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New species and new records of terrestrial isopods (Crustacea, Isopoda, Oniscidea) of the families Philosciidae and Scleropactidae from Brazilian caves

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Abstract. After the examination of a large collection of Oniscidea from caves in the Brazilian states of Bahia, Minas Gerais, Pará, Sergipe and São Paulo, 12 species were recognized in the families Philosciidae and Scleropactidae. Four new species are described: *Alboscia jotajota* sp. nov. from the Açungui group; *Androdeloscia akuanduba* sp. nov. and *Amazoniscus spica* sp. nov. from the Carajás Formation; and *Metaprosekia igatuensis* sp. nov. from the Quadrilátero Ferrífero karst region. In addition, *Atlantoscia inflata*, *Benthana longicornis*, *B. olfersii*, *B. picta* and *Paratlantoscia rubromarginata* (Philosciidae) are recorded from Brazilian caves for the first time; and *Benthana iporangensis*, *B. taeniata* and *Circoniscus bezzii* (Scleropactidae) have the knowledge of their distribution extended to cave habitats.

Keywords. Subterranean environment, Açungui group, Carajás Formation, Quadrilátero Ferrífero karst region, Neotropical.

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Introduction

South America comprises twelve countries and four dependencies, with approximately 17.8 million km^2. Despite this large extension, only 2% of its territory has suitable lithology for the development of karstic systems (Auler 2004, 2017). In the 19 karst areas of Brazil ca 18 000 caves are presently known (18% of the total estimated cave number, ca 100 000) (Auler 2002; CECAV 2015; Rubbioli *et al*. 2019). Most of these caves occur in carbonatic rocks, where the largest subterranean systems have been developed, and some in siliciclastic rocks. Moreover, non-karst cavities may occur in ferruginous and other types of rocks and sediments (Sallun Filho & Karmann 2012).

Terrestrial isopods (Oniscidea) are one of the unique lineages among crustaceans completely adapted to a terrestrial way of life (Hornung 2011; Richardson & Araujo 2015; Taiti 2018). To date, more than 3700 species in 38 families are known worldwide (Javidkar *et al.* 2015; Sfenthourakis & Taiti 2015).

The Oniscidea are among the most important macrofauna components in tropical habitats, including the Neotropical region (Leistikow 1999, 2001; Schmidt 2003, 2007; Campos-Filho *et al.* 2015a, 2017a; WoRMS 2019), where Philosciidae Kinahan, 1857 and Scleropactidae Verhoeff, 1938 are most abundant. To date, the Philosciidae comprise more than 500 species in 107 genera worldwide and the Scleropactidae include more than 100 species in 26 genera (Sfenthourakis & Taiti 2015; López-Orozco *et al.* 2016, 2017; Campos-Filho *et al.* 2018a; Carpio-Díaz *et al.* 2018; Taiti *et al.* 2018).

Among the invertebrates collected in cave environments, the Oniscidea are one of the most representative groups (Trajano & Bichuette 2010; Gallão & Bichuette 2012, 2018; Silva & Ferreira 2015; Fernandes *et al.* 2019), and their presence is strictly related to the abiotic and biotic conditions of these environments, i.e., humidity, temperature stability and the variety of substrates such as guano and organic matter carried into the cave (Fernandes *et al.* 2019). To date, more than 300 troglobiotic species in 16 families of terrestrial isopods are known, mostly from the northern part of the globe (Taiti & Gruber 2008; Taiti & Xue 2012; Campos-Filho *et al*. 2014, 2016; Taiti 2014; Reboleira *et al.* 2015; Taiti & Montesanto 2018). In Brazil, more than 190 species of terrestrial isopods are known (Campos-Filho *et al.* 2018a, 2018b, 2019), of which 16 species are considered to be troglobionts (see Campos-Filho *et al.* 2018a, 2019; Fernandes *et al*. 2019).

In this paper, four new species of terrestrial isopods are described in the families Philosciidae and Scleropactidae from Brazilian caves. In addition, *Benthana longicornis* Verhoeff, 1941, *B. olfersii* (Brandt, 1833), *B. picta* (Brandt, 1833) and *Paratlantoscia rubromarginata* Araujo & Leistikow, 1999 are recorded for the first time in cave habitats, and *Benthana iporangensis* Lima & Serejo, 1993, *B. taeniata* Araujo & Buckup, 1994 and *Circoniscus bezzii* Arcangeli, 1931 have the knowledge of their distributions extended to the subterranean environment.

Material and methods

Specimens were collected by active search and stored in 75% ethanol. Identifications and descriptions are based on morphological characters with the aid of micropreparations. For each new species, details on the type material, the description, etymology and remarks are given. For already known species, distribution and remarks, if necessary, are given. The synonymic list includes the original publication and only citations of records from Brazil. The complete references are available in Schmalfuss (2003) and Campos-Filho *et al.* (2018a). The illustrations of the habitus were obtained with the aid of a Sony DSC-W800 camera mounted on a Biofocus SQF-L-BI microscope. The appendages were illustrated with the aid of a camera lucida mounted on a CH2 Olympus microscope. Coordinates of the 'noduli laterales' were obtained and illustrated as described in Vandel (1962). The final illustrations were prepared using the software GIMP (ver. 2.8) with the method proposed by Montesanto (2015, 2016). The material is deposited in the collections of the Laboratório de Estudos Subterrâneos, Universidade Federal de São Carlos, São Carlos (LES), and Museu de Zoologia, Universidade de São Paulo (MZUSP), both in the state of São Paulo, Brazil.

Study Area

Our study covered a large latitudinal extension of the Brazilian territory. The characteristics of climate, vegetation, geomorphology, biogeographic history and potential threats to the hypogean environments for each region are given below.

Alto Ribeira karst area, state of São Paulo, southeastern Brazil

The Alto Ribeira karst area (Fig. 1A–B) is one of the largest fragments of the Brazilian Atlantic forest protected by law and under Conservation Units. The presence of hydrographic basins, forests and a large number of caves in the region represents strategic strongholds of the endemic epigean and hypogean biodiversity (SEMA 1997). The region has the Atlantic forest as the main vegetation domain (Ab'Saber 1977). According to Koppen's criteria (Alvares *et al.* 2013), the climate of the region is subtropical humid without a dry season, where lowlands and highlands have hot summers (Cfa) and temperate summers (Cfb), respectively. Our samples were collected in caves under the limits of two Conservation Units of Integral Protection, Parque Estadual Intervales (PEI) and Parque Estadual Turístico do Alto Ribeira (PETAR). The PEI covers the territories of Iporanga, Eldorado Paulista, Sete Barras and Ribeirão Grande, and is bordered by other Conservation Units, including PETAR, while PETAR covers the municipalities of Apiaí and Iporanga (SEMA 2006; Sallun & Sallun Filho 2009). Both parks have several different cave systems in Açungui group rocks, with Precambrian metasedimentary limestone outcrops discontinuously, intercalated with insoluble rocks (Karmann & Sánchez 1979). Currently, both parks face problems with uncontrolled tourism, land conflicts and pollution of subterranean drainage due to illegal mining and agriculture (Gallão & Bichuette 2018).

Presidente Olegário, state of Minas Gerais, southeastern Brazil

The karst area of Presidente Olegário (Fig. 1C–D) municipality is inserted in the northeastern portion of the state of Minas Gerais. This is a limestone area of the Bambuí geomorphologic unit with more than 200 recorded caves. The Paracatu hydrographic sub-basin, southern São Francisco River Basin, irrigates the region (Auler *et al.* 2001). According to Köppen's criteria (Alvares *et al.* 2013), the climate of the region is humid subtropical with dry winters and hot summers (Cwa). The landscape was originally covered by the Cerrado domain (Ab'Saber 1977), with transition spots of Seasonal Semideciduous Forest (Atlantic rainforest) near the limestone outcrops where caves are inserted. To date, agriculture and cattle farming are present in the region, culminating in extensive deforestation, including areas near the caves. Moreover, it is a region threatened by the construction of small hydroelectric centers (Gallão & Bichuette 2018).

Itabirito, state of Minas Gerais, southeastern Brazil

Itabirito is part of the metropolitan sprawl of Belo Horizonte, capital of the state of Minas Gerais, southeastern Brazil. Its landscape is part of the Cerrado Domain with transition spots of Seasonal Semideciduous Forest. According to Köppen's criteria (Alvares *et al.* 2013), the climate of the region is humid subtropical with dry winters and hot summers (Cwa). The caves in this region occur in iron ore rocks of the Quadrilátero Ferrífero, a speleological unit of great interest to mining companies. Due to this lithology, the caves present several small spaces and more connections with surface environments than limestone caves (Bichuette *et al.* 2015; Ferreira *et al.* 2015). Biospeological studies in iron ore caves only started a few years ago, but a rich and diverse fauna has already been described, even in caves with little linear development (Bichuette *et al.* 2015; Ferreira *et al.* 2015). Itabirito is near several mining areas, and its subterranean environments and fauna suffer continuously from the impacts of ore exploitation.

Fig. 1. Study areas. **A**. Ressurgência das Areias de Água Quente, PETAR. **B**. Caverna Passoca Cave, PETAR. **C**. Vereda da Palha Cave. **D**. Presidente Olegário karst area. **E**. Surrounding area of Rio dos Pombos Cave, Povoado de Igatu. **F**. Rio dos Pombos Cave.

Chapada Diamantina region, state of Bahia, northeastern Brazil

Chapada Diamantina is a highland area in the central part of the state of Bahia, where several rivers have their origins. Its landscapes have great scenic beauty (e.g., mountains, waterfalls and natural pools) surrounded by the exuberant vegetation of the Caatinga domain, i.e., shrubby and thorny components typical of drier climate areas (Fig. 1E–F) (Ab'Saber 1977). According to Köppen's criteria (Alvares *et al.* 2013), the climate of the region is semi-arid tropical (Aw). Geologically, karst landforms predominate, with three structurally different geomorphological regions: carbonate rocks from the Una Group, intercalated with other rock types, including the Irecê Formation, which is bordered by the metamorphic sandstones of Serra do Espinhaço (Karmann & Sánchez 1979). Altitudes vary from 1000 to 1700 m a.s.l., representing a natural drainage between the São Francisco and East Basins (Trajano *et al.* 2016). The region is considered a hotspot of cave biodiversity in Brazil. The Chapada Diamantina is protected by law (Parque Nacional Chapada Diamantina), due to its ecological relevance and scenic beauty (Trajano *et al.* 2016). Among the areas not yet protected, the impacts in the subterranean environments are innumerous, like the lowering of the water table, uncontrolled tourism, deforestation for agrobusiness and illegal 'garimpo' (= diamond-digging) (Gallão & Bichuette 2018).

Serra do Ramalho karst area, state of Bahia, northeastern Brazil

The Serra do Ramalho karst area comprises several municipalities in the southwest of the state of Bahia to Minas Gerais, along the middle São Francisco river basin (Trajano *et al.* 2016). The Caatinga with transitions to Cerrado domains are the typical surrounding vegetation (Ab'Saber 1977). According to Koppen's criteria (Alvares *et al.* 2013), the climate of the region is tropical (Aw) with hot summers and a prolonged dry season in winters, from March to October. Despite the fact that the Serra do Ramalho karst area is one of the richest spots of subterranean biodiversity (Trajano *et al.* 2016), there is no legal protection of its caves. Deforestation for charcoal production, timber extraction and agriculture are common and, in the near future, mining will be a concrete threat (Gallão & Bichuette 2018).

Specimens were collected inside Gruna do Enfurnado Cave, located in the municipality of Coribe. This cave was developed in Neoproterozoic metalimestones from the Bambuí Group intercalated with silty-clay and arenitic metasediments (Karmann & Sánchez 1979). The cave itself is 7560 m long, crossed by two streams that connect to each other during heavy rains. Floods bring abundant and varied organic matter, sustaining a rich community inside the cave (Trajano *et al*. 2009).

State of Sergipe, northeastern Brazil

Sergipe is the smallest Brazilian state, comprising 75 municipalities. Among them, 18 have natural cavities (Costa *et al.* 2015). According to Köppen's criteria (Alvares *et al.* 2013), the main climate of the region is tropical with winter rainfall and dry summers (As). The vegetation is Tropical Atlantic domain, which originally covered most of the state (Ab'Saber 1977). Actually, a vast area has been deforested for pastures, even near some caves sampled in this study (Costa *et al.* 2015). Transition zones towards vegetation typical of drier climates appear in the northwest with small spots of Caatinga domain (Ab'Saber 1977).

Our assessment was conducted in the center of the state along a karst strip from northeast to southeast. Knowledge of the karst environments of the state of Sergipe is still incipient, but it is already known that its limestone and dolomites are from the Sergipe Group, Cotinguiba and Riachuelo Formations (Barreto *et al.* 2005). In this karst area, composed of limestone outcrops, caves are frequent. Because of paleoclimate conditions, only few caves have a large horizontal development, such as the Toca da Raposa (90 m) and Aventureiros caves (140 m). The caves of the Sergipe Group are warmer and wetter than usual, and food input is relatively abundant, consisting primarily of guano from frugivorous, insectivorous or hematophagous bats. Most of the environments outside the caves are well preserved, except for those near Toca da Raposa Cave, which have been suffering from deforestation (Costa *et al.* 2015).

To date, no study evaluating the conservation status and threats hanging over the subterranean fauna and environments of Sergipe has been conducted. However, mining of limestone for cement and gravels used in the construction industry is intense near Laranjeiras and Nossa Senhora do Socorro (Macedo *et al.* 2012).

Serra dos Carajás (Canaã dos Carajás and Parauapebas), state of Pará, northern Brazil
This region is part of the Equatorial Amazonian Domain, with small mountain ranges covered with Amazon forests (Ab'Saber 1977). At Serra dos Carajás, series of discontinuous mountains and hills have extensive and ancient erosions, which prevented the development of forest, contrasting with the surrounding dense forest (Campos & Castilho 2012; Crescencio & Carmo 2013; Campos-Filho *et al.* 2014). According to Köppen's criteria (Alvares *et al.* 2013), the climate of the region is tropical monsoon (Am) with an annual mean temperature above 26°C. The total annual rainfall ranges from 2200 to 2500 mm; monsoons concentrate from February to May, with a total of ca 400 mm of rainfall per month during this period. Caves in this region are inserted in iron ore rocks, with connections to the surface via small spaces (Bichuette *et al.* 2015; Ferreira *et al.* 2015). Iron ore mining has been a consistent threat to the subterranean environments of Serra dos Carajás, sometimes reaching a complete destruction of landscapes and caves, by polluting soil and drainages (Gallão & Bichuette 2018).

