Nauplius
THE JOURNAL OF THE BRAZILIAN CRUSTACEAN SOCIETY

e-ISSN 2358-2936
www.scielo.br/nau
www.crustacea.org.br

A new species of *Spelunconiscus* (Isopoda: Oniscidea: Styloniscidae) for Brazilian caves: new record for the type species and an emended diagnosis for the genus

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ABSTRACT

Spelunconiscus Campos-Filho, Araujo and Taiti, 2014 is a monotypic genus of the family Styloniscidae represented by a troglobitic species, *Spelunconiscus castroi* Campos-Filho, Araujo and Taiti, 2014, from the cave MOC-32, in the state of Minas Gerais, southeastern Brazil. New representatives of this family were found in three additional caves, which revealed a new species, *Spelunconiscus septemlacuum* sp. nov., from Taboa and Tatuzinhos caves and a new occurrence for the type-species in Retiro cave. The original diagnosis of *Spelunconiscus* is emended due to the discovery of a spur-like structure in the male pereopod VII ischium, as well as some supplementary traits that have not been previously considered. *Spelunconiscus septemlacuum* sp. nov. differs from *S. castroi* in the number of articles of the antennal flagellum, in the proportion between this flagellum and 5th article of peduncle of antenna, in the size of maxilliped endite, in the morphology of male pleopod II and in body size. A discussion is provided for both taxonomic and ecological concerns.

KEYWORDS

Conservation, Neotropical region, subterranean biodiversity, Synocheta, troglobites

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SUBMITTED 04 August 2021
ACCEPTED 18 January 2022
PUBLISHED 15 July 2022

DOI 10.1590/2358-2936e2022018

Introduction

Currently, around 190 species of Oniscidea are recorded for Brazil belonging to 54 genera and 20 families (Cardoso *et al.*, 2020a; 2020b; Campos-Filho *et al.*, 2018; 2019). Although most Oniscidea representatives inhabit terrestrial environments, there are species considered secondarily aquatic, like *Trogloniscus clarkei* Taiti and Xue, 2012 and *Trogloniscus trilobatus* Taiti and Xue, 2012, occurring in southern China. Other species present amphibious habits, like *Thailandonicus annae* Dalens, 1989, species of *Xangoniscus* Campos-Filho, Araujo and Taiti, 2014, *Speluconiscus* Campos-Filho, Araujo and Taiti, 2014, and *Iuiuniscus iuiuensis* Souza, Ferreira and Senna, 2015. All these examples comprise species strictly found in subterranean habitats, *i.e.*, troglobites.

Brazil presents a rich speleological heritage with around 21,500 recorded caves and potential for tenfold this number (CECAV, 2021). Collections conducted in the last decade in Brazilian caves by representatives of universities and consultancy companies provided material to taxonomists, culminating in the description of several new species, including isopods (Campos-Filho and Araujo, 2011; Campos-Filho *et al.*, 2014; 2016; 2017; 2019; Cardoso *et al.*, 2016; 2018; 2020a; 2020b; Bastos-Pereira *et al.*, 2017; Fernandes *et al.*, 2018; Souza *et al.*, 2010; 2015). An impressive increase in the number of inventoried caves occurred due to changes in the Brazilian law that guides the conservation of the speleological patrimony. Since 2008, caves are supposed to be studied and classified regarding their relevance prior to the establishment of anthropogenic activities in the areas where they occur (Brasil, 2008). Troglobitic species are singularly important in this scenario because the presence of a rare troglobite raises the cavity to the maximum degree of relevance, which may guarantee its integral protection against negative irreversible impacts. This is especially important for the conservation of caves, considering that 65 % of cavities recorded in Brazil are outside the limits of protected areas (CECAV, 2021).

Oniscidean isopods are represented by 54 described species in Brazilian caves (Campos-Filho *et al.*, 2014; 2019; Cardoso *et al.*, 2021b; Campos-Filho *et al.*, 2022). Styloniscidae is the most representative family among those restricted to subterranean habitats, including 23 species in six genera: *Iuiuniscus iuiuensis*, *Chaimowiczia tatus* Cardoso, Bastos-Pereira, Souza and Ferreira, 2021, *Chaimowiczia uai* Cardoso, Bastos-Pereira, Souza and Ferreira, 2021, *Cylindroniscus flaviae* Campos-Filho, Araujo and Taiti, 2017, *Cylindroniscus platoi* Fernandes, Campos-Filho and Bichuette, 2018, *Xangoniscus aganju* Campos-Filho, Araujo and Taiti, 2014, *Xangoniscus odara* Campos-Filho, Bichuette and Taiti, 2016, *Xangoniscus itacarambiensis* Bastos-Pereira, Souza and Ferreira, 2017, *Xangoniscus ceci* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020b, *Xangoniscus santinhoi* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020b, *Xangoniscus dagua* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020b, *Xangoniscus lundi* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020b, *Xangoniscus ibiracatuensis* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020b, *Xangoniscus lapaensis* Campos-Filho, Gallo and Bichuette in Campos-Filho *et al.*, 2022, *Xangoniscus loboi* Campos-Filho, Gallão and Bichuette in Campos-Filho *et al.*, 2022, *Pectenoniscus liliae* Campos-Filho, Bichuette and Taiti, 2019, *Pectenoniscus montalvaniensis* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020a, *Pectenoniscus juveniliensis* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020a, *Pectenoniscus iuiuensis* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020a, *Pectenoniscus carinhanhensis* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020a, *Pectenoniscus santanensis* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020a, *Pectenoniscus morrensis* Cardoso, Bastos-Pereira, Souza and Ferreira, 2020a, and *Spelunconiscus castroi* Campos-Filho, Araujo and Taiti, 2014.

Until now, *Spelunconiscus* represented a monotypic genus with occurrence in one cave in the municipality of Matozinhos, state of Minas Gerais, Brazil (Campos-Filho *et al.*, 2014). Recently, a new species of this genus was found in two caves in the municipality of Sete Lagoas, also in the state of Minas Gerais. During the description of this species, important morphological traits were observed. Although also present in *S. castroi*, they had not been described by Campos-Filho *et al.* (2014). In this sense, the present work aims to provide an emended diagnosis for the genus, a complementary description of *S. castroi,* present a new occurrence record for this species, and describe a new species of *Spelunconiscus*.

Material and Methods

The new species was found in two caves, Taboa and Tatuzinhos caves, the latter is also known as CAV09, both located in the same limestone outcrop that belongs to the Bambuí speleological group (Fig. 1). Specimens of *S. castroi* were collected in Retiro Cave located in the municipality of São José da Lapa, state of Minas Gerais, which is also part of the Bambuí speleological group.

Individuals of the new species were collected, fixed in 70 % ethanol and taken to the Center for Studies on Subterranean Biology of the Federal University of Lavras, Lavras, Brazil. All individuals were measured using a Zeiss Axio Zoom V16 microscope. One entire male was defined as the holotype and other four males (designated as paratypes) were dissected and mounted on semi-permanent slides using Kaiser glycerol as the medium. Morphological analyses of all appendages were made under a Zeiss Scope A1 optical microscope. All appendages were photographed and measured in this microscope with a coupled camera (Axiocam 105 cor). The same procedures of dissection and morphological analysis were adopted for *S. castroi*.

The illustrations were obtained with the aid of a camera lucida mounted on a stereomicroscope (Leica DM750). The final illustrations were made with the software GIMP (v. 2.8) (Montesanto, 2015; 2016). The nomenclature of characters was mainly based on Schmidt (2002) and related works (*e.g.*, Bastos-Pereira *et al.*, 2017; Cardoso *et al.*, 2020a; 2020b). Holotype and paratypes of the new species, as well as specimens of *S. castroi,* were deposited in the Collection of Subterranean Invertebrates of Lavras (ISLA) in the Federal University of Lavras.

In the original paper on *S. castroi* two males were designated as paratypes, one entire and the other in micro-preparation, but the material deposited in the Museu de Zoologia, Universidade de São Paulo (MZUSP) consists of two entire individuals, one female and one male. Micro-preparations were not lodged in the museum. The senior author examined the entire specimens on July 5th 2018 in MZUSP, when the male was illustrated.

Systematics

Order Isopoda Latreille, 1817

Suborder Oniscidea Latreille, 1802

Family Styloniscidae Vandel, 1952

Genus *Spelunconiscus* Campos-Filho, Araujo and Taiti, 2014

Type species. Spelunconiscus castroi Campos-Filho, Araujo and Taiti, 2014, by original designation and monotypy.

