral spatulate setae (**Ss**) and four long setae around the tarsal claw. No paragonopods (ninth pair of leg) were found, perhaps vestigial (reduced) or non-existent in this species. Gonopods elongated (Fig. 5A, B), with basal section wider than distal one; **Cx** fused to sternum, with two large, rounded, gonopodal processes. Distal region with two well-developed extensions: a long and slender angiocoxite (**Ag**) resembling a thin shell adhered to colpocoxite (**K**) and carrying short setae in distal portion. **K** with curved setae in the latter portion; tip with a membranous area (**Ma**) surrounding the end of a seminal groove (**Sg**). **Sg** visible at **K** beginning with junction of gonopodal segments. Both **Ag** and **K** with thick edges.

Notes. The new species can be recognized, in males, by a slight difference in head chaetotaxy. In the Brazilian species, the first row of setae is close to the occipital suture, the row being composed of 4 setae, as observed in *S. brasiliensis* **sp. nov.**, *S. amazonicus* and *S. wellingtoni*, or 2 setae (maybe 2+2 dislocated), as in *S. adisi* (cf. Mauriés 1984). Furthermore, there are other, straight or diagonal rows. These setae are arranged mainly near the suture on the clypeus, on the frons and labrum (Silvestri 1916; Mauriès 1984).

As regards the gonopod, the genus *Stemmiulus* shows remarkable variation between the species, mainly in **Ag** and **K** structure (Chamberlin 1952; Loomis 1964; Hoffman 1977; Mauriés 1979, 1989; Mauriès & Golovatch 2006; Mauriès *et al*. 2010). According to Mauriès (1989), most of the American species have a distolaterally expanded **Ag**. The species *S. amazonicus*, *S. wellingtoni* and *S. adisi* share this trait (Mauriés 1984), but the new species has no evident expansion. The **Ag** structure in *S. brasiliensis* **sp. nov.** seems to serve as a lateral shield to **K**.

In the Brazilian species of *Stemmiulus*, males generally show no meaningful differences in leg structure, although there is some variation in the second and third pairs. All Brazilian species are similar in leg 1

conformation. The second pair is the most strongly reduced. In *S. brasiliensis* **sp. nov.**, **Cx** is very different from that in the other species. Both *S. adisi* and *S. amazonicus* show a kind of shoulder while such a structure is absent from *S. brasiliensis* **sp. nov.** In all Brazilian species, **Cx** is large, yet without **Lcs** in *S. adisi*, *S. amazonicus* and *S. wellingtoni*, while **Tp** digitiform. However, its outline slightly varies between the species. In leg 3 structure, *S. brasiliensis* **sp. nov.** is notably different, mainly in **Pf** and **F** which are not enlarged.

The size and number of body segments can vary between species. In the Brazilian species, this number ranges from 42 to 53 (Mauriés 1984). In *S. brasiliensis* **sp. nov.**, the body is with 35–41 rings. This variation is common within the order, with extremes found in S*temmiulus annulatus* Silvestri, 1916 (38 segments, regardless of the new species described herein) and *S. diversicolor* Loomis, 1964 (54 segments) (Silvestri 1916; Loomis 1964). Although there are few studies concerning stemmiulidan ontogeny, the development can be recognized as euanamorphotic (Mauriés 1984; Enghoff *et al*. 1993).