Results

Order Isopoda Latreille, 1817
Suborder Oniscidea Latreille, 1802
Family Philosciidae Kinahan, 1857

Genus ***Alboscia*** Schultz, 1995

Type species

Alboscia elongata Schultz, 1995, by original designation and monotypy.

Alboscia jotajota Campos-Filho, Bichuette & Taiti sp. nov.
urn:lsid:zoobank.org:act:872601F5-076C-44FD-83E7-0FC35123E54D
Figs 2–4, 14

Diagnosis

Eyes reduced to rudimentary ommatidia, distal article of antennula with six lateral aesthetascs plus apical pair and male pleopod 1 endopod slightly longer than exopod, with short and thickset distal portion.

Etymology

This new species is named after Joaquim Justino dos Santos (*in memoriam*), also known as 'Jota Jota', who discovered several caves in the Alto Ribeira karst area and was a fantastic guide at PETAR.

Material examined

Holotype
BRAZIL – **São Paulo State, Iporanga** • ♂; PEI, Gruta Minotauro; 24°16′34″ S, 48°27′22″ W; 26–30 Mar. 2009, F. Pellegatti-Franco leg.; parts in micropreparations; LES 647.

Paratypes
BRAZIL – **São Paulo State, Iporanga** • 2 ♀♀; PETAR, Ressurgência das Areias de Água Quente Cave; 24°33′45″ S, 48°40′18″ W; 29 Sep. 2012; M.E. Bichuette leg.; LES 18852.

Description

Measurements. Maximum body length: male 4 mm, female 4.5 mm.

Body. Body pigments absent. Body (Fig. 2A) slender with lateral sides almost parallel; dorsal surface smooth, bearing short, triangular scale-setae (Fig. 2B). Noduli laterales very long (Fig. 2C); d/c and b/c coordinates as in Fig. 2D–E.

Cephalon. Lateral lobes not developed, frontal line absent, suprantennal line slightly bent downwards in middle; eyes reduced, with rudimentary ommatidia (Fig. 2F).

Pereon. Pereonite 1 epimera with anterior corners slightly directed upwards, not surpassing median portion of cephalon, epimera 2–7 gradually directed backwards (Fig. 2A).

Pleon. Narrower than pereon; pleonites 3–5 epimera short, adpressed with small posterior points directed backwards, bearing some glandular pores; telson triangular with lateral margins straight, rounded apex (Fig. 2G).

Antennula. Composed of three articles, distal article bearing six lateral aesthetascs in three sets plus apical pair (Fig. 2H).

Antenna. Very long, reaching fourth pereonite when extended backwards; flagellum of three articles, distal article longest; apical organ short, bearing two long free sensilla (Fig. 2I).

Mouth. Mandibles bearing dense cushion of setae on incisor process, molar penicil consisting of several branches; right mandible (Fig. 3A) with 1+1 penicils, left mandible (Fig. 3B) with 2+1 penicils. Maxillula (Fig. 3C) inner endite with distal margin rounded and bearing two penicils; outer endite with four simple teeth plus accessory tooth on outer set, inner set of five pectinate teeth plus one vestigial tooth on rostral surface. Maxilla (Fig. 3D) inner lobe rounded, covered with thick and thin setae; outer lobe slightly wider than inner lobe, covered with thin setae. Maxilliped (Fig. 3E) palp with two strong setae on proximal article; endite subrectangular, medial seta strong, surpassing distal margin, distal margin with two hook-like setae, rostral surface with setose sulcus ending in one strong, triangular seta.

Pereopods. Pereopods 1–7 merus to propodus bearing sparse, long setae on sternal margin; pereopod 1 carpus with transverse antennal grooming brush; dactylus of two claws, inner claw not surpassing outer claw, dactylar and ungual setae simple, not surpassing outer claw.

Uropod. Protopod subquadrangular with endopod and exopod inserted at same level; protopod and exopod outer margins grooved, bearing glandular pores; exopod slightly longer than endopod (Fig. 4A).

Pleopod exopods. Without respiratory structures (Fig. 4E–I).

Male

Pereopods 1 and 7. Without any sexual dimorphism (Fig. 4B–C).

Genital papilla. Stout, with triangular ventral shield, papilla slightly longer than ventral shield, bearing two apical orifices (Fig. 4D).

Pleopods. Pleopod 1 (Fig. 4E) exopod subcircular, wider than long; endopod short and stout, with distal portion thickset and slightly bent outwards, rounded apex. Pleopod 2 (Fig. 4F) exopod triangular, outer margin almost straight, bearing one seta, distal margin rounded; endopod longer than exopod. Exopods of pleopod 3 and 4 subrectangular, outer margin almost straight and bearing three long setae (Fig. 4G–

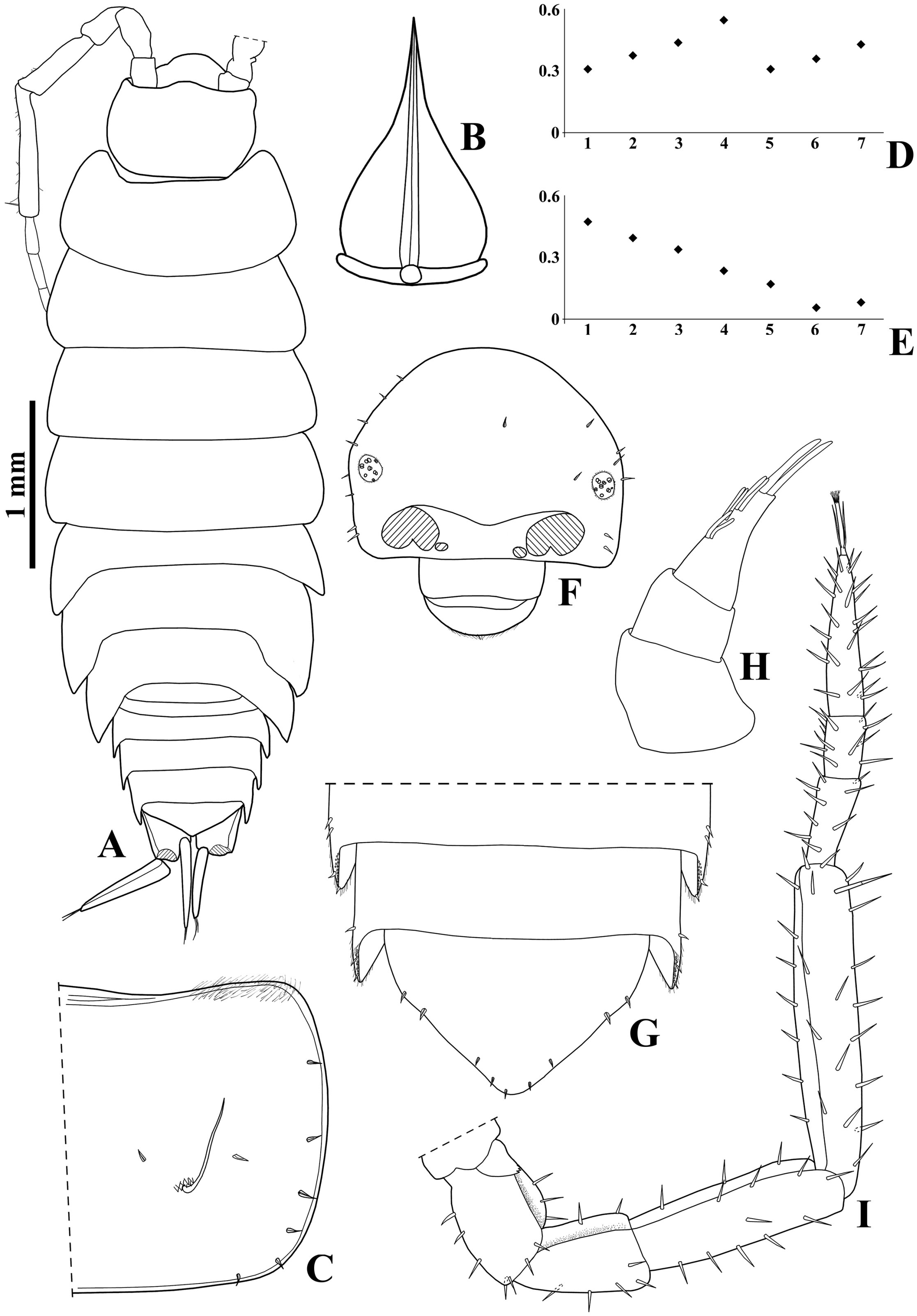

Fig. 2. *Alboscia jotajota* Campos-Filho, Bichuette & Taiti sp. nov., ♀, paratype (LES 18852). **A**. Habitus, dorsal view. **B**. Dorsal scale-seta. **C**. Pereonite 1 epimeron, dorsal view. **D**. Noduli laterales d/c coordinates. **E**. Noduli laterales b/c coordinates. **F**. Cephalon, frontal view. **G**. Pleonites 4–5 and telson. **H**. Antennula. **I**. Antenna.

H). Pleopod 5 exopod (Fig. 4I) triangular, outer margin convex, bearing three long setae, distal margin rounded.

Remarks

To date, the genus *Alboscia* comprises four species: *A. elongata* Schultz, 1995 from Paraguay; *A. itaipuensis* Araujo & Quadros, 2005, *A. ornata* Araujo, 1999 and *A. silveirensis* Araujo, 1999 from Brazil (Schultz 1995; Araujo 1999; Araujo & Quadros 2005). The genus is mainly defined by the slender habitus with lateral sides almost parallel, presence of conspicuous noduli laterales, epimera of pleonites closely appressed to pleon, maxillula outer endite with pectinate teeth on outer set and pleopod exopods without respiratory structures (Araujo 1999). The presence of pectinate teeth on the outer endite of the maxillula is present in other lineages of Oniscidea, e.g., *Ligia* Fabricius, 1798 (Ligiidae Leach, 1814), *Armadilloniscus* Uljanin, 1875 (Detonidae Budde-Lund, 1906)), *Benthana* Budde-Lund, 1904, *Benthanops* Barnard, 1932 and *Ctenoscia* Verhoeff, 1928 (Philosciidae), and Rhyscotidae Budde-Lund,

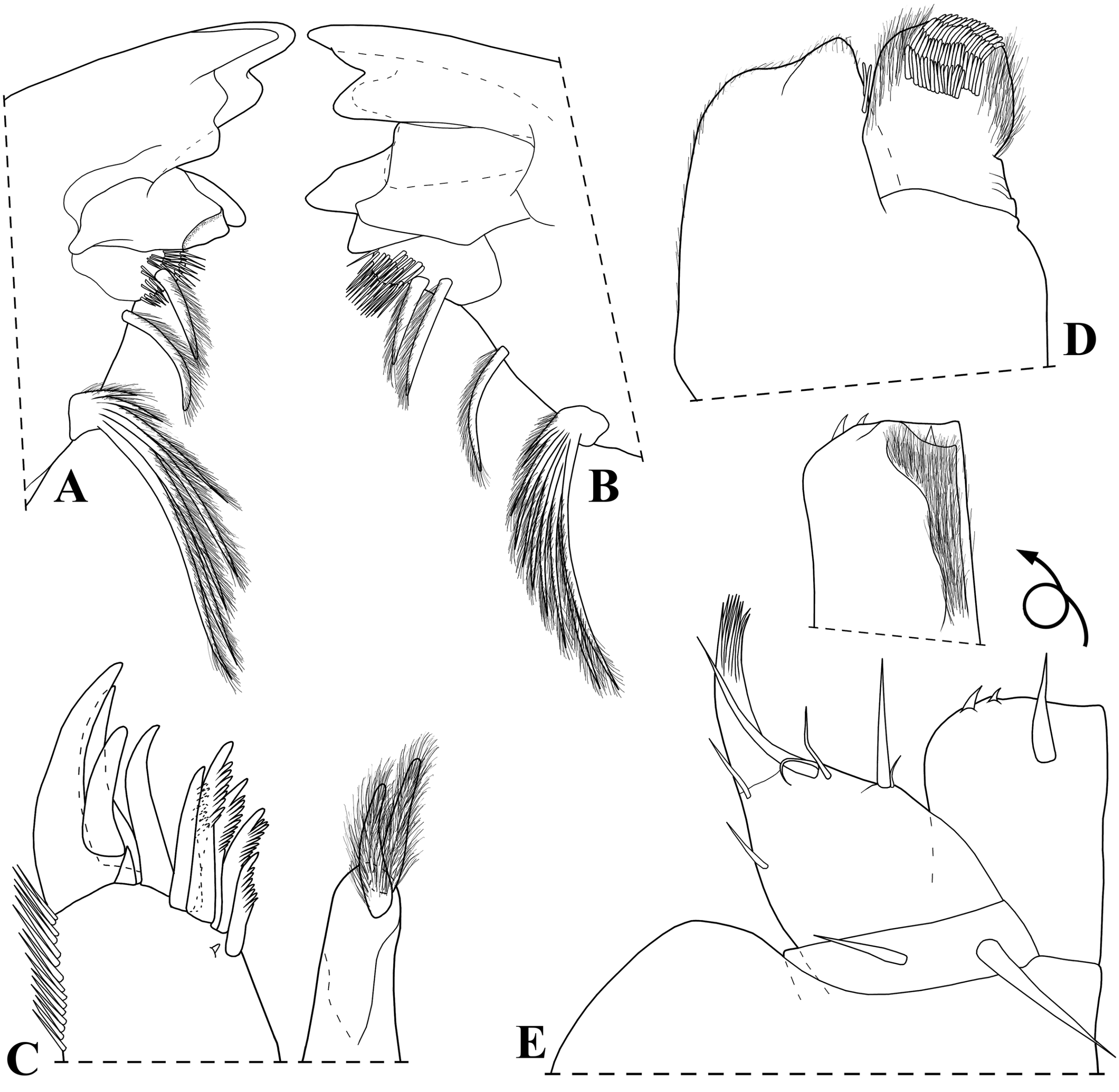

Fig. 3. *Alboscia jotajota* Campos-Filho, Bichuette & Taiti sp. nov., ♀, paratype (LES 18852). **A**. Right mandible. **B**. Left mandible. **C**. Maxillula. **D**. Maxilla. **E**. Maxilliped.