Emended diagnosis. Body unpigmented, slender, flexible, able to bend, surface smooth, with pointed scale setae. Eyes absent. Antennal flagellum with at least 4 articles. Right mandible bearing (or not) one penicil in the molar process. Maxillule outer branch with one slender stalk. Maxilliped endite narrow surrounded by two or three spines. Male pereopod VII ischium with a proximal spur-like structure on the rostral face. Male pleopod I exopod longer or shorter than endopod. Male pleopod II endopod distal portion narrow, triangular or beak-like. Pleonites 3–5 with epimera reduced, adpressed, without visible posterior points.

***Spelunconiscus castroi* Campos-Filho, Araujo and Taiti, 2014**
(Figs. 2–5)

Material examined. Male, holotype (MZUSP 27521), MOC-32 cave (recorded at National Registry of Speleological Information (CECAV, 2021) as Eritrina Cave — original name of the cave), Matozinhos, Minas Gerais, Brazil (19°31'0.62"S 44°02'56.81"W), 8 to 18 February 2011, coll. F. Franco; 1 entire male (MZUSP 27521), one entire female (MZUSP 27522), same data as holotype; 4 males (ISLA 62796), 18 females (ISLA 62795), Retiro Cave, São José da Lapa, Minas Gerais, Brazil (19°39'49.60"S 43°57'7.81"W), June 2018, coll. R.L. Ferreira. Maximum body length: 8.3 mm; 4 males mounted on slides (ISLA 62795, ISLA 64887, ISLA 64888, ISLA 64798).

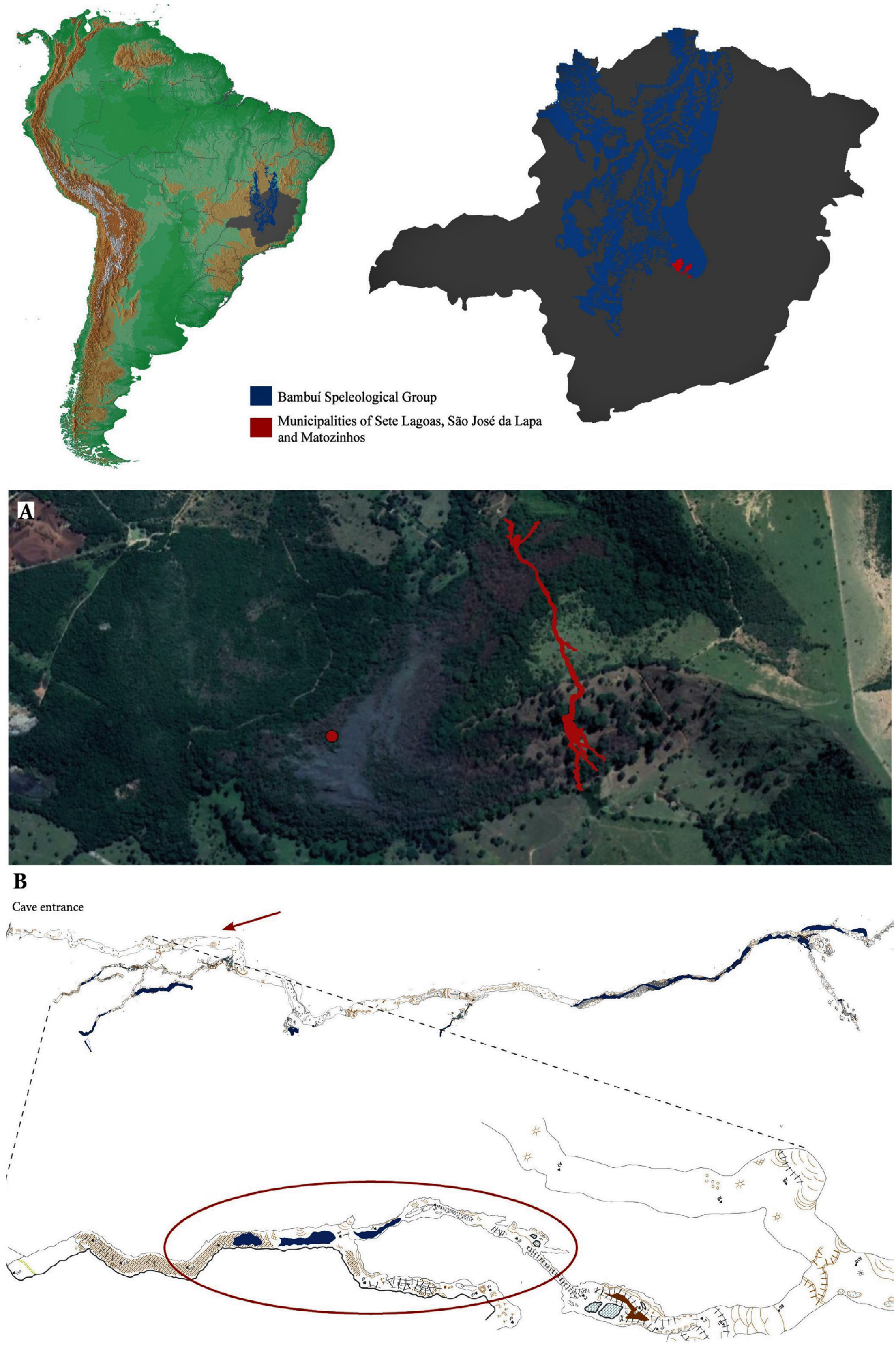

Figure 1. A. Taboa Cave shape highlighted in red in the aerial photograph of the region (municipality of Sete Lagoas, state of Minas Gerais, Brazil) and Tatuzinhos cave indicated by the red dot; **B**: ground floor of Taboa cave indicating where individuals of *Spelunconiscus septemlacuum* sp nov. were collected, the red arrow indicates the place where one individual was observed once, far from the region where the isopods were commonly found.

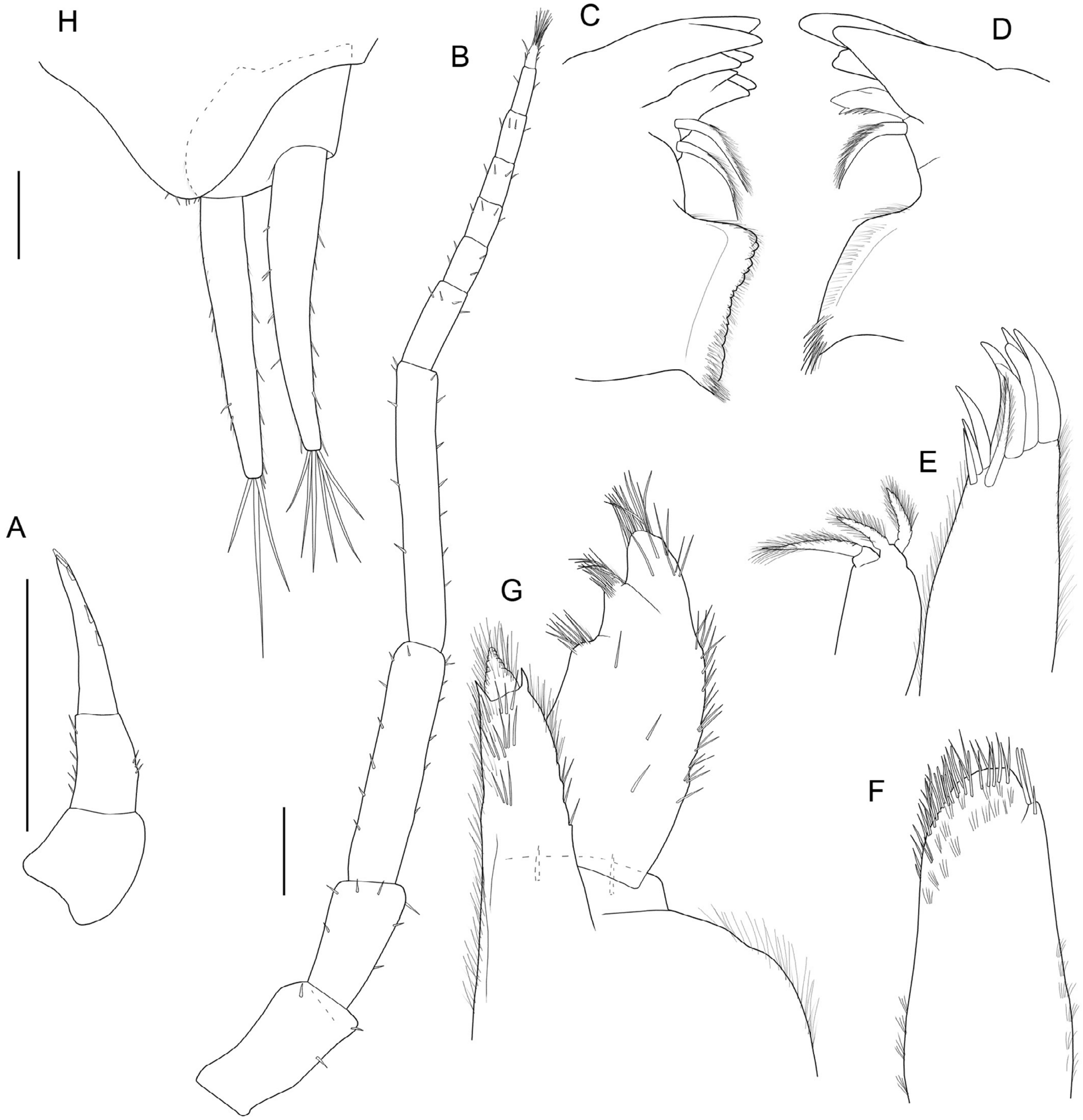

Figure 2. *Spelunconiscus castroi* Campos-Filho, Araujo and Taiti, 2014. **A**: Antennule, **B**: antenna; **C**: left mandible; **D**: right mandible; **E**: maxillule; **F**: maxilla; **G**: maxilliped; **H**: uropod. Scale bar: 0.2 mm.