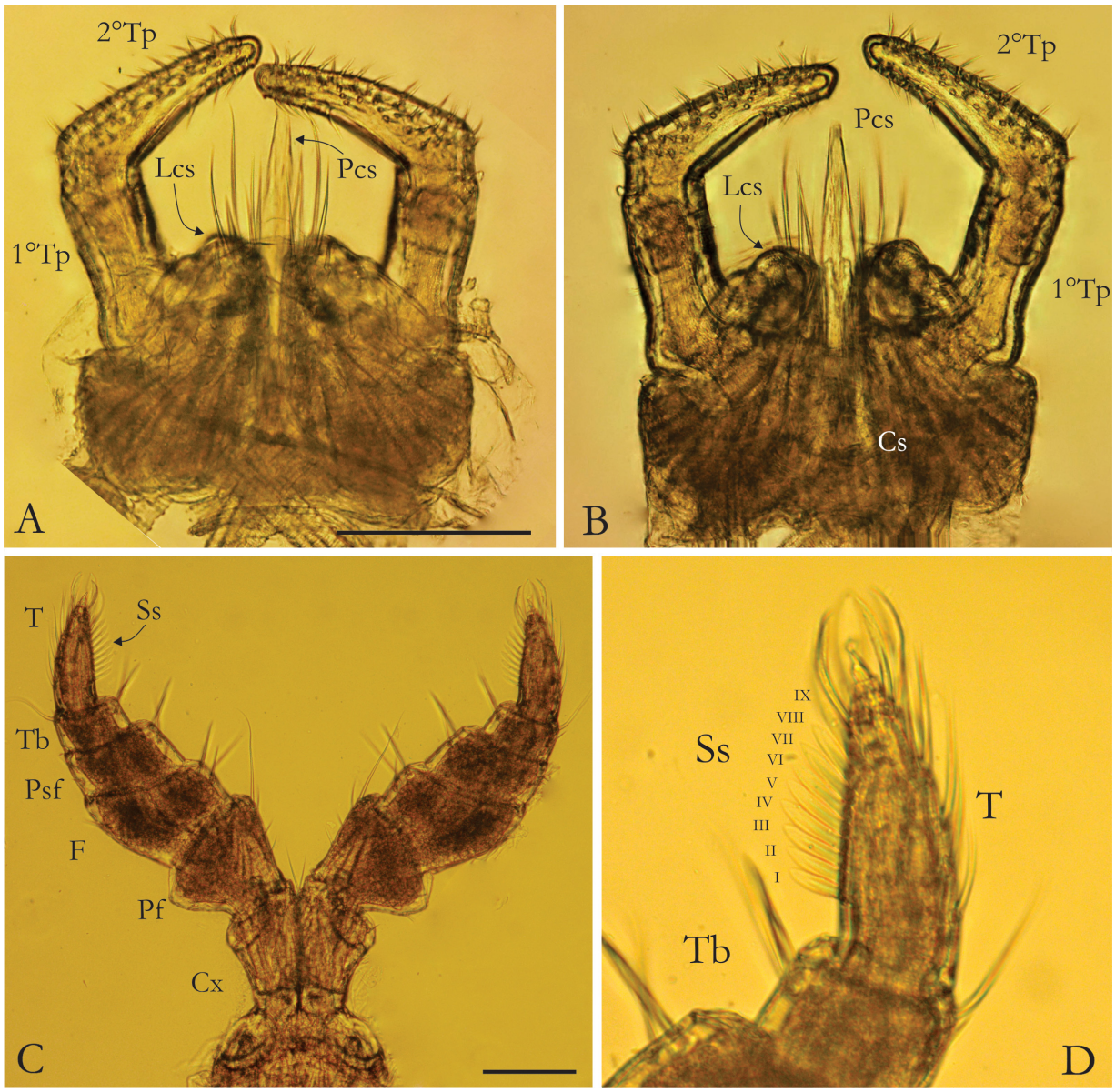

FIGURE 4. Microscopic images of male paratype of *Stemmiulus brasiliensis* **sp. nov**. (ISLA 3701). A) Second pair of legs in oral view and B) Second pair of legs in caudal view; C) Third pair of legs; D) Detail of tarsus of third pair. **Scale bar:** 0.1 mm. **Abbreviations:** Cx = coxae; Pf = prefemur; F = femur; Psf = postfemur; Tb = tibia; T = tarsus; Ss = spatulate setae; Cs = coxosternite; Lcs = coxosternal lobe; Pcs = coxosternal process; 1° Tp = first telopoditomere; 2° Tp = second telopoditomere. **Scale bar:** 0.1 mm. The roman numbers indicate the sequence of spatulate setae.