1908 (see Taiti & Ferrara 1982; Leistikow 1997; Schmidt 2002, 2003; Campos-Filho *et al.* 2015a). This character state is considered to be plesiomorphic (Leistikow 2001; Schmidt 2002).

In the shape of the male pleopod 1 exopod, *Alboscia jotajota* sp. nov. resembles *A. elongata* and *A. silveirensis*. It differs from both species in having eyes with rudimentary ommatidia (vs three ommatidia in *A. elongata*; single ommatidium in *A. silveirensis*), antennula with six lateral aesthetascs

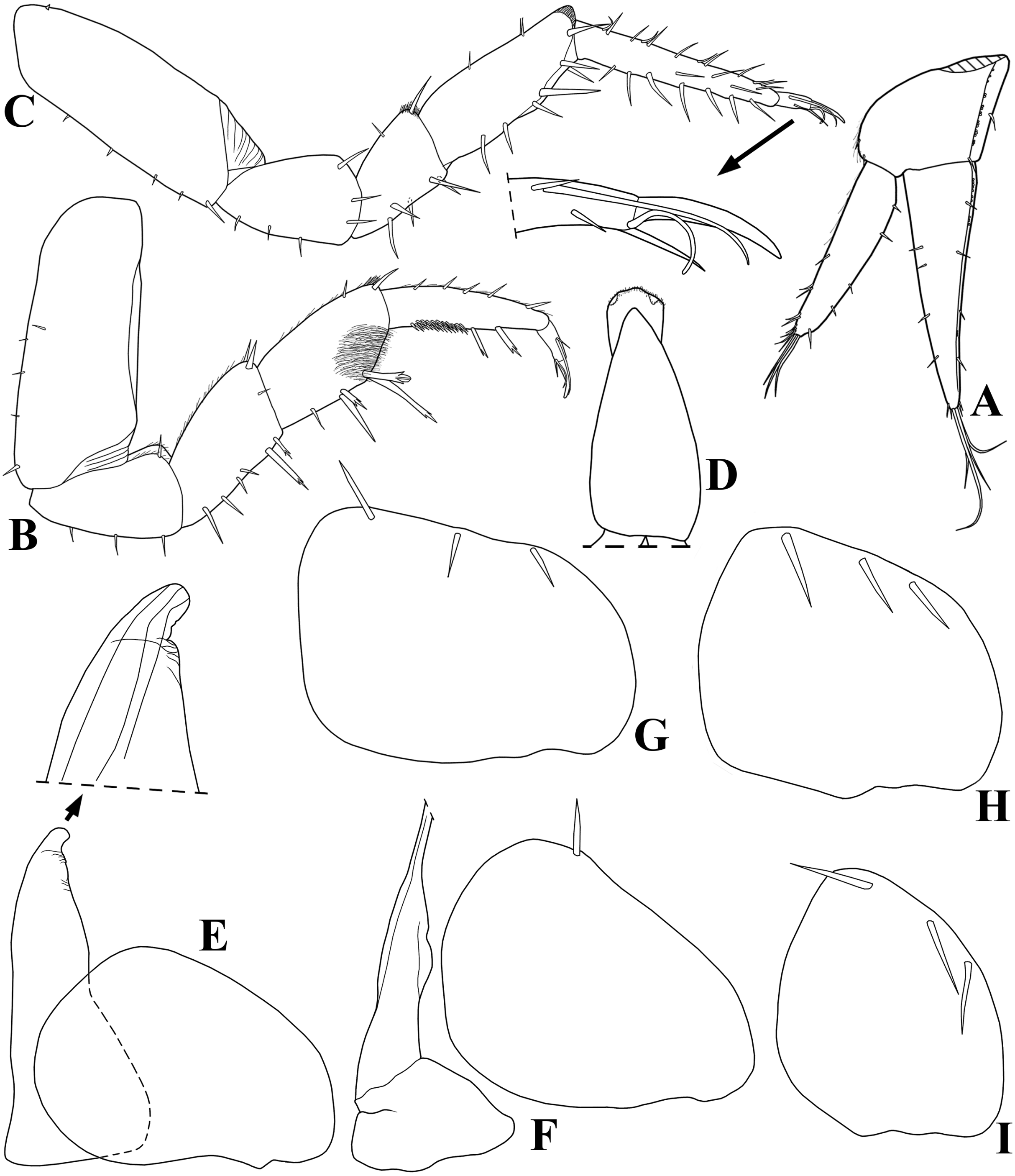

Fig. 4. *Alboscia jotajota* Campos-Filho, Bichuette & Taiti sp. nov., ♀, paratype (LES 18852) (A) and ♂, holotype (LES 647) (B–I). **A**. Uropod. **B**. Pereopod 1. **C**. Pereopod 7. **D**. Genital papila. **E**. Pleopod 1. **F**. Pleopod 2. **G**. Pleopod 3 exopod. **H**. Pleopod 4 exopod. **I**. Pleopod 5 exopod.

arranged in three sets (vs five in one set in *A. elongata*; two in one set in *A. silveirensis*) and the male pleopod 1 endopod slightly longer than the exopod, with short and thickset distal portion (vs more than twice as long as exopod and distal portion slender in *A. elongata*; three times as long as exopod and distal portion slender in *A. silveirensis*).

The absence of body pigment and absent/reduced eyes are common to all species of *Alboscia*, which probably indicates an endogean way of life. However, *Alboscia jotajota* sp. nov. is considered to be troglobiotic since no specimen was collected during surveys outside the caves where this species occurs.

Genus ***Androdeloscia*** Leistikow, 1999

Type species

Chaetophiloscia hamigera Vandel, 1952, by original designation.

Androdeloscia akuanduba Campos-Filho, Cardoso & Taiti sp. nov.
urn:lsid:zoobank.org:act:C46894DA-7022-440B-94FC-45CABB001E16
Figs 5–7, 14

Diagnosis

Eyes with eight ommatidia, telson with lateral sides almost straight, male pleopod 1 exopod heart-shaped with outer margin slightly concave, and male pleopod 1 endopod with distal portion tapering, slightly bent outwards and bearing setae on medial margin.

Etymology

This new species is named after the divinity Akuanduba of the Araras native people, who is responsible to bring order to the world.

Material examined

Holotype

BRAZIL – **Pará State, Serra Sul** • ♂; Floresta Nacional Carajás, Gruta N4WC15 Cave; 6°03′ S, 50°10′ W; 20 Apr.–4 May 2010; R. Andrade leg.; MZUSP 39670.

Paratypes

BRAZIL – **Pará State, Parauapebas** • 6 ♀♀, 2 juvs; Gruta N4E77 Cave; 6°01′57″ S, 50°09′02″ W; 13–30 Jan. 2010; R. Andrade leg.; MZUSP 39671 • 1 ♀; Gruta N4E78 Cave; 6°01′57″ S, 50°09′04″ W; 19 Nov.–4 Dec. 2010; MZUSP 39672 • 1 ♀; Gruta S11D-79 Cave; 6°23′32″ S, 50°18′57″ W; 1–14 Jul. 2010; leg. R. Andrade leg.; MZUSP 39673 • 1 ♀; Gruta S11D-33 Cave; 6°24′39″ S, 50°20′37″ W; 13–30 Jan. 2010; R. Andrade leg.; MZUSP 39674 • 1 ♀; Gruta S11D-37 Cave; 6°24′46″ S, 50°21′30″ W; 3–19 Aug. 2010; R. Andrade leg.; MZUSP 39675 – **Pará State, Canaã dos Carajás** • 1 ♀; Gruta S11-23 Cave; 6°25′21″ S, 50°17′57″ W; 24 Feb.–4 Mar. 2010; R. Andrade leg.; MZUSP 39676.

Description

Measurements. Maximum body length: male 2 mm, female 4 mm.

Body. Body with faintly visible light brown pigments. Body outline as in Fig. 5A; dorsal surface covered with triangular scale-setae (Fig. 5B). Noduli laterales very long (Fig. 5C); d/c and b/c coordinates as in Fig. 5D–E.

Cephalon. Lateral lobes not developed; frontal line absent; suprantennal line bent downwards in middle; eyes composed of eight ommatidia (Fig. 5A, F).

Pereon. Pereonite 1 epimera with anterior corners directed frontwards; pereonites 2–4 with posterior margins straight, 5–7 gradually arched (Fig. 5A).

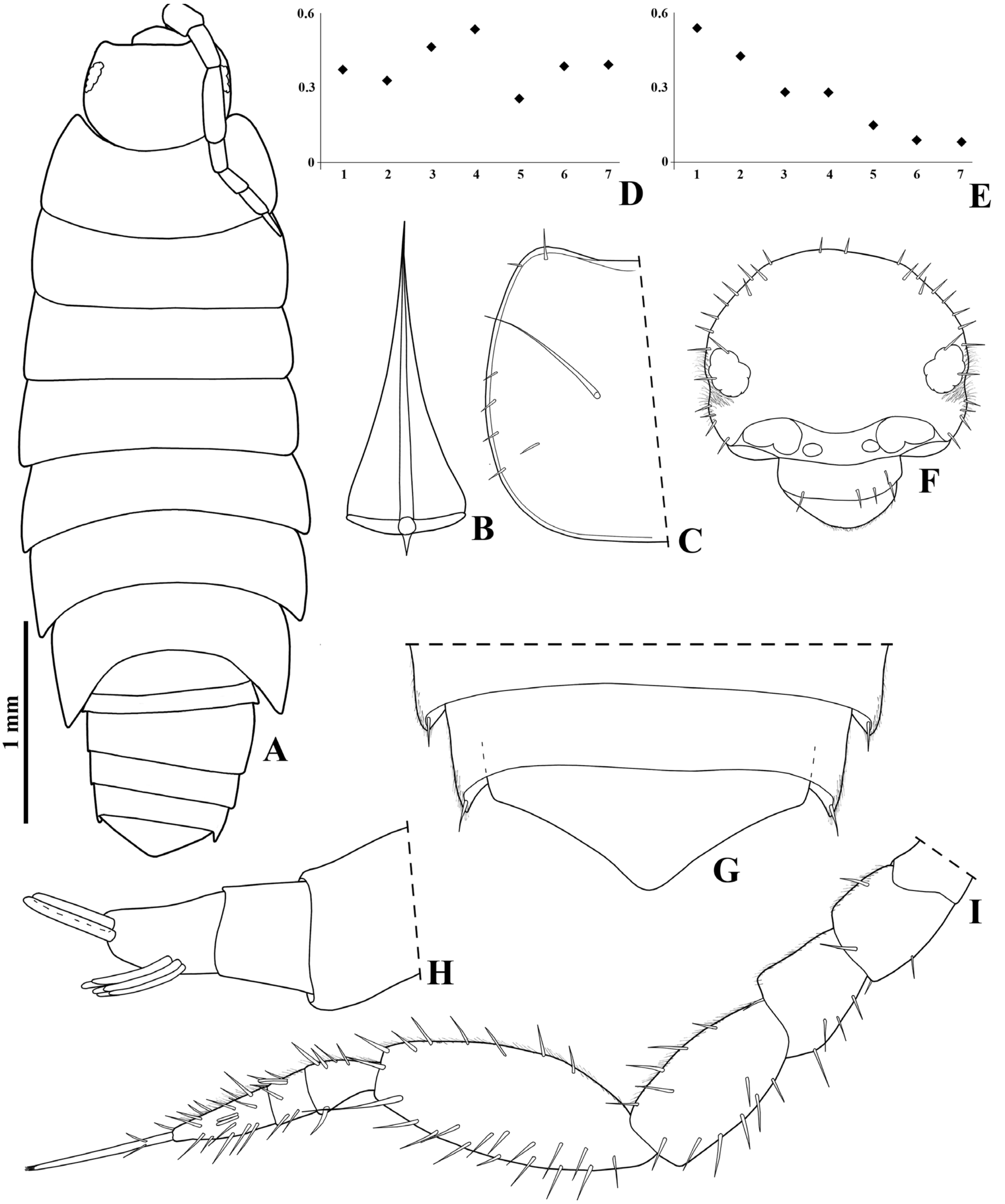

Fig. 5. *Androdeloscia akuanduba* Campos-Filho, Cardoso & Taiti sp. nov., ♀, paratype (MZUSP 39671). **A**. Habitus, dorsal view. **B**. Dorsal scale-seta. **C**. Pereonite 1 epimeron, dorsal view. **D**. Noduli laterales d/c coordinates. **E**. Noduli laterales b/c coordinates. **F**. Cephalon, frontal view. **G**. Pleonites 4–5 and telson. **H**. Antennula. **I**. Antenna.

Pleon. Narrower than pereon; epimera of pleonites 3–5 short, adpressed, with small posterior points directed backwards; telson triangular, with lateral margins slightly concave (Fig. 5A, G).

Antennula. Composed of three articles, proximal article longest, distal article bearing lateral tuft of six aesthetascs plus apical pair (Fig. 5H).

Antenna. Reaching pereonite 3 when extended backwards; flagellum of three articles, distal article longest and bearing two lateral aesthetascs; apical organ longer than distal article of flagellum, bearing two short, free sensilla (Fig. 5I).