Remarks. Spelunconiscus castroi previously known only from the type locality (MOC-32 cave, Matozinhos, Minas Gerais, Brazil) is now also record from the Retiro cave, São José da Lapa, Minas Gerais, Brazil.

Complementary description (some traits of the species are described based on the originally designated paratypes deposited in MZUSP and new material collected. For complete description check Campos-Filho *et al.* (2014)). Antenna "flagellum with 5 to 7 articles, according to animal size" (see discussion below) (Fig. 2B). Right mandible with 1 penicil adjacent to lacinia, 1 penicil in molar process, distal leaf-shaped (serrate) lacinia (Fig. 2D). Maxilliped distal margin rounded; endite rectangular narrowing distally, slightly surpassing palp first tuft of setae, with large apical penicil with 1 spine at each side

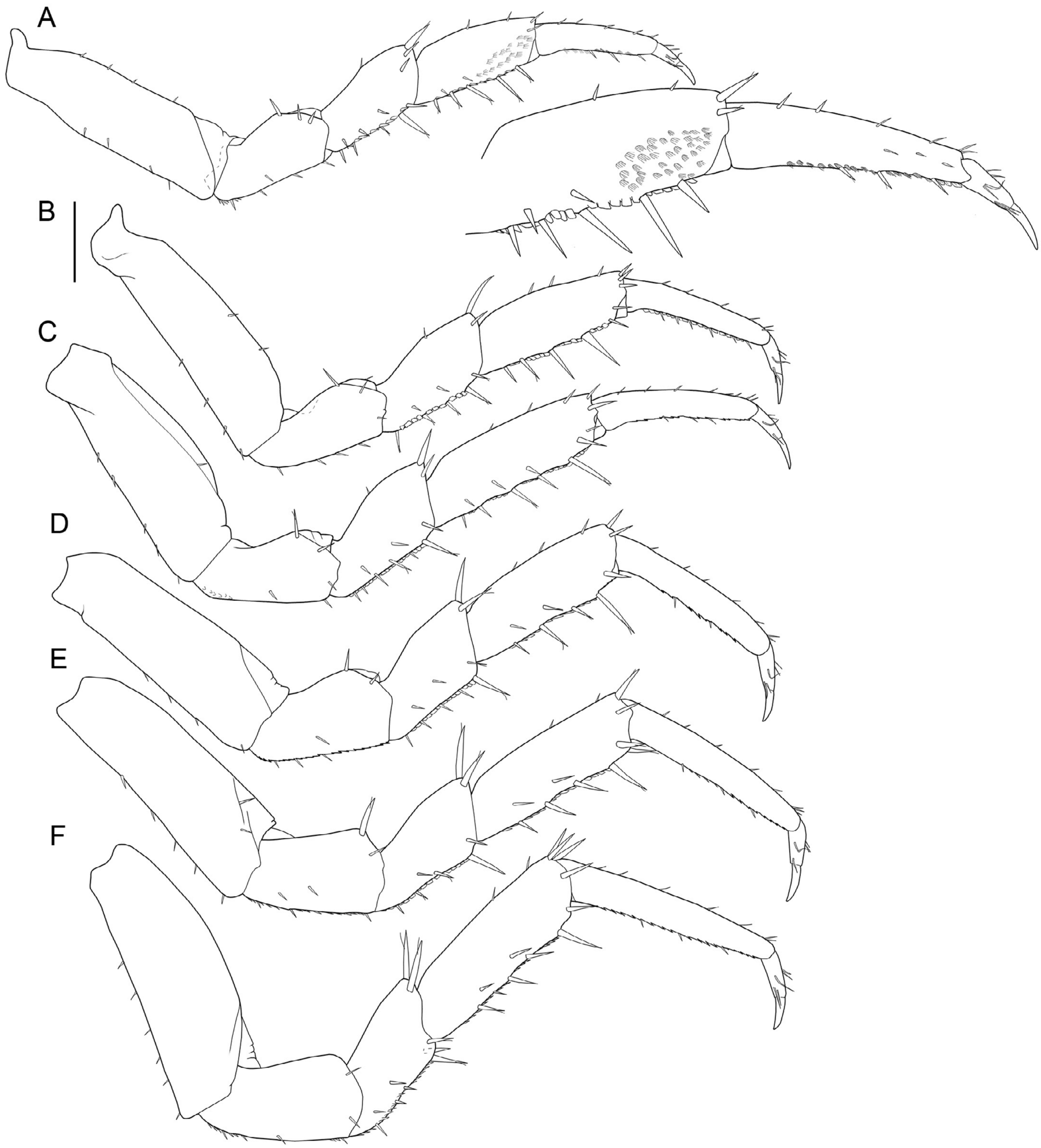

Figure 3. *Spelunconiscus castroi* Campos-Filho, Araujo and Taiti, 2014. **A – F**: Pereopods 1–6. Scale bar: 0.2 mm.

(Fig. 2G). Antennula (Fig. 2A) and other buccal pieces (Fig. 2D–G). Pereopod I with row of small scales proximally and along merus and carpus ventral face (Fig. 3A). Pereopod VII basis with rows of scales for water conducting system on caudal face; proximal spur-like structure on rostral face (Figs. 4, 5A). Pleopod II endopod about fivefold longer than wide, distal portion bearing subapical elongated accessory lobe and lateral lobe (Fig. 5C–E).

Spelunconiscus septemlacuum sp. nov.

(Figs. 6–8)

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Etymology. The specific epithet means *septem* (seven) + *lacuum* (lakes) in Latin, in reference to the name of the municipality where the cave is located (Sete Lagoas, in Portuguese, meaning “seven lakes”).

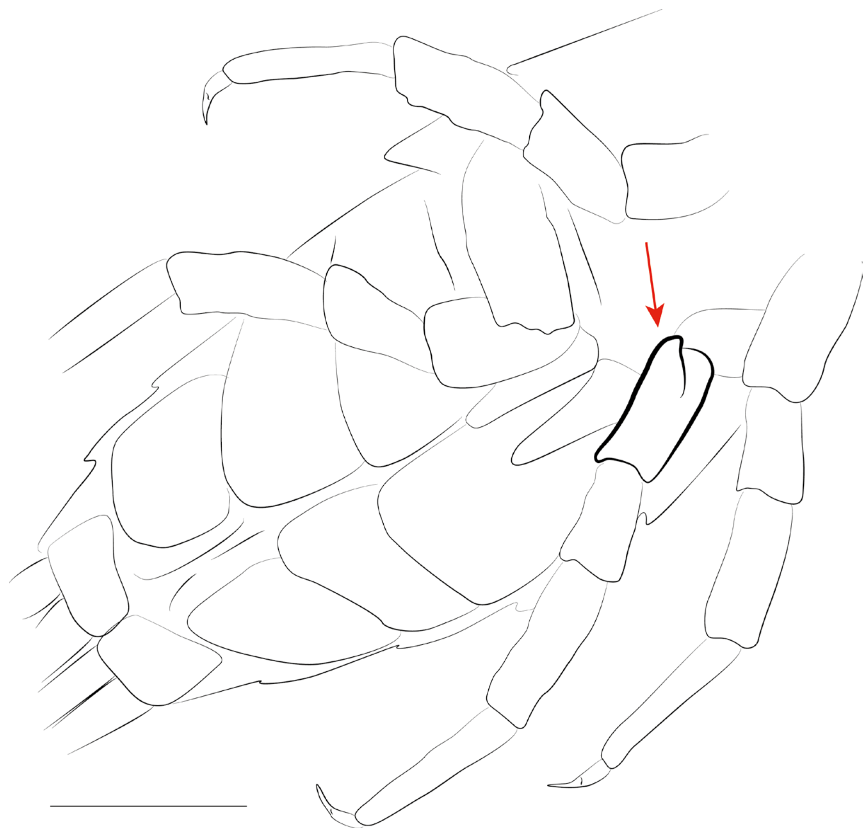

Figure 4. Ventral view of the holotype of *Spelunconiscus castroi* (MZUSP27521) highlighting the presence of a spur-like structure proximally on the pereopod 7 ischium inner face (red arrow). Scale bar: 1 mm.

