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A new species of *Trichorhina* Budde-Lund, 1908 (Isopoda: Oniscidea: Platyarthridae) from Paraná caves, southern Brazil

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ABSTRACT: The genus *Trichorhina* Budde-Lund, 1908 in Brazil includes 22 described species, four of which occur in caves. The present work aims at describing the first cave species for the state of Paraná. *Trichorhina kaingangi* n. sp. was collected in Água Boa cave, municipally of Almirante Tamandaré, and Ermida Paiol do Alto cave, municipally of Adrianópolis, both in the Açungui karst area.

Key words: Crustacea, terrestrial isopods, Açungui karst group, Neotropic.

Introduction

Until 2004, approximately 300 species of troglobiotic terrestrial isopods (Oniscidea) were known worldwide, mostly described from caves in the northern hemisphere (Taiti, 2004). Biospeleological surveys conducted in the last decades in Australia, Asia and South America have partly modified this scenario and to date 331 troglobiotic Oniscidea species are known (Taiti and Gruber, 2008; Taiti and Xue, 2012; Tabacaru and Giurginca, 2013; Campos-Filho *et al.*, 2014; Taiti 2014; Souza *et al.*, 2015; Taiti and Wynne, 2015). This number is certainly not exhaustive, since a large amount of material has been recently collected and many new taxa are still waiting formal descriptions. The taxonomic impediment has been the major problem for subterranean research development and cave conservation (Bichuette and Trajano, 2010; Cordeiro *et al.*, 2014).

Nowadays about 170 species of terrestrial isopods are known from Brazil, 29 of which are recorded from cave environments (Souza-Kury, 1993; Souza *et al.*, 2006; 2010; 2015; Campos-Filho *et al.*, 2014; 2015). Thirteen species are known from the state of Paraná, but none of them was recorded from caves. Only two species have been recorded exclusively from the state of Paraná: *Benthana itaipuensis* Campos-Filho and Araujo, 2011 from Foz do Iguaçu, and *Benthana guayanas* Campos-Filho, Costa and Araujo, 2013 from Morretes and São João da Graciosa (Souza-Kury, 1998; Campos-Filho and Araujo, 2011; Costa *et al.*, 2014; Campos-Filho *et al.*, 2013; 2015).

The genus *Trichorhina* Budde-Lund, 1908 in Brazil includes 22 species, including the pantropical *Trichorhina tomentosa* (Budde-Lund, 1908) and *Trichorhina heterophthalma* Lemos de Castro, 1964. Four species of *Trichorhina* are known to occur in caves: *Trichorhina guanophila* Souza-Kury, 1993 from the state of Bahia, *Trichorhina yiara* Campos-Filho, Araujo and Taiti, 2014 and *Trichorhina curupira* Campos-Filho, Araujo and Taiti, 2014 from the state of Pará, and *Trichorhina anhanguera* Campos-Filho, Araujo and Taiti, 2014 from the state of Minas Gerais (Schmalfuss, 2003; Araujo and Almerão, 2007; Souza *et al.*, 2011; Campos-Filho *et al.*, 2014).

In the present work the first cave-dwelling species of *Trichorhina* from the state of Paraná is described. The material was collected in Água

Boa cave, municipally of Almirante Tamandaré, and Ermida Paiol do Alto cave, municipally of Adrianópolis, both located in the Açungui karst area.

Material and Methods

Specimens are stored in 75% ethanol and identifications are based on morphological characters. Some specimens were dissected and the appendages and pereonites were mounted in micropreparations. Drawings were prepared using a camera lucida. The coordinates of the *noduli laterales* were obtained and figured as in Vandel (1962). The type material is deposited at Museu de História Natural de Capão da Imbuia (MHNCI), Curitiba, state of Paraná, Brazil, Museu de Zoologia, Universidade de São Paulo (MZUSP), São Paulo, state of São Paulo, Brazil, and Natural History Museum, Section Zoology 'La Specola', Florence, Italy (MZUF).