Mouth. Mandibles with dense cushion of setae on incisor process, molar process of 4–6 branches, right mandible (Fig. 6A) with 1+1 penicils, left mandible (Fig. 6B) with 2+1 penicils. Maxillula (Fig. 6C)

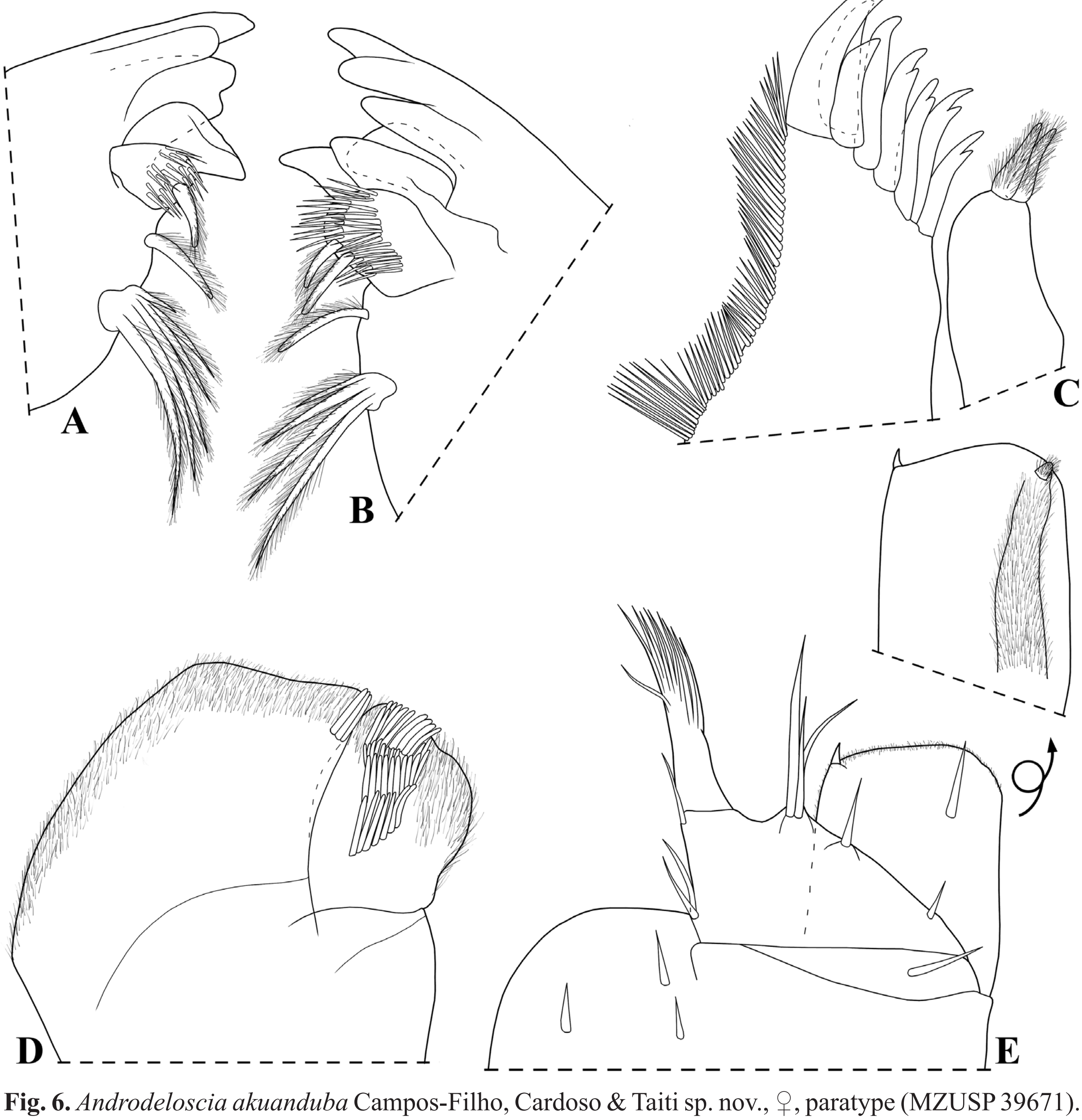

Fig. 6. *Androdeloscia akuanduba* Campos-Filho, Cardoso & Taiti sp. nov., ♀, paratype (MZUSP 39671). **A**. Right mandible. **B**. Left mandible. **C**. Maxillula. **D**. Maxilla. **E**. Maxilliped.

inner endite with two apical penicils; outer endite with 4+4 teeth, inner set apically cleft, outer margin strongly concave. Maxilla (Fig. 6D) inner lobe rounded, covered with thick and thin setae; outer lobe twice as wide as inner lobe, covered with thin setae, distal margin truncate. Maxilliped (Fig. 6E) palp

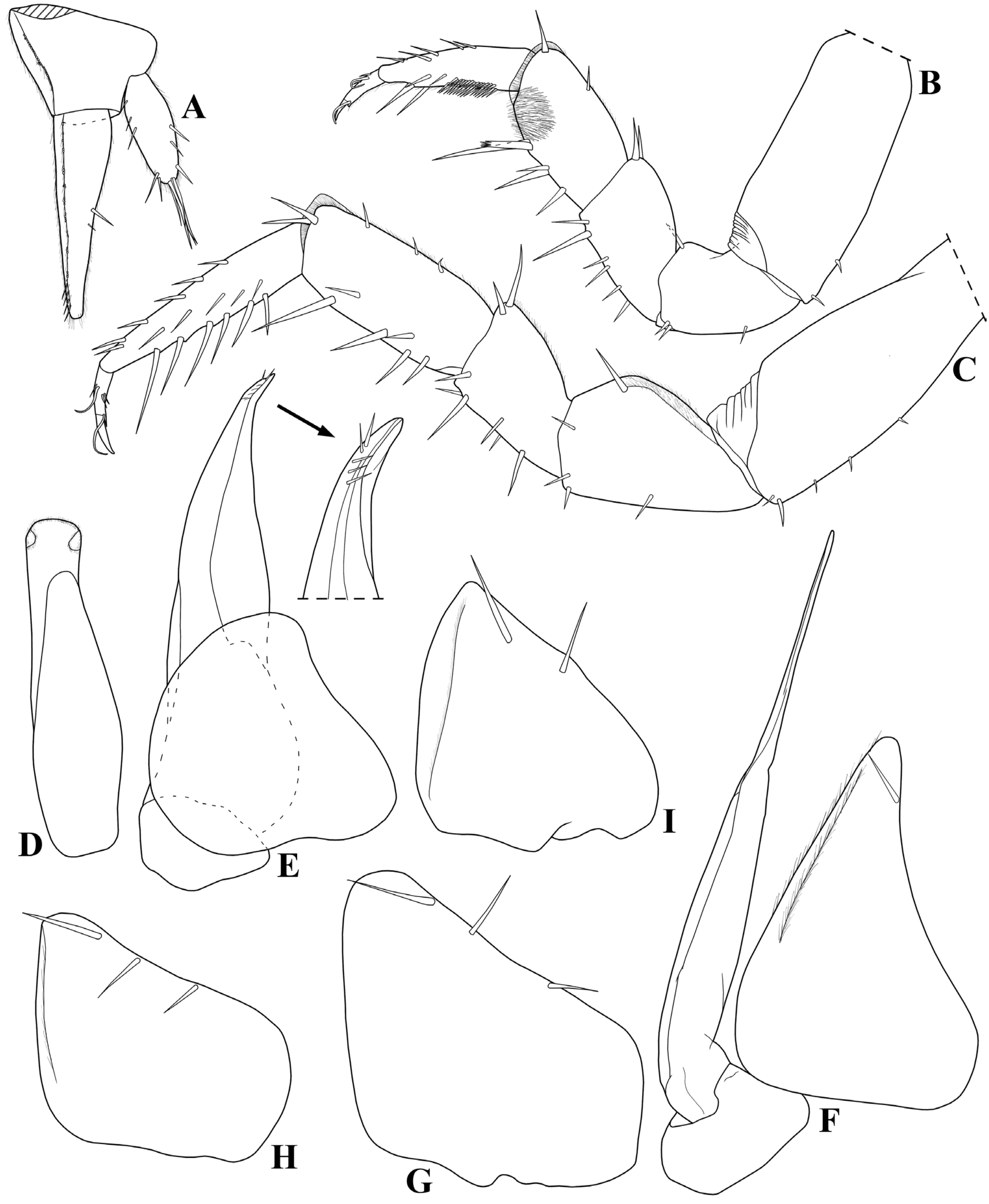

Fig. 7. *Androdeloscia akuanduba* Campos-Filho, Cardoso & Taiti sp. nov., ♀, paratype (MZUSP 39671) (A) and ♂, holotype (MZUSP 39670) (B–I). **A**. Uropod. **B**. Pereopod 1. **C**. Pereopod 7. **D**. Genital papilla. **E**. Pleopod 1. **F**. Pleopod 2. **G**. Pleopod 3 exopod. **H**. Pleopod 4 exopod. **I**. Pleopod 5 exopod.

with one seta on proximal article; endite subrectangular, medial seta slightly surpassing distal margin, distal margin bearing one seta on outer portion, rostral surface with setose sulcus ending in one penicil.

Pereopods. Pereopod 1–7 merus to propodus bearing sparse setae on sternal margin, pereopod 1 (Fig. 7B) carpus with short transverse antennal grooming brush; dactylus of two claws, inner claw short, dactylar seta simple, not surpassing outer claw, ungual seta simple, surpassing outer claw.

Uropod. Protopod subquadrangular; protopod and exopod outer margins grooved, bearing glandular pores; exopod twice as long as endopod, endopod inserted proximally (Fig. 7A).

Pleopod exopods. Without respiratory structures.

Male

Pereopods 1 and 7. Without sexual dimorphism (Fig. 7B–C).

Genital papilla. Bearing triangular ventral shield, papilla longer than ventral shield bearing two subapical orifices (Fig. 7D).

Pleopods. Pleopod 1 (Fig. 7E) exopod heart-shaped, outer margin slightly concave; endopod twice as long as exopod, distal portion tapering, slightly bent outwards and bearing setae on medial margin. Pleopod 2 (Fig. 7F) exopod triangular, outer margin concave bearing one seta; endopod flagelliform, distinctly longer than exopod. Exopods of pleopod 3 and 4 (Fig. 7G–H) rhomboid, outer margin slightly concave and bearing three long setae. Pleopod 5 exopod (Fig. 7I) triangular, outer margin almost straight, bearing two long setae, inner margin grooved to accommodate pleopod 2 endopod.

Remarks

The genus *Androdeloscia* comprises 25 species distributed in the tropical forest areas of South and Central America (Schmalfuss 2003; Schmidt & Leistikow 2005; Grangeiro & Souza 2006; Grangeiro & Christoffersen 2010; López-Orozco *et al.* 2016). The genus is mainly defined by animals with reduced length, antennula with one lateral tuft of aesthetascs plus an apical pair, antennal flagellum of three articles and long apical organ, d/c noduli laterales coordinates with nodulus 4 distant from the lateral margin, male pleopod 1 exopod rounded, endopod stout, bearing a complex distal apparatus, male pleopod 2 endopod elongated and male pleopod 5 exopod grooved on inner margin and distally elongated to accommodate the endopod of pleopod 2 (see Leistikow 1999; Schmidt & Leistikow 2005). Most of these characters are present in *Androdeloscia akuanduba* sp. nov., although the male pleopod 1 exopod is heart-shaped, the endopod lacks a distal complex apparatus and the male pleopod 5 exopod does not have the distal portion elongated. However, these characteristics are also observed in other species of the genus: *A. digitata* Leistikow, 1999, *A. merolobata* Leitiskow, 1999, *A. muscorum* Schmidt & Leistikow, 2005, *A. longiunguis* Leistikow, 1999 and *A. silvatica* (Lemos de Castro & Souza, 1986) have the male pleopod 1 exopod that is heart-shaped (see Leistikow 1999; Schmidt & Leistikow 2005); *A. pseudosilvatica* Leistikow, 1999 has the male pleopod 1 endopod without a distal complex apparatus (Leistikow 1999); and *A. colombiana* López-Orozco, Carpio-Diaz & Campos-Filho, 2016, *A. dalensi* Leistikow, 1999, *A. opercularis* Leistikow, 1999, *A. pseudosilvatica,* and *A. silvatica* do not have the distal portion of the male pleopod 5 exopod elongated (Leistikow 1999; López-Orozco *et al.* 2016). This species is probably troglophilic. Future surveys in- and outside caves are necessary to confirm this statement.

Genus ***Atlantoscia*** Ferrara & Taiti, 1981

Type species

Atlantoscia alceui Ferrara & Taiti, 1981, by monotypy (junior synonym of *Philoscia floridana* Van Name, 1940).

Atlantoscia inflata Campos-Filho & Araujo, 2015
Fig. 14

Atlantoscia inflata Campos Filho & Araujo *in* Zimmermann *et al.*, 2015a: 705, figs 1–2, 5–6, tables 1–3.

Atlantoscia inflata – Zimmermann *et al.* 2018a: 475, figs 5–6, tables 1–2. — Zimmermann *et al*. 2018b: figs 1–4.

Material examined

BRAZIL – **São Paulo State, Iporanga, PETAR** • 1 ♂, 1 ♀; outside Caverna Morro Preto; 24°31′50″ S, 48°41′59″ W; 30 Sep. 2012; M.E. Bichuette leg.; parts of ♂ in micropreparations; LES 4420 • 1 ♀; Passoca de Cima; 24°33′57″ S, 48°43′00″ W; 3 Aug. 2013; M.E. Bichuette leg.; LES 18853.

Distribution

Typical in Atlantic forest areas in the states of Rio Grande do Sul and Paraná (Zimmermann *et al*. 2015a, Campos-Filho *et al*. 2018a). This is the first record of the genus for the subterranean environment and it extends the known distribution of this species to the state of São Paulo.

Genus ***Benthana*** Budde-Lund, 1908

Type species

Philoscia picta Brandt, 1833, by subsequent designation (Van Name 1936).

Benthana iporangensis Lima & Serejo, 1993
Fig. 14

Benthana iporangensis Lima & Serejo, 1993: 490, figs 1–4.

Benthana iporangensis – Pinto-da-Rocha 1995: 97. — Souza-Kury 1998: 659. — Leistikow & Wägele 1999: 14. — Schmalfuss 2003: 53. — Campos-Filho *et al*. 2015a: 44. figs 30–31, 32c. — Pires *et al*. 2015: 69, table 1. — Trajano *et al*. 2016: 1819. — Bastos-Pereira *et al*. 2017: 292. — Cavalcanti 2017: 49, table 2. — Gallão & Bichuette 2018: 7, table 1. — Campos-Filho *et al*. 2018a: 10. — Fernandes *et al*. 2019: 1106, table 1.

Material examined

BRAZIL – **São Paulo State, Iporanga** • 1 ♂, 2 ♀♀; PEI (Sede), Gruta Detrás; 24°16′15″ S, 48°25′08″ W; 825 m a.s.l.; 26–30 Mar. 2009; F. Pellegatti-Franco leg.; LES 0640 • 2 ♂♂, 2 ♀♀, 2 mancas; PETAR, Gruta do Couto; 24°32′00″ S, 48°41′56″ W; 13–20 Apr. 2009; F. Pellegatti-Franco leg.; LES 1771 • 2 ♀♀; PETAR, Caverna Morro Preto; 24°31′50″ S, 48°41′59″ W; 30 Sep. 2012; LES 4422 • 1 ♀; same collection data as for preceding; LES 4425 • 5 ♀♀; same collection data as for preceding; LES 4426.