Material examined. Holotype: male (ISLA 79134), June 2018, Taboa Cave, Sete Lagoas, Minas Gerais, Brazil (19°28'30.00"S 44°19'41.70"W); coll. R. Ferreira. Paratypes: 3 males (ISLA 62791, ISLA 62792, ISLA 62793) and 1 female (ISLA 62794) mounted on slides, July and December 2015; 3 males (ISLA 79133), 5 females (ISLA 62797), same data as holotype; 1 male mounted on slide (ISLA 62790), Tatuzinhos cave, Sete Lagoas, Minas Gerais, Brazil (19°28'26.28"S 44°20'1.60"W), July 2015, coll. F. Bondezanll.

Diagnosis. Antennula distal article with 5 long aesthetascs. Antenna fifth article of peduncle longer than flagellum; flagellum with 4 or 5 articles proximal article longer (subequal in length to the distal ones). Pleopod II exopod sub-rectangular, distal margin straight; endopod three to fourfold longer than exopod, distal article about twofold longer than proximal, about fourfold longer than wide, robust, cylindrical, with beak-like distal portion, proximally with lateral lobe, distally with digitiform structure and several small projections.

Description. Maximum body length: 10.6 mm. Body unpigmented, slender, flexible, able to bend, surface smooth, with pointed scale setae (Fig. 6A). Eyes absent. Cephalon trapezoidal in dorsal view; posterior margin straight; less than half of its length, inserted in pereonite 1; small quadrangular antennal lobes; vertex with 2 shallow transverse antero-lateral grooves; profrons with supra-antennal line medially truncated, directed to projected clypeus. Antennula distal article longer than second and first; second article shorter than first, distal article with 5 apical aesthetascs (Fig. 6B). Antenna fifth article of peduncle article longer than flagellum; flagellum with 4 to 5 articles, proximal article longer (subequal in length to distal ones) (Fig. 6C). Right mandible with 1 penicil; distal leaf-shaped (serrate) lacinia; molar process with 1 short penicil (Fig. 6D). Left mandible with 2 penicils (Fig. 6E). Maxillula outer branch with 5 + 5 teeth apically entire and 1 slender stalk; inner branch with 3 penicils, inner penicil longest (Fig. 6F). Maxilla setose, inner lobe larger than outer lobe (Fig. 6G).

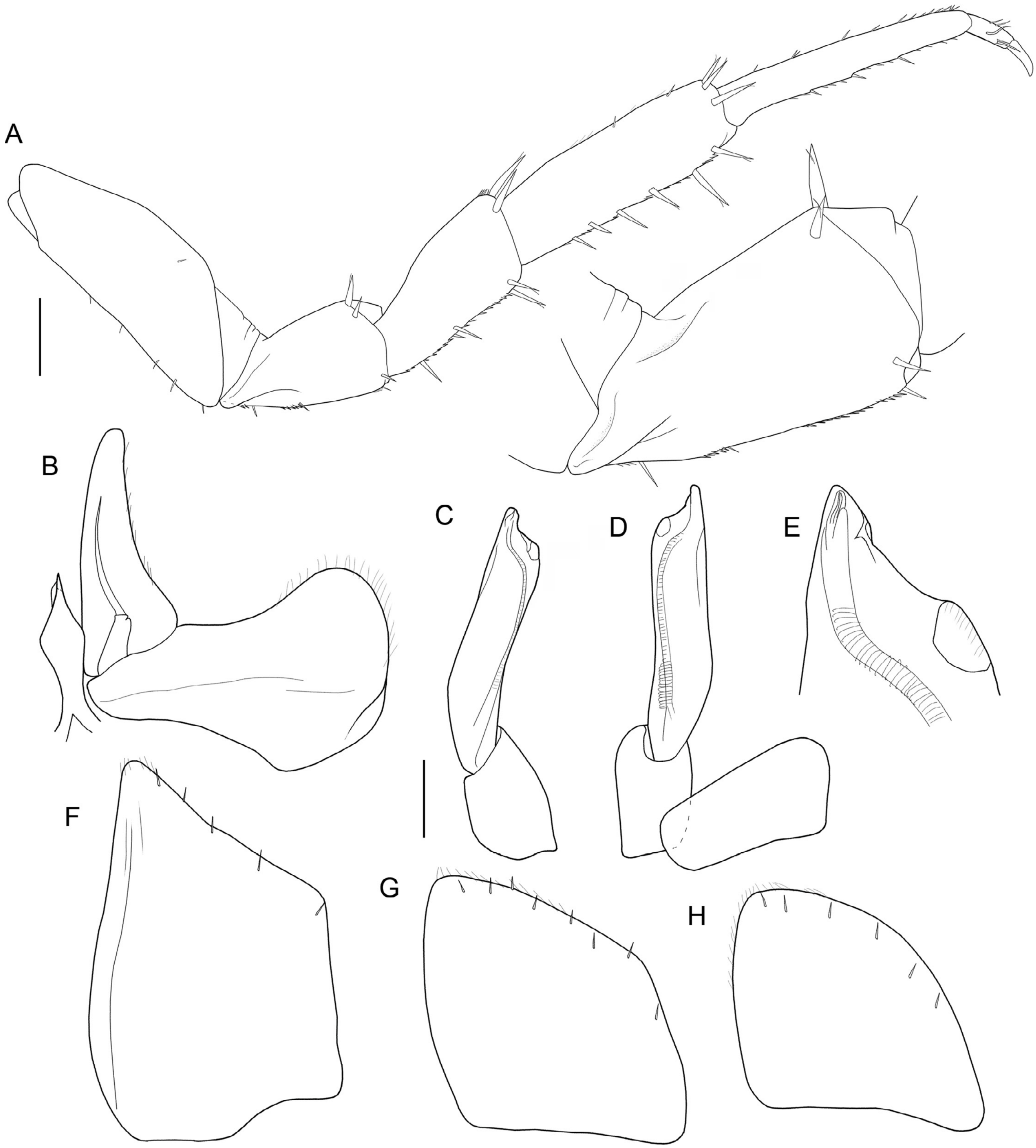

Figure 5. *Spelunconiscus castroi* Campos-Filho, Araujo and Taiti 2014. **A**: Pereopod 7 and detail of the spur-like structure on the ischium. **B**: pleopod 1; **C – E**: pleopod 2; **F**: pleopod 3; **G**: pleopod 4; **H**: pleopod 5. Scale bar: 0.2 mm.

Maxilliped basis triangular enlarged on distal portion, outer, inner, and distal margins with fringe of thin setae; palp with 3 projections, each of them with 1 tuft of setae; endite narrow, densely setose, narrowing towards apex with large conical penicil not attaining palp first tuft of setae, 1 proximal spine at each side (Fig. 6H). Pereopod I carpus with antennal grooming brush (Fig. 7A). Pereopod VII basis with water-conducting scale-rows on caudal face, dactyli with glabrous and unbranched dactylar setae. Uropod