Study Area

The Açungui karst area is composed of three stratigraphic formations: Capiru, Votuverava and Antinha (Fiori and Gaspar, 1993). The geomorphological evolution of Açungui karst area comprises three main events: (1) the creation of the Purunã Surface; (2) the creation of the Alto Iguaçu Surface; and (3) the opening of the Ribeira River Valley (Alto Ribeira basin), dated from Lower Miocene (Ab'Saber and Bigarella, 1961). The Açungui karst area developed in a uniform geological, geomorphological and climatic environment (Nascimento *et al.*, 2010). The two caves investigated are located in the Alto Ribeira basin, ca. 70 km apart, near limestone extraction areas (Fig. 1).

The Água Boa cave belongs to the Capiru Formation, composed mainly of dolomitic limestone. The cave is about 110 m long, very moist with water dripping from the ceiling and forming water puddles in the middle portion. It has two entrances, one of which is used by the mining company which explores the area. The main organic substrates are composed of vegetal matter (entrance and twilight zone) and guano (aphotic zone) of the hematophagous bat *Desmodus rotundus*

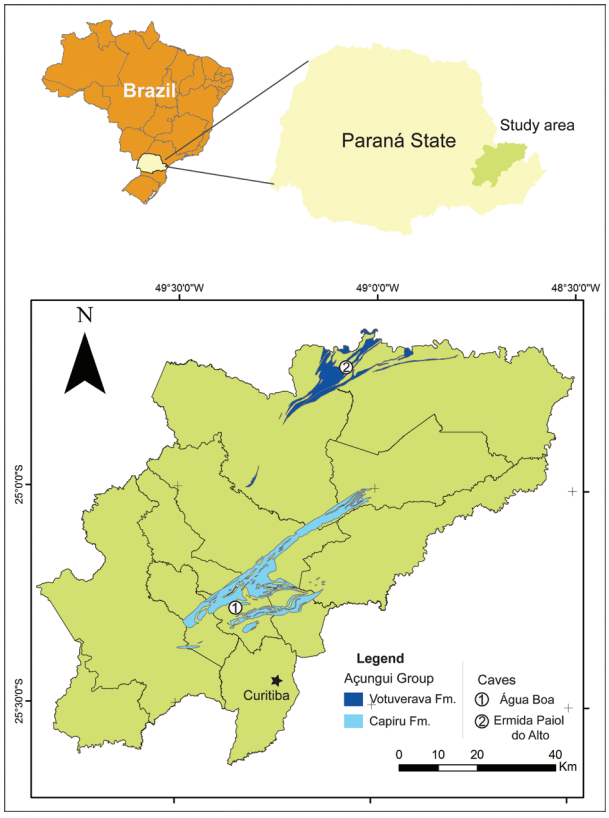

Figure 1. Map of Açungui karst locating the Votuverava and Capiru formations. Numbers indicate cave position. Legend: Fm = formation.

(E. Geoffroy, 1810). The bat population in the cave has recently suffered a significant reduction due to chemical control to prevent rabies (Arnone, 2008). Most of the bat guano is old and dry, indicating resource depletion.

The Ermida Paiol do Alto cave is located in the Votuverava formation, composed of calcite limestone. The cave is about 140 m long, with a downhill orientation, contributing to accumulate organic material with different levels of decomposition from the entrance to the twilight zone. The cave has two main conduits and no evidence of hydric activity. Bat guano, probably of the hematophagous bat *Diphylla ecaudata* Spix, 1823, is present in the twilight and aphotic zones. Fungi are found throughout the cave on the walls and over the bat droppings.

Systematics

Family Platyarthridae Verhoeff, 1949

Genus *Trichorhina* Budde-Lund, 1908

Type species. Bathytropa thermophila Dollfus, 1896 [= *Trichorhina tomentosa* (Budde-Lund, 1893)] by original designation.

Diagnosis. Schmidt (2002) and Souza *et al.* (2011).