Distribution

Benthana iporangensis was described from three caves in the Areias system: Ressurgência das Areias de Água Quente, Areias de Cima and Areias de Baixo caves, Alto Ribeira karst area, state of São Paulo (Lima & Serejo 1993). Our records extend the known distribution of this species to other caves within the Alto Ribeira karst area. This species is recorded only from caves and is considered to be troglobiotic.

Benthana longicornis Verhoeff, 1941
Fig. 14

Benthana longicornis Verhoeff, 1941: 121, figs 1–7.

Benthana longicornis – Gruner 1955: 446, figs 10–13. — Lemos de Castro 1958: 115, figs 93–98. — Andersson 1960a: 557, fig. 10; 1960b: 415. — Araujo *et al*. 1996: 115, figs 5–10. — Souza-Kury 1998: 659. — Leistikow & Wägele 1999: 14. — Schmalfuss 2003: 53. — Costa *et al*. 2014: 173, fig. 3. — Campos-Filho *et al*. 2015a: 13, figs 5–6, 9c; 2018a: 10.

Material examined

BRAZIL – **São Paulo State, Iporanga, PETAR** • 2 ♂♂, 2 ♀♀; Gruta Couto, Santana; 24°32′00.9″ S, 48°41′56″ W; 16–20 Sep. 2009; F. Pellegatti-Franco leg.; LES 1783 • 1 ♂, 3 ♀♀; Gruta Chapéu Mirim 1, Caboclos 1; 24°26′03″ S, 48°35′10″ W; 26–30 Mar. 2009; F. Pellegatti-Franco leg.; LES 0636 • 3 ♂♂, 3 ♀♀; Gruta do Capinzal, Bulhas D'água; 24°19′05″ S, 48°30′05″ W; 16 Feb. 2013; M.E. Bichuette, J.E. Gallão and T. Zepon leg.; LES 18854 • 1 ♀; same collection data as for preceding; LES 18855.

Distribution

Typical in Atlantic forest areas in the states of Rio de Janeiro (= Distrito Federal in Campos-Filho *et al*. 2015a), São Paulo, Paraná and Santa Catarina (Campos-Filho *et al*. 2018a). This is the first record of this species in cave environments, suggesting a troglophilic status.

Benthana olfersii (Brandt, 1833)
Fig. 14

Philoscia Olfersii Brandt, 1833: 183.

Benthana olfersii – Campos-Filho *et al*. 2018a: 11 (for previous records).

Material examined

BRAZIL – **Minas Gerais State, Itabirito** • 1 ♂; Caverna VL-33; 20°19'54″ S, 43°56′15″ W; 29 Mar.–3 Apr. 2012; Andrade leg.; LES 18860.

Distribution

Typical in Atlantic forest areas in the states of Rio de Janeiro and São Paulo (Campos-Filho *et al.* 2015a). This is the first record of this species in cave environments, suggesting a troglophilic status.

Benthana picta (Brandt, 1833)
Fig. 14

Philoscia picta Brandt, 1833: 183.

Benthana picta – Campos-Filho *et al*. 2018a: 11 (for previous records). — Fernandes *et al*. 2019: 1106, table 1.

Material examined

BRAZIL – **São Paulo State, Alto Ribeira karst area** • 2 ♀♀; PEI, Gruta Beija-flor; 24°16′25.6″ S, 48°25′11.1″ W; 26–30 Mar. 2009; F. Pellegatti-Franco leg.; LES 0634 • 1 ♂; PEI, Gruta Colorida; 24°16′25.6″ S, 48°25′11.1″ W; 26–30 Mar. 2009; F. Pellegatti-Franco leg.; LES 0639 • 1 ♂, 2 ♀♀; PEI, Gruta Meninos; 24°15′58″ S, 48°24′57″ W; 26–30 Mar. 2009; F. Pellegatti-Franco leg.; LES 0637 • 1 ♂; PEI, Gruta Detrás; 24°16′14.5″ S, 48°25′0.9″ W; 14–16 Sep. 2009; F. Pellegatti-Franco leg.; LES 1782 • 1 ♀; PETAR, Gruta Santana; 24°32′0.9″ S, 48°41′58″ W; 14–16 Sep. 2009; F. Pellegatti-Franco leg.; LES 1773 • 1 ♂; PETAR, Ribeirão Grande, Gruta Meninos; 24°15′58″ S, 48°24′57″ W; 14–16 Sep. 2009; F. Pellegatti-Franco leg.; LES 1787 • 1 ♂; PETAR, Caverna Morro Preto; 24°32′00″ S, 48°41′56″ W; 30 Sep. 2012; LES 4422 • 1 ♀; same collection data as for preceding; LES 4423 • 1 ♂; PETAR, Gruta Tatu; 24°16′16.8″ S, 48°25′2.7″ W; 26–30 Mar. 2009; F. Peleggatti-Franco leg.; LES 0633 • 1 ♂;

PETAR, Sumidouro da Passoca; 24°33′57″ S, 48°43′ W; 3 Aug. 2013; LES 18856 • 1 ♂; same locality as preceding; 3 Aug. 2013; LES 18857 • 1 ♀; PETAR, outside Gruta Santana; 24°32′00.9″ S, 48°41′58″ W; M.E. Bichuette leg.; LES 18858 • 1♀; PETAR, Alambari de Baixo; 24°33′15″ S, 48°39′55″ W; 2 Oct. 2012; M.E. Bichuette leg.; LES 4367 • 1 ♂; PETAR, Ressurgência das Areias de Água Quente; 24°33′45″ S, 48°40′18″ W; 29 Sep. 2012; M.E. Bichuette leg.; LES 18859.

Distribution

Typical in Brazilian Atlantic forest areas from the state of Espírito Santo to Rio Grande do Sul, and in Paraguay, Villarica District, Guair Department (Campos-Filho *et al*. 2015a). This is the first record of this species in cave habitats. The wide occurrence and abundance inside caves suggest a troglophilic status.

Benthana taeniata Araujo & Buckup, 1994
Fig. 14

Bentheana taeiata Araujo & Buckup, 1994: 269, figs 1–13, 28.

Benthana taeniata – Campos-Filho *et al*. 2018a: 11 (for previous records).

Material examined

BRAZIL – **São Paulo State, Alto Ribeira karst area, PETAR** • 1 ♂; Ressurgência das Areias de Água Quente; 24°33′45″ S, 48°40′18″ W; 29 Sep. 2012; M.E. Bichuette leg.; LES 4419 • 2 ♂♂, 1 ♀; same collection data as for preceding; LES 4421 • 1 ♀; same collection data as for preceding; LES 18861 • 1 ♂; Gruta do Capinzal; 24°19′55″ S, 48°30′05″ W; 16 Feb. 2013; M.E. Bichuette, J.E. Gallão and T. Zepon leg.; LES 18862.

Distribution

Benthana taeniata has been recorded from the states of Distrito Federal (capital of Brazil) to the state of Rio Grande do Sul (Campos-Filho *et al*. 2015a). In cave habitats, this species was recorded from Gruta Zeferino I, São Roque de Minas and Serra da Canastra, Minas Gerais State (Campos-Filho *et al*. 2014). The species is probably troglophilic.

Genus ***Metaprosekia*** Leistikow, 2000

Type species

Metaprosekia nodilinearis Leistikow, 2000, by original designation and monotypy.

Metaprosekia igatuensis Campos-Filho, Fernandes & Bichuette sp. nov.
urn:lsid:zoobank.org:act:24B7CEE5-59B7-4943-AA9A-D50D79BD995D
Figs 8–10, 14

Metaprosekia sp. – Fernandes *et al.* 2019: 1108, table 1.

Diagnosis

Telson with lateral sides almost straight, mandibles with molar penicil simple, maxillula outer endite of 4+5 teeth (two apically cleft), male pleopod 1 exopod subtriangular with outer and inner margins slightly convex, male pleopod 2 endopod with distal portion slender.

Etymology

This new species is named after the locality where the specimens were collected, Povoado de Igatu, which holds a high diversity of subterranean fauna.

Material examined

Holotype

BRAZIL – **Bahia State, Andaraí** • ♂; Povoado de Igatu, Gruna Rio dos Pombos; 12°54′12″ S, 41°19′04″ W; 31 Feb. 2013; M.E. Bichuette, J.E. Gallão and D.M. Schimonsky leg.; LES 6349.

Paratypes

BRAZIL • 1 ♂, 3 ♀♀, 1 juv.; same collection data as for holotype; parts of ♂ and 1 ♀ in micropreparations; LES 6349.

Description

Measurements. Maximum body length: male and female 2 mm.

Body. Body pigment absent. Body outline as in Fig. 8A; dorsal surface densely covered with fan-shaped scale-setae (Fig. 8B). Noduli laterales piliform (Fig. 8C); d/c and b/c coordinates as in Fig. 8D–E.

Cephalon. Lateral lobes and frontal line absent; suprantennal line bent downwards in middle; eyes composed of four ommatidia (Fig. 8A, F).

Pereon. Pereonite 1 epimera with anterior corners slightly directed frontwards; pereonites 1–4 with posterior margins straight, 5–7 gradually arched (Fig. 8A).

Pleon. Slightly narrower than pereon, epimera of pleonites 3–5 short and directed backwards; telson more than twice as long as wide, triangular with lateral margins almost straight, with rounded apex (Fig. 8G).

Antennula. Composed of three articles, proximal article longest, distal article conical, bearing one lateral tuft of five aesthetascs plus apical pair (Fig. 8H).

Antenna. Reaching pereonite 3 when extended backwards; flagellum of three articles, medial and distal articles subequal in length; apical organ long, bearing two short free sensilla (Fig. 8I).

Mouth. Mandibles with dense cushion of setae on incisor process, molar process simple, left mandible (Fig. 9A) with 2+1 penicils, right mandible (Fig. 9B) with 1+1 penicils. Maxillula (Fig. 9C) inner endite with two apical penicils and small triangular point; outer endite with 4+5 teeth, inner set with two teeth apically cleft. Maxilla (Fig. 9D) inner lobe rounded, covered with thick setae; outer lobe rounded, three times as wide as inner lobe, covered with thin setae. Maxilliped (Fig. 9E) palp with two setae on proximal article; endite subrectangular, medial seta surpassing distal margin, distal margin bearing outer tip, rostral surface with setose sulcus ending with one short penicil.

Pereopods. Pereopod 1–7 merus to propodus bearing sparse setae on sternal margin, pereopod 1 carpus with short transverse antennal grooming brush and distal seta hand-like; dactylus of two claws, inner claw shorter, dactylar seta simple, not surpassing outer claw, ungual seta simple, slightly surpassing outer claw.

Uropod. Protopod subquadrangular; protopod and exopod outer margins grooved, bearing glandular pores; exopod twice as long as endopod, endopod inserted proximally (Fig. 10A).

Pleopod exopods. Without respiratory areas.

Male

Pereopods 1 and 7. Without sexual dimorphism (Fig. 10B–C).

Genital papilla. Bearing triangular ventral shield, papilla slightly longer than ventral shield, bearing two subapical orifices (Fig. 10D).

Pleopods. Pleopod 1 (Fig. 10E) exopod subtriangular, with outer and inner margins slightly convex; endopod more than twice as long as exopod, distal portion tapering, slightly directed outwards and bearing small setae on medial margin. Pleopod 2 (Fig. 10F) exopod triangular, outer margin concave

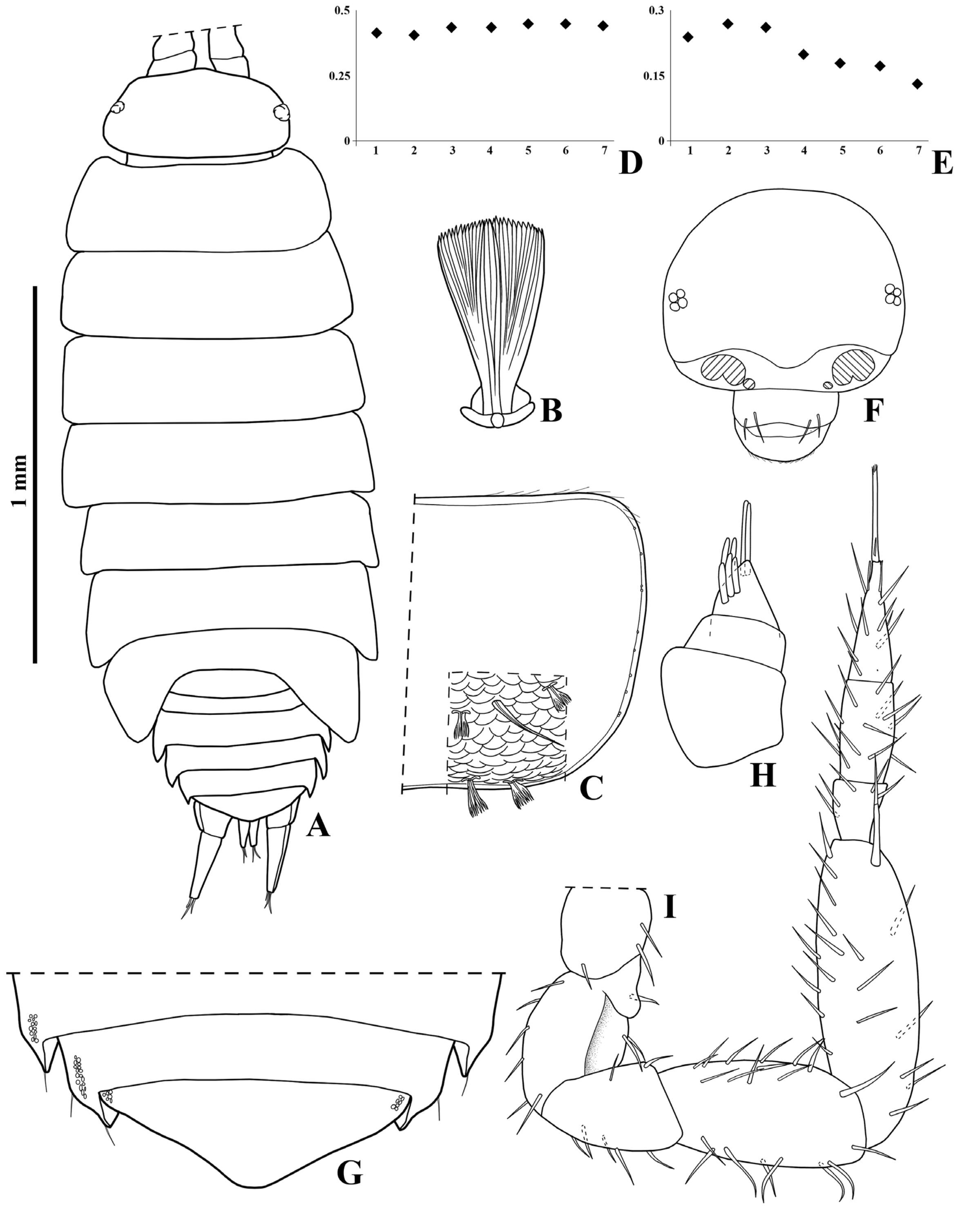

Fig. 8. *Metaprosekia igatuensis* Campos-Filho, Fernandes & Bichuette sp. nov., ♀, paratype (LES 6349). **A**. Habitus, dorsal view. **B**. Dorsal scale-seta. **C**. Pereonite 1 epimeron, dorsal view. **D**. Noduli laterales d/c coordinates. **E**. Noduli laterales b/c coordinates. **F**. Cephalon, frontal view. **G**. Pleonites 4–5 and telson. **H**. Antennula. **I**. Antenna.

bearing one seta; endopod flagelliform, longer than exopod. Exopods of pleopods 3 and 4 as in Fig. 10G and H, respectively. Pleopod 5 exopod (Fig. 10I) rhomboid, outer margin convex, bearing five long setae, inner margin grooved to accommodate pleopod 2 endopod.