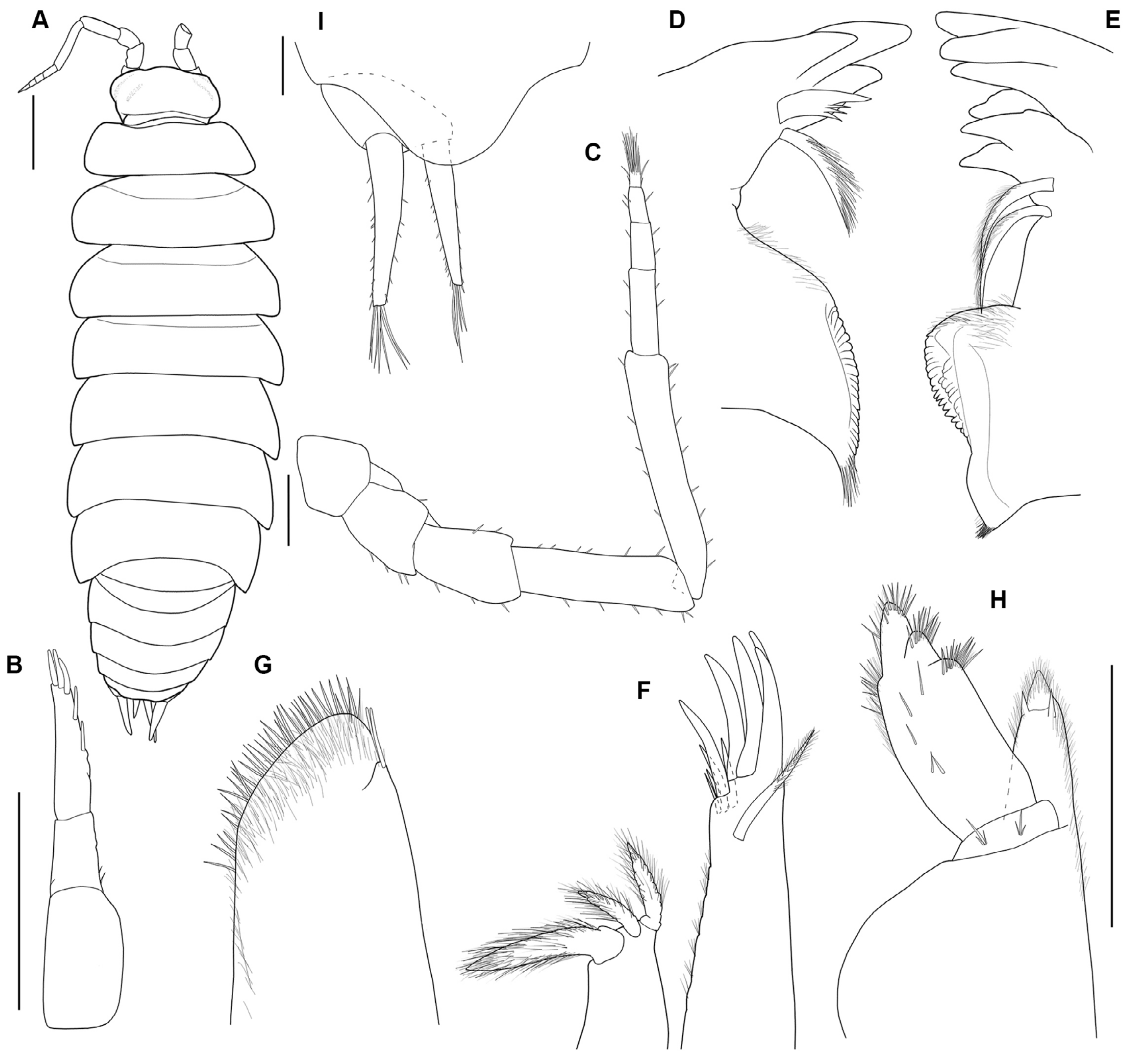

Figure 6. *Spelunconiscus septemlacuum* sp. nov. **A**: Habitus; **B**: antennule, **C**: antenna; **D**: right mandible; **E**: left mandible; **F**: maxillule; **G**: maxilla; **H**: maxilliped; **I**: pleotelson and uropod. Scale bar: 0.2 mm.

endopod slightly shorter than exopod, both inserted at same level; exopod more than twice the protopod length (Fig. 6I).

Male. Pereopod VII ischium rostral face with spur-like structure (Fig. 8A). Genital papilla lanceolate. Pleopod I exopod triangular; endopod 2-jointed; protopod external half enlarged projecting latero-distally, with simple setae on lateral and distal margins (Fig. 8B). Pleopod II exopod sub-rectangular, with rounded vertices, distal margin straight; endopod 2-jointed, three- to fourfold longer than exopod, distal article about twofold longer than proximal, about fourfold longer than wide, robust, cylindrical, with beak-like distal portion, proximally with lateral lobe, distally with digitiform structure and several small projections (Fig. 8C–E). Pleopod exopods III to V sub-trapezoidal with short setae at margins (Fig. 8F–H).

Discussion

Taxonomy

Spelunconiscus was described by Campos-Filho *et al.* (2014) as a new genus based on the short and thickset aesthetascs in the distal article of antennula (this kind of aesthetasc is present in some *Xangoniscus* species [see Cardoso *et al.*, 2020] and also in other Synocheta - some Titanidae and Turanoniscidae); unbranched and glabrous dactylar setae in pereopods (as also occurs in *Xangoniscus* species) and male pleopod I exopod longer than endopod. Additional analysis of the holotype (male) of *S. castroi* (type species) has revealed the presence of a spur-like structure proximally on the rostral face of pereopod VII ischium, which is also present in *S. septemlacuum* sp. nov. Modifications in the male pereopod VII has a dispersed occurrence in Oniscidea, whether cylindrical or spur-shaped, or occurring on the ischium, merus or both. For instance, in Crinocheta the species *Adinda palniensis* Ferrara, Meli and Taiti, 1995 (Scleropactidae) presents a "spur-like lobe directed proximally at the base of the pereopod 7 ischium" (Ferrara *et al.*, 1995) and in Synocheta a spur-like structure also occurs on the ischium of pereopod VII of the genus *Coatonia* Kensley, 1971 (Titanidae), which is very similar to that found in *Spelunconiscus* species. In *Hyloniscus* Verhoeff, 1908 (Trichoniscidae) a similar structure is observed on the male pereopod VII. However, in this case the spur is distally pointed and located on the merus — "meropodite of the pereopod VII male presents at its base a hook-like, curved spur" (Giurginca *et al.*, 2015) — *e.g.*, in *Hyloniscus riparius* (C. Koch, 1838). A lobe is also observed in *Trichoniscoides* Sars, 1898 (Trichoniscidae), *e.g.*, *Trichoniscoides broteroi* Vandel, 1946 and *Trichoniscoides sicoensis* Reboleira and Taiti, 2015 — "presence of a lobe on the mid-sternal margin of the male pereopod VII merus" (Reboleira *et al.*, 2015) and so on in many others. In all the cases, such a structure must be related to copulation. This kind of structure has not yet been reported for the Brazilian Styloniscidae and is here interpreted as a putative synapomorphy of *Spelunconiscus*.

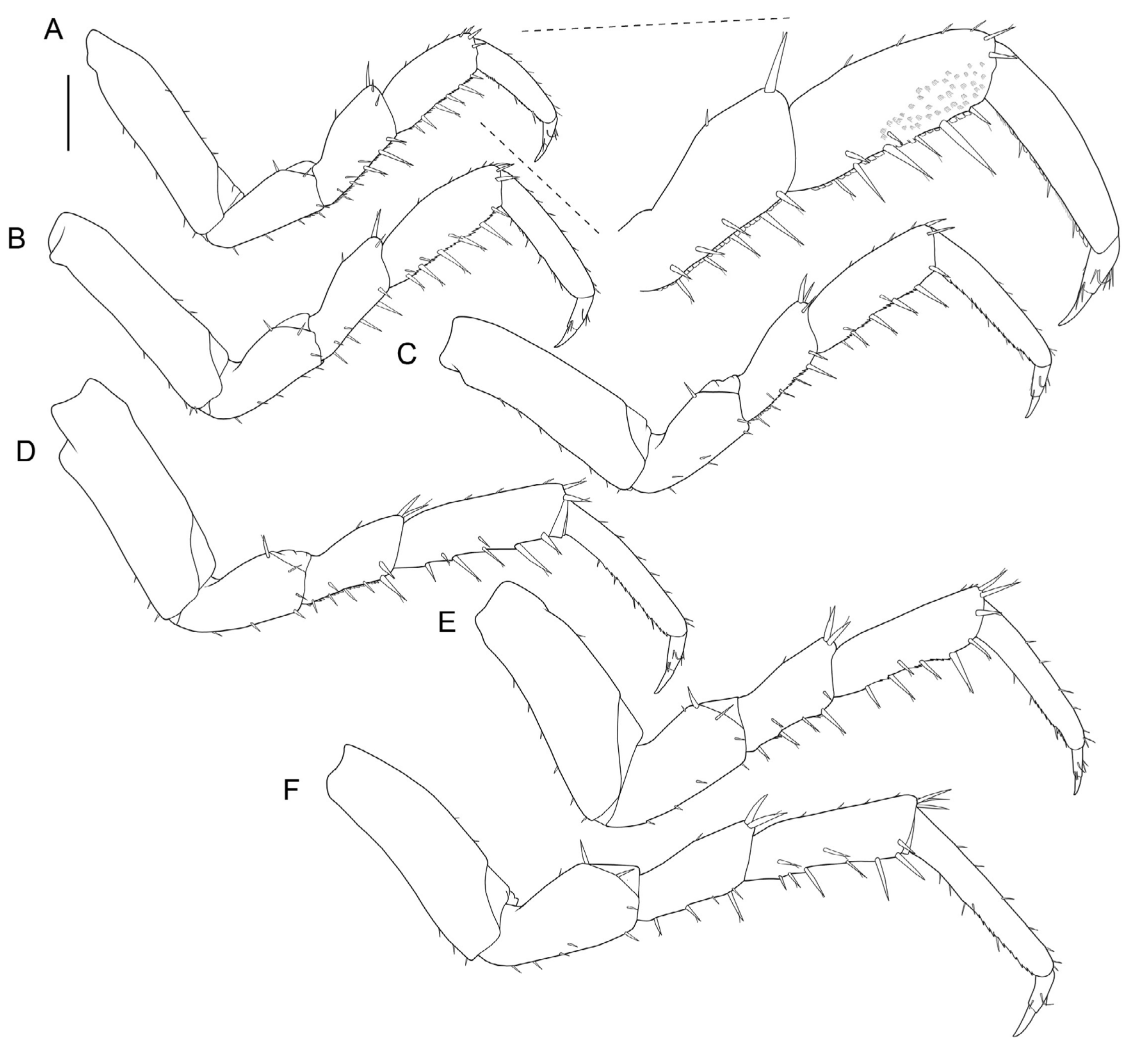

Figure 7. *Spelunconiscus septemlacuum* sp. nov. **A – F**: Pereopods 1 – 6. Scale bar: 0.2 mm.