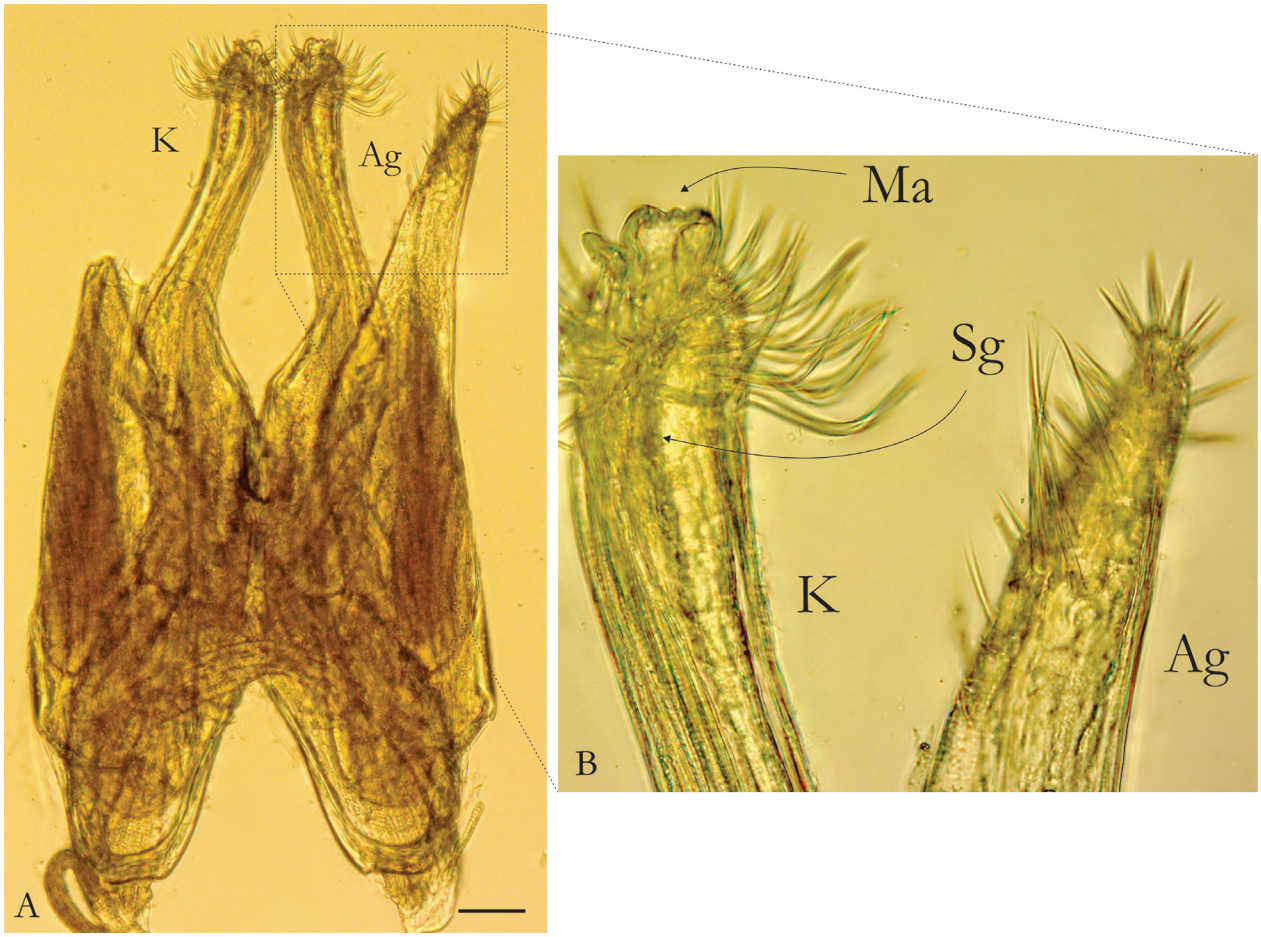

FIGURE 5. Microscopic images of male paratype of *Stemmiulus brasiliensis* **sp. nov.** (ISLA 3701). A) and B) gonopod. **Abbreviations:** Sg = seminal groove; Ag = angiocoxite; K = colpocoxite; Ma = Membranous area. **Scale bar:** 0.5 mm.

Key of Brazilian species of *Stemmiulus*

1. Angiocoxite bi- (or with a medial lateral projection) or trifurcate. Amazonas State 2
- Angiocoxite unipartite, a single structure. Pará State. . . . . *S. brasiliensis* **sp. nov.**
2. Angiocoxite trifurcate . . . . . *S. wellingtoni*
- Angiocoxite bifid, with two tips 3
3. Lateral striations on body rings oblique and parallel; angiocoxite tip finger-shaped. . . . . *S. amazonicus*
- Lateral striations on body rings oblique, but clearly diverging caudad at ozopore level; angiocoxite tip larger, with a short lateral projection . . . . . *S. adisi*

Ecological remarks. Species of Stemmiulida are usually found in rainforest living near dead plant remains or in decomposing organic matter (Silvetri 1916; Mauriés 1984). However, some species are bromeliad- (Silvestri 1916) or cave-dwelling (Mauriès *et al*. 2010).

Most of the species found in caves are considered troglophiles (Mauriès *et al*. 2006) and only one presumably troglobitic species is known (Mauriès *et al*. 2010). Considering the lack of any obvious troglomorphic traits in *S. brasiliensis* **sp. nov.**, coupled with the rather wide distribution area (including caves located in distinct lithotypes that are unlikely connected by subterranean spaces), this species is probably a troglophile. Most of the millipedes associated with cave environments are found in limestone caves (Golovatch & Kime 2009). Currently, little is known about the distribution of these organisms in other lithologies, although in the Brazilian Atlantic rainforest, the relative richness of invertebrates in general is higher in ferruginous caves (Souza Silva *et al*. 2011).

All individuals of *S. brasiliensis* **sp. nov.** were found in low abundance inside the caves, not exceeding four individuals per cave (Fig. 2A, B). Potential food resources include vegetal debris and, especially, bat guano. These caves are usually extremely superficial (shallow subterranean environments) surrounded by forest. Accordingly, it

is possible that the main habitat of the species is the forest rather than the caves. However, the high degree of deforestation associated with other human activities in the area, such as mining (Fig. 1C), certainly alter the original habitat. Thus, specimens of *S. brasiliensis* **sp. nov.** may eventually be using the caves as shelters, since their pristine habitat is under severe pressure.