Remarks

The genus *Metaprosekia* comprises three species: *M. nodilinearis* Leistikow, 2000 from the department of Merida, Venezuela; *M. caupe* Campos-Filho, Araujo & Taiti, 2014 and *M. quadriocellata* Campos-Filho, Araujo & Taiti, 2014 from the state of Pará, Brazil (Leistikow 2000; Campos-Filho *et al.* 2014). The genus is mainly defined by its small size, dorsal surface covered with fan-shaped or pointed scale-setae, epimera of pereonites 1–7 with noduli laterales inserted at same level from lateral margins, cephalon with suprantennal line and eyes of 3–4 ommatidia, antennula with one lateral tuft of aesthetascs plus apical pair, maxillula outer endite with 4+4 teeth (some of them cleft at apex), maxilliped endite with rostral penicil and pleopod exopods without respiratory structures (see Leistikow 2000; Campos-Filho *et al.* 2014).

The new species differs from other species of the genus in having the mandibles with molar penicil simple instead of dichotomized, the shape of the male pleopod 1 and male pleopod 2 endopod, with the distal portion slender rather than thick. Moreover, it differs in having the suprantennal line bent downwards in the middle (vs. straight in *M. caupe* and *M. nodilinearis*; slightly bent downwards in *M. quadriocellata*) and in having the apical organ of the antennal flagellum shorter than the distal article (vs subequal in *M. caupe*; longer in *M. nodilinearis* and *M. quadriocellata*).

The presence of fan-shaped scale-setae is related with the creeper eco-morphological strategy (Schmalfuss 1984), which functionally reduces the adhesive forces and facilitates the movement of the animal in unconsolidated substrates. However, this is not the case for species of *Metaprosekia*.

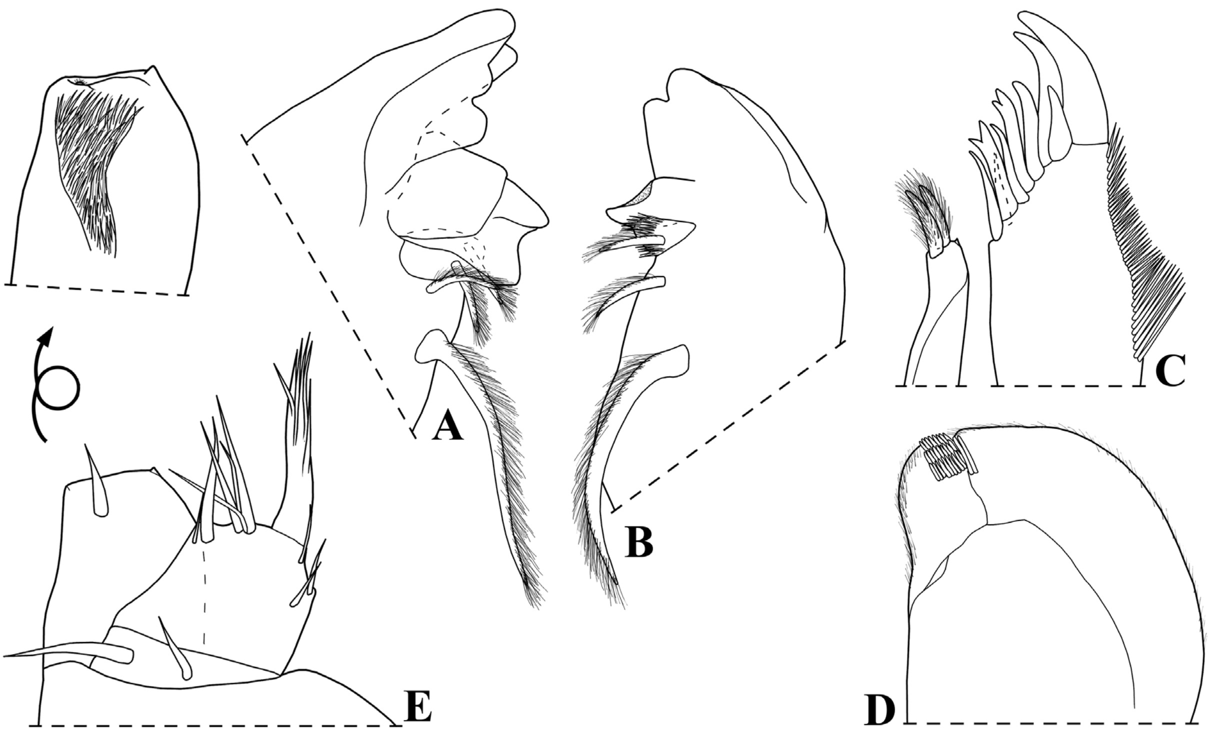

Fig. 9. *Metaprosekia igatuensis* Campos-Filho, Fernandes & Bichuette sp. nov., ♀, paratype (LES 6349). **A**. Left mandible. **B**. Right mandible. **C**. Maxillula. **D**. Maxilla. **E**. Maxilliped.

As mentioned by Campos-Filho *et al.* (2014), the presence of fan-shaped scale-setae on the dorsal surface and of eyes with a reduced number of ommatidia can be related to an endogean life-style. This species is considered here as troglobiotic, since many expeditions were carried out outside the cave where it was collected and no specimens were found.

Genus ***Paratlantoscia*** Zimmermann, Campos-Filho & Araujo, 2018

Type species

Paratlantoscia robusta Zimmermann, Campos-Filho & Araujo, 2018, by original designation.

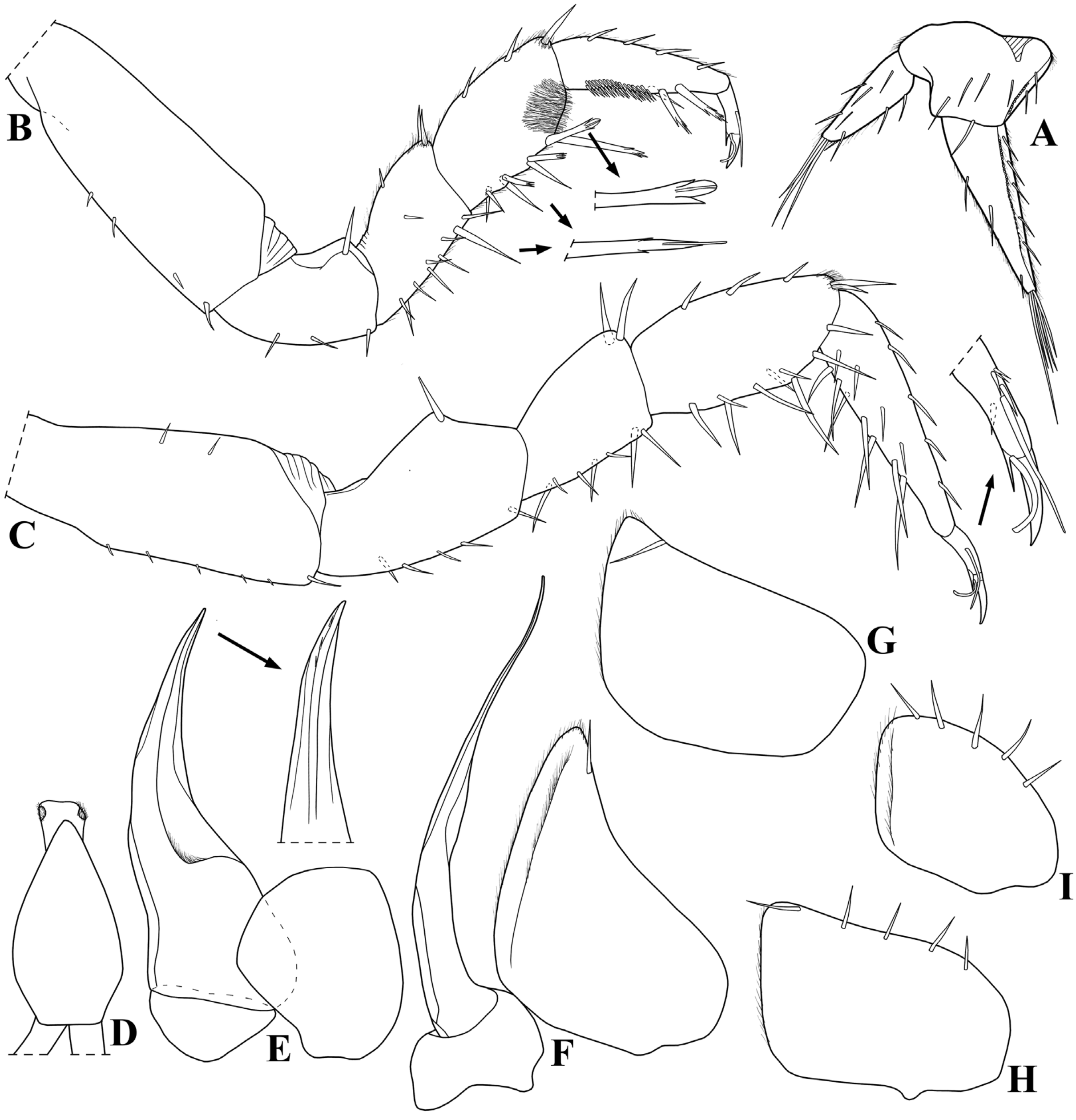

Fig. 10. *Metaprosekia igatuensis* Campos-Filho, Fernandes & Bichuette sp. nov., ♀, paratype (LES 6349) (A) and ♂, paratype (LES 6349) (B–I). **A**. Uropod. **B**. Pereopod 1. **C**. Pereopod 7. **D**. Genital papilla. **E**. Pleopod 1. **F**. Pleopod 2. **G**. Pleopod 3 exopod. **H**. Pleopod 4 exopod. **I**. Pleopod 5 exopod.

Paratlantoscia rubromarginata (Araujo & Leistikow, 1999)
Fig. 14

Atlantoscia rubromarginata Araujo & Leistikow, 1999: 110, figs 1–5.

Atlantoscia rubromarginata – Leistikow 2001: 6. — Schmalfuss 2003: 49. — Campos-Filho *et al*. 2012: 141; 2013: 466, fig. 12b. — Lisboa *et al*. 2013: 394. — Zimmermann *et al*. 2015a: 704, figs. 5–6, tables 1–3; 2015b: 3, table 1.
Paratlantoscia rubromarginata – Zimmermann *et al*. 2018a: 474, figs 5–6, tables 1–2. — Campos-Filho *et al*. 2018a: 14.

Material examined

BRAZIL – **Sergipe State** • 2 ♂♂, 1 ♀; Nossa Senhora do Socorro, outside Pau Cruzado; 10°30′46.44″ S, 37°6′2.52″ W; 20 Oct. 2014; M.E. Bichuette, D. Cardoso, M. Bolfarini, M. Rosendo and R. Moreira leg.; LES 10818 • 3 ♀♀; Laranjeiras, Caverna dos Aventureiros; 10°48′11.6″ S, 37°10′50″ W; 20 Oct. 2014; M.E. Bichuette, D. Cardoso, M. Bolfarini, M. Rosendo and R. Moreira leg.; LES 10819 • 1 ♂; Japaratuba, Caverna Casa do Caboclo; 10°37′57.16″ S, 36°52′59.10″ W; 19 Oct. 2014; M.E. Bichuette, D. Cardoso, M. Bolfarini, M. Rosendo and R. Moreira leg.; LES 10820 • 4 juvs; Murici, Fazenda São José, Caverna Toca da Raposa; 9°13′35.95″ S, 35°54′46.23″ W; 22 Oct. 2014; M.E. Bichuette, D. Cardoso, M. Bolfarini, M. Rosendo and R. Moreira leg.; LES 10828.

Distribution

This species has been recorded from Atlantic and Amazon forest areas in the states of Alagoas, Bahia, Pará and Sergipe (Campos-Filho *et al.* 2013, 2017a). This is the first record of this species in the subterranean environment, but *P. rubromarginata* is considered here as trogloxene.

Family Scleropactidae Verhoeff, 1938

Genus ***Amazoniscus*** Lemos de Castro, 1967

Type species

Amazoniscus arlei Lemos de Castro, 1967, by original designation and monotypy.

Amazoniscus spica Campos-Filho, Aguiar & Taiti sp. nov.
urn:lsid:zoobank.org:act:C67F79F2-111D-49D7-A9E2-FA112D32DB4B
Figs 11–14

Diagnosis

Body pigments and eyes absent, frontal shield bent backwards over vertex, dactylus of pereopods with ungual seta simple and surpassing outer claw, male pleopod 1 exopod heart-shaped and male pleopod 1 endopod with distal portion bent outwards, bearing small setae on median margin.