Additionally, a characteristic of the maxilliped has also not been mentioned in the description of *S. castroi* (although it has been somehow illustrated by Campos-Filho *et al.*, 2014) — the presence of spines apically surrounding the large conical robust penicil on the endite (as also occurs in other Synocheta, *e.g.*, in some *Styloniscus* and in some Titanidae). In this sense, such traits were added to the diagnosis of the genus.

Except for *Cylindroniscus* Arcangeli, 1929 and *Pectenoniscus* Andersson, 1960 that are not assumed to be aquatic, the basis of maxilliped distally enlarged is recurrent in the Brazilian amphibious Styloniscinae and Iuiuniscinae. Taiti and Xue (2012) have already included this trait among the characters used to associate two species of *Trogloniscus* Taiti and Xue, 2012 with an aquatic lifestyle and to distinguish them from terrestrial ones.

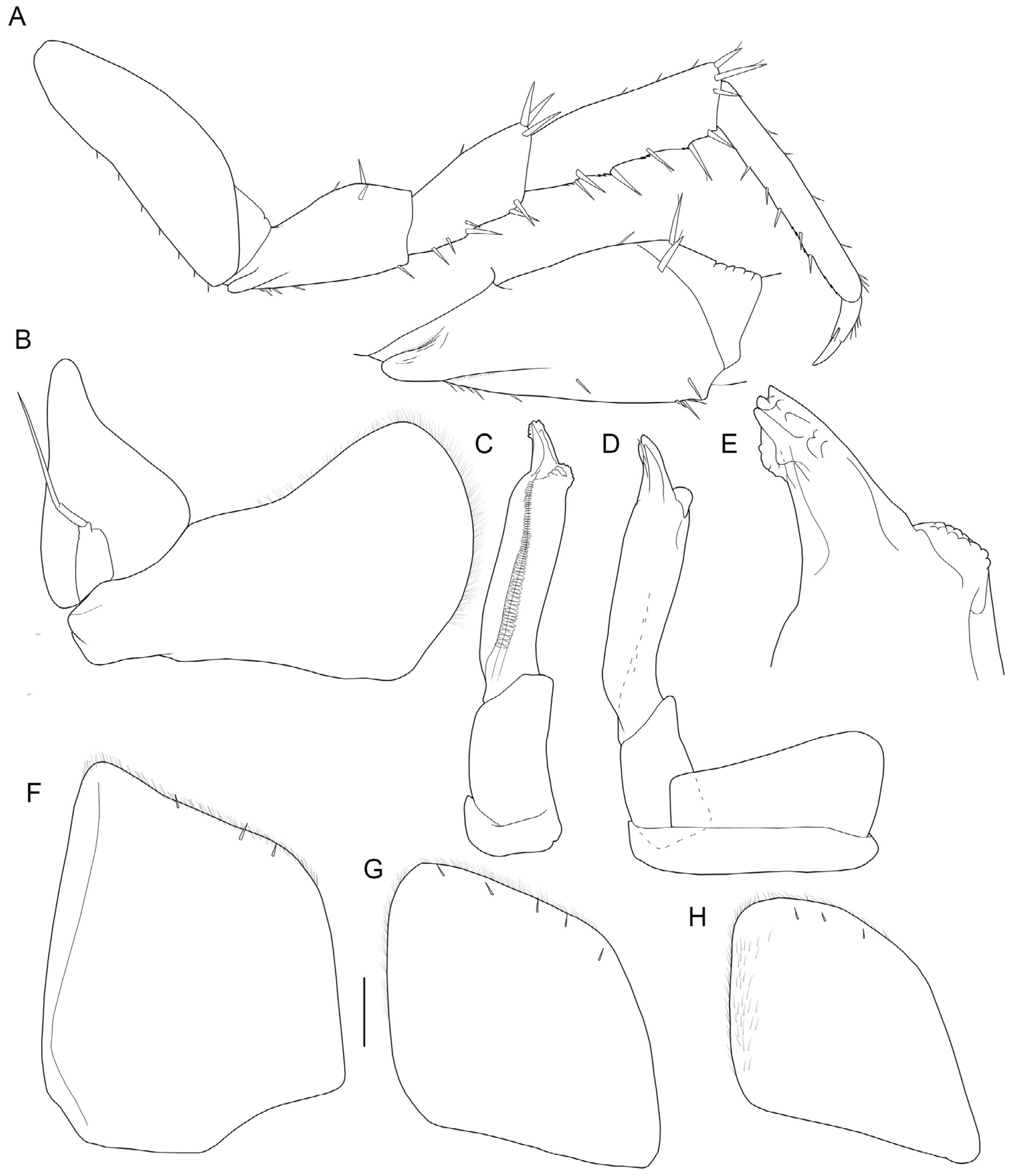

Figure 8. *Spelunconiscus septemlacuum* sp nov. **A**: Pereopod 7 and detail of the spur-like structure on the ischium; **B**: pleopod 1; **C – E**: pleopod 2; **F**: pleopod 3; **G**: pleopod 4; **H**: pleopod 5. Scale bar: 0.2 mm.

Campos Filho *et al.* (2014: 368) stated about the antennal flagellum of *S. castroi*: "flagellum of between five and seven articles, according to animal size". By indicating that the number of articles is related to the animal size, the authors assumed that a reference to differentiate semaphoronts is implicit. Perhaps it would be more appropriate to state: "between five and seven articles in adult individuals (with similar size)". This is the semaphoront used to characterize the species in Oniscidea. Hence, to remedy this conceptual error in the characterization of *S. castroi*, we could assume that the largest (or smallest?) number of articles is found in the largest individuals, corresponding to the adult semaphoront of length between 6 mm (maximum length reported in the original description) and 8.3 mm (maximum length reported here based on the new examined material of this species). We could then consider that there are seven articles in the antennal flagellum of *S. castroi* as showed in the original illustration and in the illustration and photo provided here. Considering that *S. castroi* has a maximum size of 8.3 mm and seven articles in the antennal flagellum and *S. septemlacuum*, 10.6 mm and five articles, respectively, we notice a marked difference between the two species regarding this character. Moreover, *S. septemlacuum* sp. nov. and *S. castroi* differ in the antennula, antenna, maxilliped, male pleopod 1 and 2, and body size, as presented in Tab. 1.

Ecology

The outcrop where Taboa and Tatuzinho caves are located is found in a zone of pronounced anthropogenic impacts (Fig. 1A). The native vegetation external to the caves was strongly modified and vegetation fragments are mainly associated with the outcrops in areas inappropriate for agriculture. Furthermore, many outcrops in the surroundings were anthropogenically altered or destroyed by mining activities.

Although many caves were the target of speleological inventories in the region, individuals of the new species are restricted to Taboa and Tatuzinhos cave. The entrances of such cavities are about 550 m apart from each other, but their elevation is distinctly different (Taboa cave: 753 m a.s.l., Tatuzinhos cave: 864 m a.s.l.) (Fig. 1A). Although these caves are not connected by macrospaces, interstitial spaces may allow the movement and migration of small invertebrates (like isopods) between them.

Taboa cave consists of a predominantly linear projection of around 1,200 m, formed by a main conduit with some lateral branches (smaller conduits), that trespass the limestone outcrop (Fig. 1A). The representatives of Styloniscidae can be easily found in this cave in some travertine pools located in a lateral conduit not far from the main entrance (Figs. 1B, 9B). Such travertine pools are filled with percolating water. Regardless of the season, individuals can be found in the deeper ponds that do not dry out during the dry season (from April to September). In the rainy periods (from October to March), most travertines are filled, and specimens are more widespread along the conduit. During such periods, it is common to observe other travertines located in the main conduit of the cave filled with water. On some occasions, specimens were observed in such ponds (Figs. 1B, 9C) and in one visit (16 May 2000) a single specimen was found quite far from the area in which they are

Table 1. Comparative table of distinctive morphological characters of *Spelunconiscus* (Styloniscidae, Oniscidea, Isopoda) species.