Acknowledgements

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References

Chamberlin, R.V. (1952) Further records and descriptions of American millipeds. *The Great Basin Naturalist*, 12 (4), 13–34.

Enghoff, H., Dohle, W. & Blower, J.G. (1993) Anamorphosis in millipedes (Diplopoda) – the present state of knowledge with some developmental and phylogenetic considerations. *Zoological Journal of the Linnean Society*, 109, 103–234. http://dx.doi.org/10.1111/j.1096-3642.1993.tb00305.x

Golovatch, S.I. & Kime, R.D. (2009) Millipede (Diplopoda) distribuitions: A review. *Soil Organisms,* 81, 565–597.

Hoffman, R.L. (1977) A stemmiulid milliped from central Africa. *Revue Suisse de Zoologie*, 84 (4), 831–835.

Hoffman, R.L., Golovatch, S.I., Adis, J. & de Morais, J.W. (1996) Practical keys to the orders and families of millipedes of the Neotropical region (Myriapoda: Diplopoda). *Amazoniana*, 14 (1/2), 1–35.

Loomis, H.F. (1964) The millipeds of Panama (Diplopoda). *Fieldiana, Zoology*, 47 (1), 1–136. http://dx.doi.org/10.5962/bhl.title.3182.

Mauriès, J.P. & Golovatch, S.I. (2006) *Stemmiulus deharvengi* sp. n., le premier Stemmiulida signalé en Indonésie (Diplopoda: Stemmiulida). *Arthropoda Selecta*, 15 (2), 91–98.

Mauriès, J.P., Golovatch, S.I. & Geoffroy, J.J. (2010) Un nouveau genre et une nouvelle espèce de l'ordre Stemmiulida du viet-Nam (Diplopoda). *Arthropoda Selecta*, 19 (2), 73–80.

Mauriès, J.P. (1979) Stemmiulides (Myriapoda-Diplopoda) nouveaux et peu connus d'Afrique et d'Amérique. *Bulletin du Museum National d'Histoire Naturelle*, 1, 625–641.

Mauriès, J.P. (1984) Les premiers Stemmiulides signalés au Brésil: Tros espèces nouivelles de la région de Manaus dont une de la forêt inondable (Prostemmiulus adisi n. sp.) (Myriapoda: Diplopoda : Stemmiulida). *Amazoniana*, 8 (3), 375–387.

Mauries, J.P. (1989) Révision des Stemmiulides: espéces nouvelles et peu connues d'Afrique (Myriapoda, Diplopoda). *Bulletin du Museum National d'Histoire Naturelle*, 11, 605–637.

Riquelme, F., Alvarado-Ortega, J., Ramos-Arias, M., Hernández, M., Le Dez, I., Lee-Whiting, T.A. & Ruvalcaba-Sil, J.L. (2013) A fossil stemmiulid millipede (Diplopoda: Stemmiulida) from the Miocene amber of Simojovel, Chiapas, México. *Historical Biology: An International Journal of Paleobiology,* 26 (4), 37–41. http://dx.doi.org/10.1080/08912963.2013.778843

Shear, W. (2011) Class Diplopoda de Blainville in Gervais, 1844. *In*: Zhang, Z.-Q. (Ed.) *Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. Zootaxa*, 3148, 159–164.

Shelley, R.M., Edwards, G.B. & Bogan, A.E. (2012) First recorded introduction of the milliped order Stemmiulida (Eugnatha: Nematophora): Potential establishment in Florida, USA, and new records from Mexico; northward range extension into southern Tamaulipas. *Insecta Mundi*, 0245, 1–5.

Sierwald, P., Jeekel, C.A.W., Hoffman, R.L., Shelley, R.M., Kiser, S.B. & Golovatch, S.I. (2006) Nomenclator Generum Diplopodorum, Version 2. A complete listing of all genus-group names in the class Diplopoda from 1758 through 1999. On-line publication: This Excel file is available to download. Available from: http://www.fieldmuseum.org/research_collections/zoology/zoo_sites/millipeet/pdfsFullarticles/MILLGEN.xls (accessed 27 June 2014)

Silvestri, F. (1916) Contribuzione alla conoscenza degli Stemmiuloidea (Diplopoda). *Bollettino del Laboratorio di Zoologia Generale e Agraria, Portici*, 10, 287–347.

Souza Silva, M., Martins, R.P. & Ferreira, R.L. (2011) Cave lithology determining the structure of the invertebrate communities in the Brazilian Atlantic Rain Forest. *Biodiversity Conservation*, 20, 1713–1729. http://dx.doi.org/10.1007/s10531-011-0057-5