Etymology

The name of this new species refers to the binary star of Spica, the brightest star in the Virgo constellation. In the Brazilian flag, this star represents the state of Pará.

Material examined

Holotype

BRAZIL – **Pará State, Parauapebas, Canaã dos Carajás** • ♂; Jaguar, CAV-20; 6°24′22″ S, 50°22′09″ W; 20–29 May 2012; Mescolotti leg.; MZUSP 40046.

Paratypes

BRAZIL • 1 ♂, 2 ♀♀; same collection data as for holotype; parts of ♂ and 1 ♀ in micropreparations; MZUSP 40047 • 1 ♀; CAV-17; 6°24′24″ S, 50°22′10″ W; 8–15 Mar. 2012; Oliveira leg.; MZUSP 40048.

Description

Measurements. Maximum body length: male and female 5.5 mm.

Body. Body pigment absent. Endoantennal conglobation. Body (Fig. 11A) strongly convex; dorsal surface smooth, bearing small triangular scale-setae (Fig. 11B). Noduli laterales (Fig. 11C) very short, inserted near posterior margins and at same distance from lateral margins.

Cephalon. Frontal shield bent backwards over vertex, lateral sides slightly protruding in frontal view, frontal margin broadly rounded; eyes absent (Fig. 11A, D–E).

Pereon. Pereonite 1 without schisma or ventral lobes; pereonites 1–4 with posterior margin straight, 5–7 gradually more concave; pereonite 1 epimera with anterior corners directed frontwards, those of 2–4 with outer margin rounded, and those of 5–7 subquadrangular (Fig. 11A).

Pleon. Outline continuous with pereon, epimera 3–5 well developed, directed backwards with acute apices; telson triangular, slightly broader than long, with slightly concave sides, rounded apex. (Fig. 11F).

Antennula. Composed of three articles, distal article longest, conical bearing about 10 lateral aesthetascs arranged in five sets (Fig. 11G).

Antenna. Short and stout, not surpassing pereonite 1 when extended backwards; flagellum consisting of two subequal articles, distal article bearing two lateral aesthetascs; apical organ as long as distal article of flagellum (Fig. 11H).

Mouth. Mandibles with dense cushion of setae on incisor process, molar process with 10 branches, left mandible (Fig. 12A) with 2+1 penicils, right mandible (Fig. 12B) with 1+1 penicils. Maxillula (Fig. 12C) inner endite with two apical penicils, distal margin bearing outer tip; outer endite with 4+5 teeth, inner set with four teeth, apically cleft. Maxilla (Fig. 12D) inner lobe rounded and covered with thick setae; outer lobe rounded, twice as wide as inner lobe, covered with thin setae. Maxilliped (Fig. 12E) basis with fringe of thin setae on distal outer margin; palp with one strong seta on proximal article; endite subrectangular, medial seta surpassing distal margin, distal margin covered with thin setae and bearing one seta on outer portion, rostral surface with setose sulcus ending with one short penicil.

Pereopods. Pereopod 1 carpus with short, transverse antennal grooming brush; dactylus with two claws, dactylar seta simple, not surpassing outer claw, ungual seta simple, surpassing outer claw.

Uropod. Protopod flattened and enlarged, filling gap between pleonite 5 and telson; exopod inserted on median margin, endopod twice as long as exopod and inserted proximally (Fig. 12F).

Pleopod exopods. Pleopods 1 and 2 with respiratory areas.

Male

Pereopod 1. Merus and carpus with sternal margin covered with short scales and sparse strong setae (Fig. 13A).

Pereopod 7. Ischium elongated, sternal margin straight; carpus twice as long as merus (Fig. 13B).

Genital papilla. Bearing triangular ventral shield, papilla slightly longer than ventral shield bearing two subapical orifices (Fig. 13C).

Pleopods. Pleopod 1 (Fig. 13D) exopod heart-shaped; endopod twice as long as exopod, distal portion bent outwards and bearing small setae on median margin. Pleopod 2 (Fig. 13E) exopod triangular, outer margin concave; endopod flagelliform, longer than exopod. Exopods of pleopods 3 and 4 as in Fig. 13F and G, respectively. Pleopod 5 exopod (Fig. 13H) triangular, outer margin sinuous, distal portion elongated, inner margin grooved to accommodate pleopod 2 endopod.

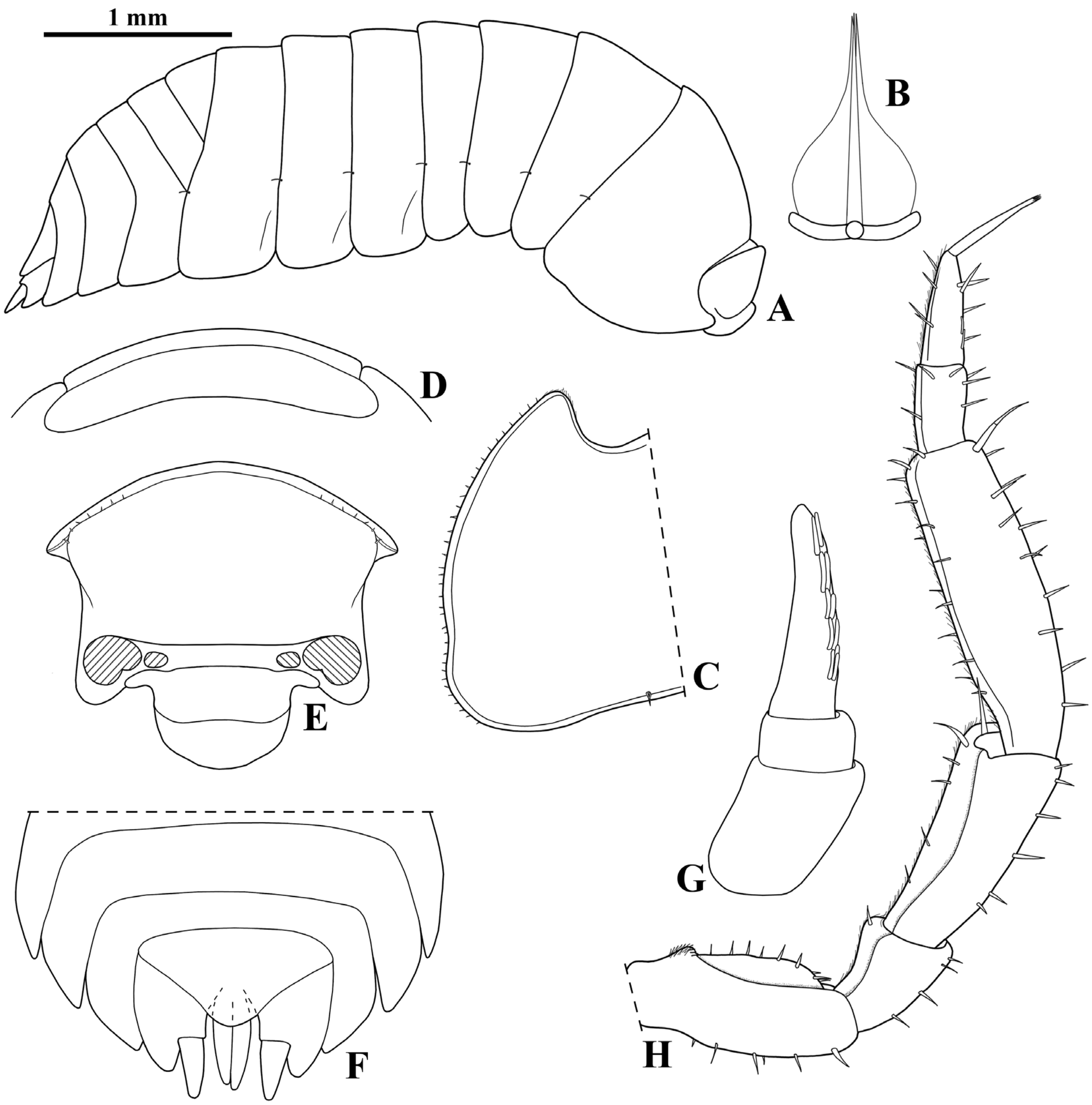

Fig. 11. *Amazoniscus spica* Campos-Filho, Aguiar & Taiti sp. nov., ♀, paratype (MZUSP 40047). **A**. Habitus, dorsal view. **B**. Dorsal scale-seta. **C**. Pereonite 1 epimeron, dorsal view. **D**. Cephalon and pereonite 1, back view. **E**. Cephalon, frontal view. **F**. Pleonites 3–5, telson and uropods. **G**. Antennula. **H**. Antenna.

Remarks

The genus *Amazoniscus* comprises five species from Brazil: *A. arlei* Lemos de Castro, 1967 from the states of Amapá, Pará, Rio de Janeiro and Tocantins; *A. eleonorae* Souza *et al.*, 2006, *A. leistikowi* Campos-Filho, Araujo & Taiti, 2014 and *A. zimmeri* Campos-Filho, Montesanto & Araujo, 2017 from the state of Pará; and *A. schmidti* Campos-Filho, Montesanto & Araujo, 2017 from the state of Minas Gerais (Souza *et al.* 2006; Campos-Filho *et al.* 2014, 2017a, 2018a). The genus is defined by having exoantennal or endoantennal conglobation, the cephalon with a frontal shield delimited superiorly by the frontal line and having a suprantennal line, pereonite 1 epimera without schisma, the antennal flagellum with two articles, the uropod protopod surpassing the telson and the male pleopod 1 exopod heart-shaped (Schmidt 2007; Campos-Filho *et al.* 2014).

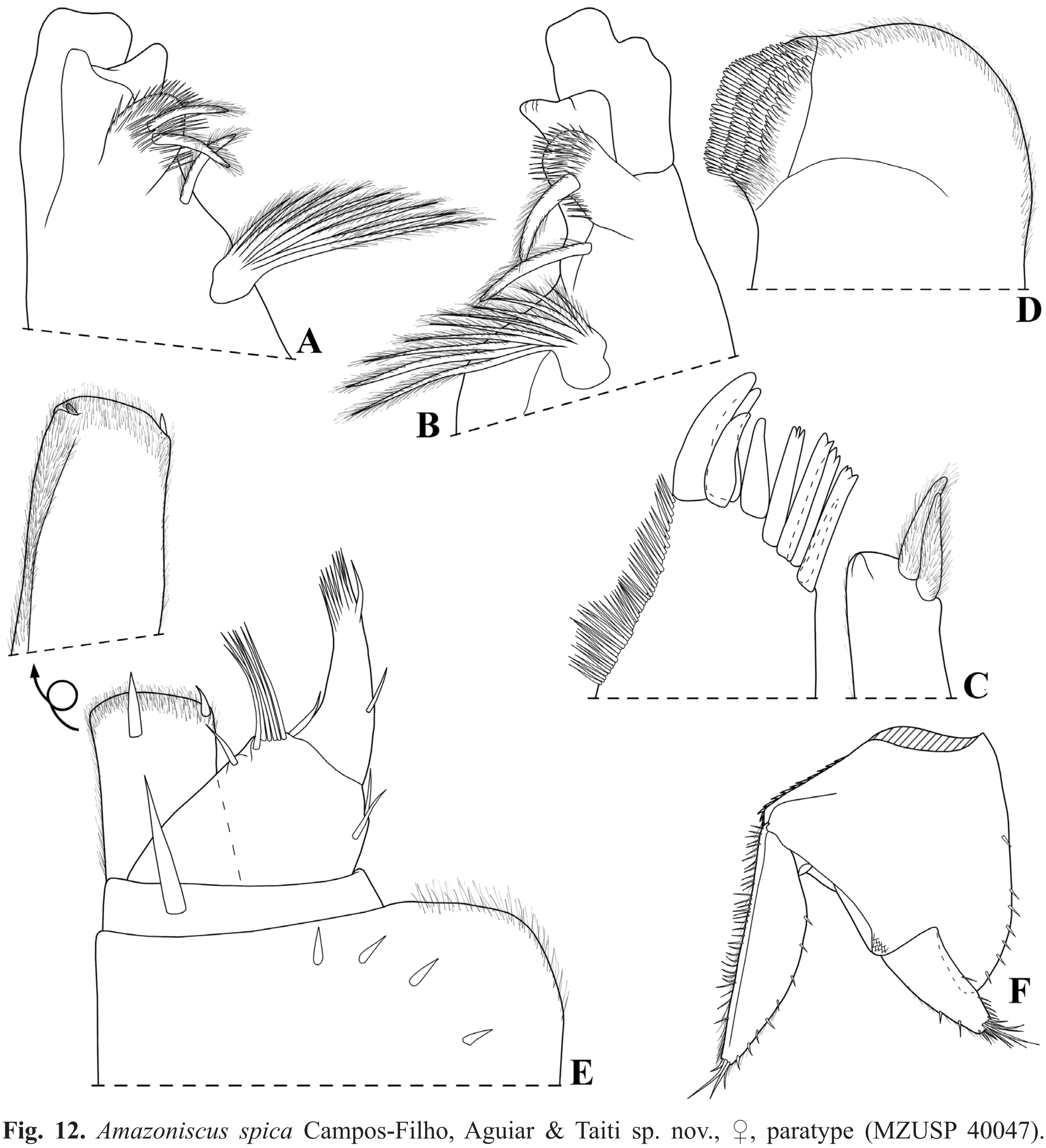

Fig. 12. *Amazoniscus spica* Campos-Filho, Aguiar & Taiti sp. nov., ♀, paratype (MZUSP 40047). **A**. Left mandible. **B**. Right mandible. **C**. Maxillula. **D**. Maxilla. **E**. Maxilliped. **F**. Uropod.

In lacking eyes and body pigment, and in having endoantennal conglobation, *Amazoniscus spica* sp. nov. is similar to *A. eleonorae* and *A. leistikowi*; it differs from both in the shape of the exopod of the male pleopods 1 and 5 (for comparisons, see Souza *et al.* 2006: figs 1–19 and Campos-Filho *et al.* 2014: figs 23–25). This species is considered here as troglobiotic.