Characters	***Spelunconiscus castroi***	***Spelunconiscus septemlacuum* sp. nov.**
Antenna: 5th article of peduncle × flagellum	5th article shorter than flagellum	5th article longer than flagellum
Antenna: flagellum articles	5 – 7	4 – 5
Maxilliped: endite length	Surpasses palp 1st tuft of setae	Does not reach palp 1st tuft of setae
Pl2: length × width endopod distal article	About 5 ×	About 4 ×
Pl2: distal article distal portion	Subapical digitiform structure	Subapical digitiform structure and several small projections
Maximum body size observed (mm)	8.3	10.6

more commonly observed (around 300 m from it), in a pond formed by the overflow of the drainage that traverses the innermost portion of the cave (Fig. 1B), thus indicating a considerable dispersal ability of the species. Specimens, however, were never observed in the drainage itself. In this cave, the isopods seem to feed mostly on organic debris (especially bat guano) deposited in the ponds (Fig. 9A). Other troglobitic species observed in Taboa cave are *Charinus taboa* Vasconcelos, Giupponi and Ferreira 2016 (Amblypygi: Charinidae), *Tisentnops onix* Brescovit and Sanchez-Ruiz 2016 (Araneae: Caponidae), an Escadabiidae harvestman, a Pyrgodesmidae millipede and springtails.

Tatuzinhos cave is quite distinct from Taboa because it consists of a small cavity (around 25 m long) devoid of aphotic areas. Contrary to Taboa cave, in which the main entrance is located at the base of the outcrop, Tatuzinhos cave is at the top (Figs. 1A, 9D) 110 m above Taboa cave. Representatives of Styloniscidae were only found on one occasion during the rainy period in a pond formed by percolating water on the cave floor (Fig. 9E). A second visit to the cave (also in the rainy period) failed to find specimens, perhaps because no ponds, or collections of water, were observed in the cave.

The distinct elevation difference between Taboa and Tatuzinhos caves strongly suggests that *S. septemlacuum* sp. nov. also inhabits the epikarst zone of the outcrop. The individuals probably migrate from the epikarst to the macro-caves during the rainy periods looking for additional food items, then returning to the epikarst during the dry periods when the ponds dry out (as in Tatuzinhos cave), or remaining in the cave if conditions and resources are available (as in Taboa cave). Such behavior of vertical migration has also been hypothesized for other species of the genus (under description). As a consequence, such species may be restricted to only one cave, or more than one provided that the caves present some connection that allow individuals to transit.

Spelunconiscus castroi was first recorded for Eritrina cave about 30 km away from the outcrop where Taboa and Tatuzinhos caves are located. The cave name in the original description of this species — MOC 32 — was attributed by consultancy companies during biological inventories. The original name of the cave — Eritrina cave — established when the cave was first discovered, in 1991, was properly recorded in the National Speleological Record (CECAV, 2021). Afterwards, specimens of *S. castroi* were found in another cave named Retiro cave, located around 20 km away from Eritrina cave, as described in the Material Examined section. Although there is no visual connectivity of the outcrops where these caves are, the occurrence of *S. castroi* in both caves provides some insight into a possible subterranean connection between them. Campos-Filho *et al.* (2014) did not provide any descriptions on the habitat of *S. castroi*. In Retiro cave, such organisms occur in a small lotic drainage, which flows through a small chamber (around 2.5 m) located in the innermost part of the cave. Moreover, this drainage reappears in a closely located cave — Moinho cave — whose entrance is located 200 meters from the Retiro cave entrance, where specimens of *S. castroi* were also observed.

Conservation issues

In general, no direct threats to *S. septemlacuum* sp. nov. inside the caves have been recorded. Taboa cave is mainly visited by speleologists that usually do not reach the conduit where specimens are found, while Tatuzinhos cave is rarely visited due to the hard access route, allied with the lack of attractiveness. Hence, the main potential threats for the species are food depletion (if the bat populations migrate from the area) and changes in the hydrological regime. *Spelunconiscus castroi* was found in caves that are also rarely visited. All caves inhabited by these species are mainly visited by speleologists and the access to the caves is difficult. Vertical descent techniques are required to access the areas where specimens are found in Eritrina and Moinho caves and, in Retiro cave, a constriction prevents non-speleologists from reaching the innermost part of the cavity where individuals occur. As observed for *S. septemlacuum* sp. nov., the potential threats for the species are changes in the external habitat (especially deforestation, agriculture, and urbanization) because, as an example, an international airport is situated quite close by (around 1.5 km) to the Retiro and Moinho caves. Such anthropogenic alterations can lead to food depletion and/or water contamination, potentially causing impacts to their populations.

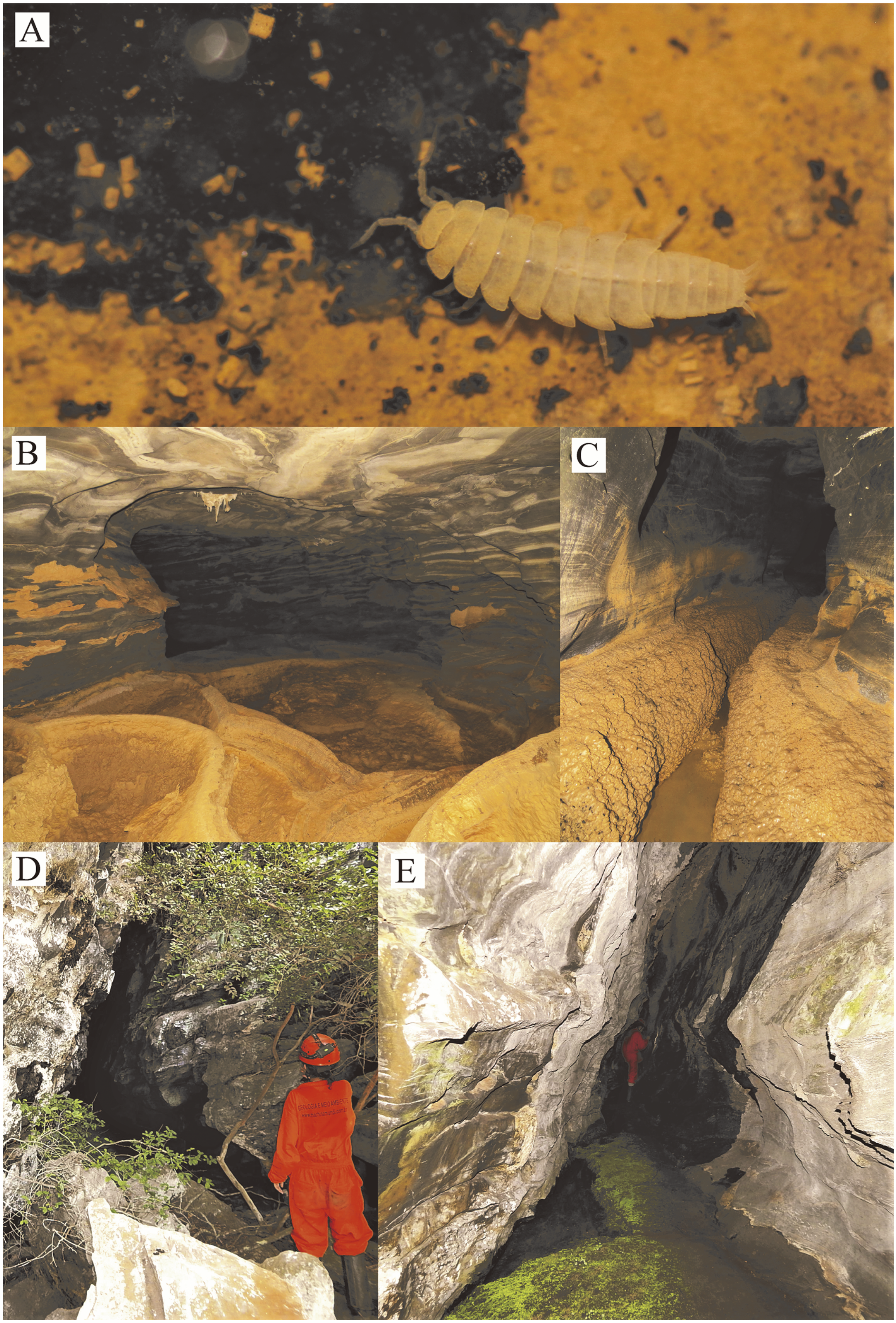

Figure 9. A: *Spelunconiscus septemlacuum* sp nov. alive in the natural habitat (Taboa Cave) probably feeding on bat guano; **B**: general overview of travertine pools right before the pools where the isopods were collected in Taboa Cave; **C**: pools where individuals were found in Taboa Cave; **D**: entrance of Tatuzinhos cave; **E**: general overview of Tatuzinhos cave highlighting the lack of aphotic zone.

The description of troglobitic species contributes directly to the conservation of Brazilian speleological patrimony. This is especially relevant in an area of high interest by mining companies. Furthermore, any information regarding the habitat, ecology, and conservation of a given species has been proven to be crucial for determining the species vulnerability. In Brazil, all troglobitic species have been evaluated according to the IUCN criteria, so distributional ranges, as well as any information on their habitats (including threats) are influential in determining the category of threat of the referred species. In turn, such categories determine the conservation policies or actions demanded to protect a given species.

Acknowledgments

The authors thank Fábio Bondezan for the collections of *S. septemlacuum* sp. nov., and for the help with field work and providing all information on the cavities and previous collections. ADESITA/CECAV (Agency of Economic and Social Development of Itabirito/ National Council of Research and Conservation of Caves) is thanked for the financial support, as is CNPq (National Council for Scientific and Technological Development) for the productivity scholarship provided to RLF (CNPq no. 308334/2018-3). The Federal University of Lavras is thanked for the scholarship provided to BSS and the Vale Company is thanked for the financial support of the Center of Studies in Subterranean Biology. Giovanna Monticelli Cardoso made valuable contributions to the illustrations.

References

Bastos-Pereira, R.B.; Souza, L.A. and Ferreira, R.L. 2017. A new amphibious troglobitic styloniscid from Brazil (Isopoda, Oniscidea, Synocheta). *Zootaxa*, 4294: 292–300.

Campos-Filho, I.S. and Araujo, P.B. 2011. Two new troglobitic species of Scleropactidae (Crustacea: Isopoda: Oniscidae) from Pará Brazil. *Nauplius*, 19: 27–39.

Campos-Filho, I.S.; Araujo, P.B.; Bichuette, M.E.; Trajano, E. and Taiti, S. 2014. Territorial isopods (Crustacea: Isopoda: Oniscidea) from Brazilian caves. *Zoological Journal of the Linnean Society*, 172: 360–425.

Campos-Filho, I.S.; Bichuette, M.E. and Taiti, S. 2016. Three new species of territorial isopods (Crustacea, Isopoda, Oniscidea) from Brazilian caves. *Nauplius*, 24: e2016001, 19p.

Campos-Filho, I.S.; Bichuette, M.E.; Montesanto, G.; Araujo, P.B. and Taiti, S. 2017. The first troglobiotic species of the family Pudeoniscidae (Crustacea, Isopod, Oniscidea), with descriptions of a new genus and two new species. *Subterranean Biology,* 23: 69–84.

Campos-Filho, I.S.; Cardoso, G.M. and Aguiar, J.O. 2018. Catalogue of terrestrial isopods (Crustacea, Isopoda, Oniscidea) from Brazil: an update with some considerations. *Nauplius,* 26: e2018038, 40p.

Campos- Filho, I.S.; Fernandes, C.S.; Cardoso, G.M.; Bichuette, M.E.; Aguiar, J.O. and Taiti, S. 2019. Two new species and new records of terrestrial isopods (Crustacea, Isopoda, Oniscidea) from Brazilian caves. *Zootaxa,* 4564: 422–448.

Campos-Filho, I.S.; Gallo, J.S.; Gallão, J.E.; Torres, D.F.; Horta, L.; Carpio-Díaz, Y.M.; López-Orozco, C.M.; Borja-Arrieta, R.; Aguiar, J.O. and Bichuette, M.E. 2022. Unique and fragile diversity emerges from Brazilian caves – two new amphibious species of *Xangoniscus* Campos-Filho, Araujo & Taiti, 2014 (Oniscidea, Styloniscidae) from Serra do Ramalho karst area, state of Bahia, Brazil. *Subterranean Biology* 42: 1–22.

Cardoso, G.M.; Campos-Filho, I.S. and Araujo, P.B. 2016. The genus *Dubioniscus* Vandel, 1963 (Oniscidea, Dubioniscidae) with descriptions of two new species from Brazil. *Tropical Zoology,* 29: 111–133.

Cardoso, G.M.; Araujo, P.B. and Bichuette, M.E. 2017. Two new species of *Neotroponiscus* Arcangeli, 1936 (Crustacea, Isopoda, Oniscidea) from Brazilian caves. *Studies on Neotropical Fauna and Environment*, 52: 122–133.

Cardoso, G.M.; Campos-Filho, I.S. and Araujo, P.B. 2018. Taxonomic revision of *Brasiloniscus* (Oniscidea, Pudeoniscidae) with description of a new species. *European Journal of Taxonomy,* 434: 1–16.

Cardoso, G.M; Bastos-Pereira, R; Souza L.A. and Ferreira, R.L. 2021. *Chaimowiczia*: a new Iuiuniscinae genus from Brazil (Oniscidea, Synocheta, Styloniscidae) with the description of two new troglobitic species. *Subterranean Biology*, 39: 45–62.

Cardoso, G.M; Bastos-Pereira, R; Souza L.A. and Ferreira, R.L. 2020a. New cave species of *Pectenoniscus* Andersson, 1960 (Isopoda: Oniscidea: Styloniscidae) and an identification key for the genus. *Nauplius*, 28: e2020039, 30p.

Cardoso, G.M.; Bastos-Pereira, R.; Souza, L.A. and Ferreira, R.L. 2020b. New troglobitic species of *Xangoniscus* (Isopoda: Styloniscidae) from Brazil, with notes on their habitats and threats. *Zootaxa*, 4819: 84–108.

CECAV. 2021. Cadastro Nacional de Informações Espeleológicas – CANIE, Centro Nacional de Pesquisa e Conservação de Cavernas. Available at http://www.icmbio.gov.br/cecav/canie.html. Accessed on 15 March 2021.

Fernandes, C.S.; Campos-Filho, I.S. and Bichuette, M.E. 2018. *Cylindroniscus platoi* (Isopoda: Oniscidea: Styloniscidae), a new cave-dwelling species from Lagoa Santa Karst, Southeastern Brazil. *Zootaxa,* 4461: 411-420.

Ferrara, F.; Meli, C. and Taiti, S. 1995. Taxonomic revision of the subfamily Toradjiinae (Crustacea, Oniscidea: Scleropactidae). *Zoological Journal of the Linnean Society,* 113: 351–459.

Giurginca, A.; Munteanu, C.M.; Vlaicu, M. and Tăbăcaru, I.G. 2015. Cavernicolous Oniscidea of Romania. București, Ed. Semne. 165p.

Grangeiro, D.C.; Souza, L.A. and Christoffersen, M.L. 2017. New species of *Xiphoniscus* and new record of *Androdeloscia escalonai* (Isopoda, Scutocoxifera, Oniscidea, Philosciidae) from Brazilian Amazon. *Zootaxa,* 4350: 374-384.

Montesanto G. 2015. A fast GNU method to draw accurate scientific illustrations for taxonomy. *ZooKeys,* 515: 191– 206.

Montesanto G. 2016. Drawing setae: a GNU way for digital scientific illustrations. *Nauplius,* 24: e2016017, 6p.

Reboleira, A.S.P.S.; Gonçalves, F.; Oromí, P. and Taiti, S. 2015. The cavernicolous Oniscidea (Crustacea: Isopoda) of Portugal. *European Journal of Taxonomy,* 161: 1–61.

Souza, L.; Senna, R.A. and Kury, B.A. 2010. A new species and first record of *Gabunillo* Schmalfuss & Ferrara, 1983 (Isopoda, Oniscidea, Armadillidae) from the Neotropics. *Zootaxa*, 2677: 1–14.

Souza, L.A.; Ferreira, R.L. and Senna, A. 2015. Amphibious shelter-builder Oniscidea species from the new world with description of a new subfamily, a new genus and a new species from Brazilian cave (Isopoda, Synocheta, Styloniscidae). *PLoS ONE,* 10: e0115021, 18p.

Schmalfuss, H. 2004. World catalog of terrestrial isopods (Crustacea, Isopoda). *Stuttgarter Beiträgezur Naturkunde*, Serie A, 639, 120p.

Schmidt, C. 2002. Contribution to the phylogenetic system of the Crinocheta (Crustacea, Isopoda). Part 1 (Olibrinidae to Scyphacidae s. str.). Mitteilungen aus dem Museum für Naturkunde Berlin. *Zoologische Reihe,* 78: 275–352.