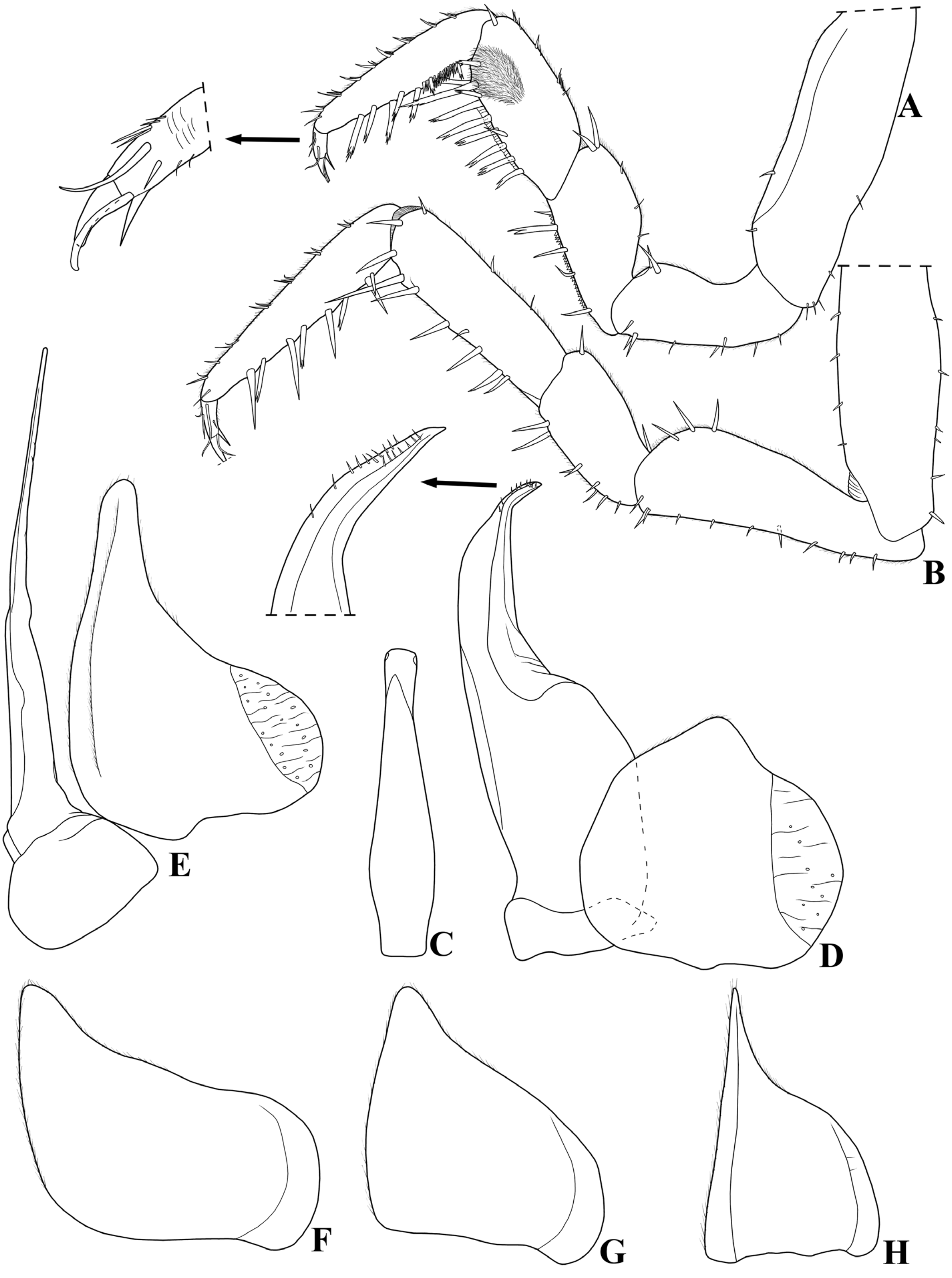

Fig. 13. *Amazoniscus spica* Campos-Filho, Aguiar & Taiti sp. nov., ♂, paratype (MZUSP 40047). **A**. Pereopod 1. **B**. Pereopod 7. **C**. Genital papilla. **D**. Pleopod 1. **E**. Pleopod 2. **F**. Pleopod 3 exopod. **G**. Pleopod 4 exopod. **H**. Pleopod 5 exopod.

Genus ***Circoniscus*** Pearse, 1917

Type species

Circoniscus gaigei Pearse, 1917, by monotypy.

Circoniscus bezzii Arcangeli, 1931
Fig. 14

Circoniscus bezzii Arcangeli, 1931: 115, pl. 2.

Circoniscus bezzii – Van Name 1936: 311, fig. 184. — Vilela *et al*. 1971: 185. — Souza & Lemos de Castro 1991: 50, figs 23–44. — Schultz 1995: 417, fig. 12j–m. — Souza-Kury 1998: 666. — Leistikow & Wägele 1999: 38. — Schmalfuss 2003: 81. — Schmidt 2007: 72, figs 224–229. — Campos-Filho *et al*. 2014: 396, fig. 40, tables 1–2; 2018a: 17. — Zimmermann *et al*. 2015b: 3, fig. 2, tables 1–2. — Fernandes *et al.* 2019: 1109, table 1.

Material examined

BRAZIL – **Minas Gerais State, Presidente Olegário** • 1 ♀; Vereda da Palha; 18°15′18″ S, 46°07′33″ W; Jan. 2014; L.P.A. Resende and T. Zepon leg.; LES 18863 • 1 ♂, 1 ♀; Lapa Zé de Sidnei; 18°18′05.62″ S, 46°05′40.63″ W; Jan. 2014; L.P.A. Resende and T. Zepon leg.; LES 18864 • 1 ♀; Arco da Lapa; 18°11′05″ S, 46°09′39″ W; Sep. 2013; M.E. Bichuette, L.P.A. Resende, T. Zepon and I.A. Ribeiro leg.; LES 18865 – **Minas Gerais State, Pains** • 1 ♂; SM-AM-004; 24 Jul. 2014; T. Santos & N.T. Pimentel leg.; LES 5474 • 1 ♀; S1-AM-027/029; 17 Feb. 2014; M. Barcelos and N.T. Pimentel leg.; LES 5475.

Distribution

This species is known from the Brazilian states of Espírito Santo, Mato Grosso, Minas Gerais and São Paulo, and doubtfully from Paraguay (Campos-Filho *et al*. 2018a; Fernandes *et al*. 2019). It has previously been recorded from the Caverna Vereda da Palha cave, Presidente Olegário, Minas Gerais State (Campos-Filho *et al*. 2014). The present records enlarge our knowledge of its distribution in the subterranean environment of the state of Minas Gerais.

Discussion

The diversity of the subterranean Oniscidea from Brazilian caves has been recorded in many contributions (e.g., Souza *et al.* 2006, 2010, 2015; Ferreira *et al.* 2010, 2015; Campos-Filho & Araujo 2011; Campos-Filho *et al.* 2014, 2015b, 2016, 2017b, 2017c, 2019; Gallão & Bichuette 2015, 2018; Silva & Ferreira 2015; Pellegrini & Ferreira 2016; Trajano *et al.* 2016; Bastos-Pereira *et al.* 2017; Fernandes *et al.* 2018, 2019; Bichuette *et al.* 2019). However, the taxonomic impediment is still a major consequence of a delay in the recognition of this fauna, considering that taxonomists that are still active are overloaded and/or face current bureaucratic obstacles, hindering the advance of this knowledge (Ebach *et al.* 2011; Campos-Filho *et al.* 2014; Coleman 2015).

Brazil is considered one of the most diverse countries in the world, comprising several ecosystems and biogeographic units (Olson *et al.* 2001; Morrone 2014), that are considered to be priorities for conservation (Myers *et al.* 2000; Mittermeier *et al.* 2005; Bini *et al*. 2006). The Brazilian subterranean environments are inserted in high diversity areas, e.g., the Bambuí karst region in Cerrado, the Carajás Formation in the Amazon Forest and the Açungui Group in the Atlantic Rainforest (Fig. 14) (CECAV 2015). Recently, some cave systems in the Cerrado, Caatinga and Atlantic Rainforest domains were recognized as hot spots of subterranean fauna in South America (Trajano *et al.* 2016). However, the Brazilian conservation units (see SNIF 2018) only protect some karst areas (partially showed in Fig. 14), and these environments have been suffering as a consequence of different threats, e.g., mining,

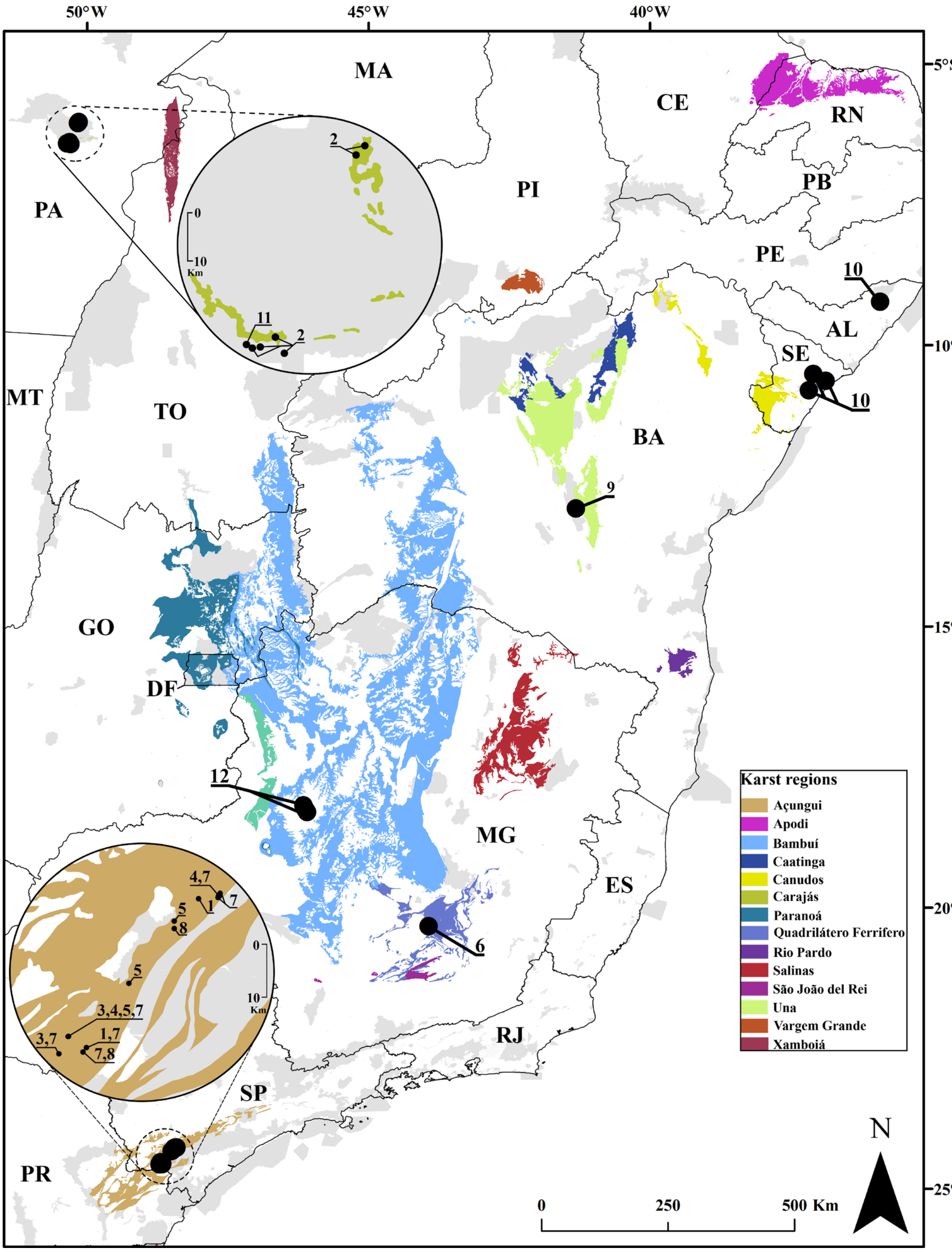

Fig. 14. Distribution map. **1**. *Alboscia jotajota* Campos-Filho, Bichuette & Taiti sp. nov. **2**. *Androdeloscia akuanduba* Campos-Filho, Cardoso & Taiti sp nov. **3**. *Atlantoscia inflata* Campos-Filho & Araujo, 2015. **4**. *Benthana iporangensis* Lima & Serejo, 1993. **5**. *B. longicornis* Verhoeff, 1941. **6**. *B. olfersii* (Brandt, 1833). **7**. *B. picta* (Brandt, 1833). **8**. *B. taeniata* Araujo & Buckup, 1994. **9**. *Metaprosekia igatuensis* Campos-Filho, Fernandes & Bichuette sp. nov. **10**. *Paratlantoscia rubromarginata* (Araujo & Leistikow, 1999). **11**. *Amazoniscus spica* Campos-Filho, Aguiar & Taiti sp. nov. **12**. *Circoniscus bezzii* Arcangeli, 1931. Light gray areas denote Brazilian conservation units. AL = Alagoas; BA = Bahia; CE = Ceará; DF = Distrito Federal; ES = Espírito Santo; GO = Goiás; MA = Maranhão; MG = Minas Gerais; MT = Mato Grosso; PA = Pará; PB = Paraíba; PE = Pernambuco; PI = Piauí; PR = Paraná; RJ = Rio de Janeiro; RN = Rio Grande do Norte; SE = Sergipe; SP = São Paulo; TO = Tocantins.

deforestation, agriculture and pollution of subterranean drainages (Gallão & Bichuette 2018). It is reasonable to suppose that the subterranean fauna and its environments suffer the consequences of these impacts, which directly modify the microclimate and the quality and quantity of food sources. These impacts may well change the composition of the fauna, leading to extinctions and to the compromise of ecological processes. It is worth mentioning that Brazilian legislation (BRAZIL 1990, 2008) guarantees integral protection to a cave in the presence of one of the attributes that classify it with the maximum degree of relevance, such as the presence of troglobiotic species.

It is clear that this delay in increasing our knowledge of the biodiversity, allied with current threats to the Brazilian subterranean environment, could result in an irreversible loss of this biodiversity. Further planning efforts are extremely necessary for the conservation of both the subterranean and surrounding environments, ensuring the stability of communities inside and outside the caves.

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