Trichorhina kaingangi n. sp. Campos-Filho, 2015

(Figs. 2–4)

Type material. Holotype Paraná: 1 ♂, Adrianópolis, Ermida Paiol do Alto cave (24°43'10"S 49°05'4"W, 25/II/2014, leg. K.M. Mise, MHNCI 4485). *Paratypes* Paraná: same data as holotype, 1 ♂ (26/II/2014, leg. Tatiana Portella *et al.*, MHNCI 4486), 1 ♂ (26/II/2014, leg. Tatiana Portella *et al.*, MHNCI 4487), 1 ♂, 1 ♀ (26/II/2014, leg. Tatiana Portella *et al.*, MZUSP 33990), 1 ♂ (on micropreparations) (MHNCI 4488), 1 ♀ (26/II/2014, leg. Tatiana Portella *et al.*, MHNCI 4489), 2 ♀ (26/II/2014, leg. Tatiana Portella *et al.*, MHNCI 4490), 1 ♀ (26/II/2014, leg. Tatiana Portella *et al.*, MHNCI 4491), 1 ♀ (26/II/2014, leg. Tatiana Portella *et al.*, MHNCI 4492), 1 ♂ (MZUSP 33991), 1 ♀ (MZUSP 33992), 1 ♂, 1 ♀ (MZUSP 33993), 2 ♂, 2 ♀ (MZUF 9614), 1 ♀, Almirante Tamandaré, Água Boa Cave (25°16'43"S 49°21'29"W, 07/IV/2014, leg. C. Souza, MHNCI 4493), 1 ♀, Almirante Tamandaré, Água Boa Cave (leg. C. Souza, MHNCI 4494).

Etymology. The new species is named after the native people Kaingang inhabiting the Brazilian states of São Paulo, Paraná, Santa Catarina and Rio Grande do Sul.

Description. Maximum body length 5 mm. *Body* stout with pereon epimera gradually directed backwards (Fig. 2A). Colourless body. *Dorsum* surface covered with fan-shaped scale-setae with anastomosed surface (Fig. 2B). One line of *noduli laterales* inserted close to posterior margins and more or less at same distance from lateral margins of pereonites (Fig. 2B); b/c and d/c coordinates as in Fig. 2C, D. *Cephalothorax* with well-developed rounded lateral lobes, suprantennal line straight, no frontal line; eyes absent (Fig. 2E, F). *Pleon* with outline continuous with that of pereon; epimera of pleonites 3–5 well-developed (Fig. 2A). *Pleotelson* triangular, lateral margins slightly concave and acute apex (Fig. 2G). *Antennula* of three articles, distal article with nine aesthetascs (Fig. 2H). *Antenna* when extended posteriorly, reaching posterior margin of pereonite 1; setose longitudinal groove for the water-conducting system (*sensu* Schmalfuss, 1998) from base of peduncle to distal article of flagellum; flagellum as long as fifth article of peduncle, second article about three times as long as first with two aesthetascs on distal portion, apical organ short with long free sensillae (Fig. 2I). *Mandible* with molar penicil of about six branches, left mandible with 2+1 penicils, right mandible with 1+1 penicils (Fig. 2J, K). *Maxillula* inner branch with two penicils; outer branch with 4+5 teeth, all simple (Fig. 2L). *Maxilla* with setose and bilobate apex; outer lobe about three times as wide as inner lobe, subquadrate and distal margin slightly rounded (Fig. 2M). *Maxilliped* basis rectangular bearing sparse scale-setae; endite subrectangular, medial seta surpassing distal margin (Fig. 2N). *Uropod* outer margin grooved bearing glandular pores, exopod slightly longer than endopod (Fig. 3A). *Pereopod* sternal setae with cleft apex; pereopod 1 with antennal grooming brush transverse reaching median margin of carpus; *dactylus* with long inner claw, ungual seta with simple apex reaching median portion of outer claw, dactylar seta with simple apex reaching tip of outer claw (Fig. 3B).

Male. *Pereopod 1-3* merus and carpus with brush of setae on sternal margin; carpus 1 distal seta with double-serrate apex (Fig. 3B). *Pereopod 7* merus and carpus with sternal setae slightly sparse, ischium sternal margin straight and distal margin bearing three large setae (Fig. 3C). *Genital papilla* as in Fig. 3D. *Pleopod 1 exopod* ovoidal, twice as broad as long, with rounded distal part; *endopod* three times as long as exopod, distal part acute, inner margin bearing minute setae along the margin (Fig. 3E). *Pleopod 2 exopod* triangular, outer margin concave bearing four setae; *endopod* slightly longer than exopod (Fig. 3F). *Pleopod 3* and *4 exopods* as in Fig. 3G, H. *Pleopod 5 exopod* triangular, outer margin convex bearing nine setae (Fig. 3I).

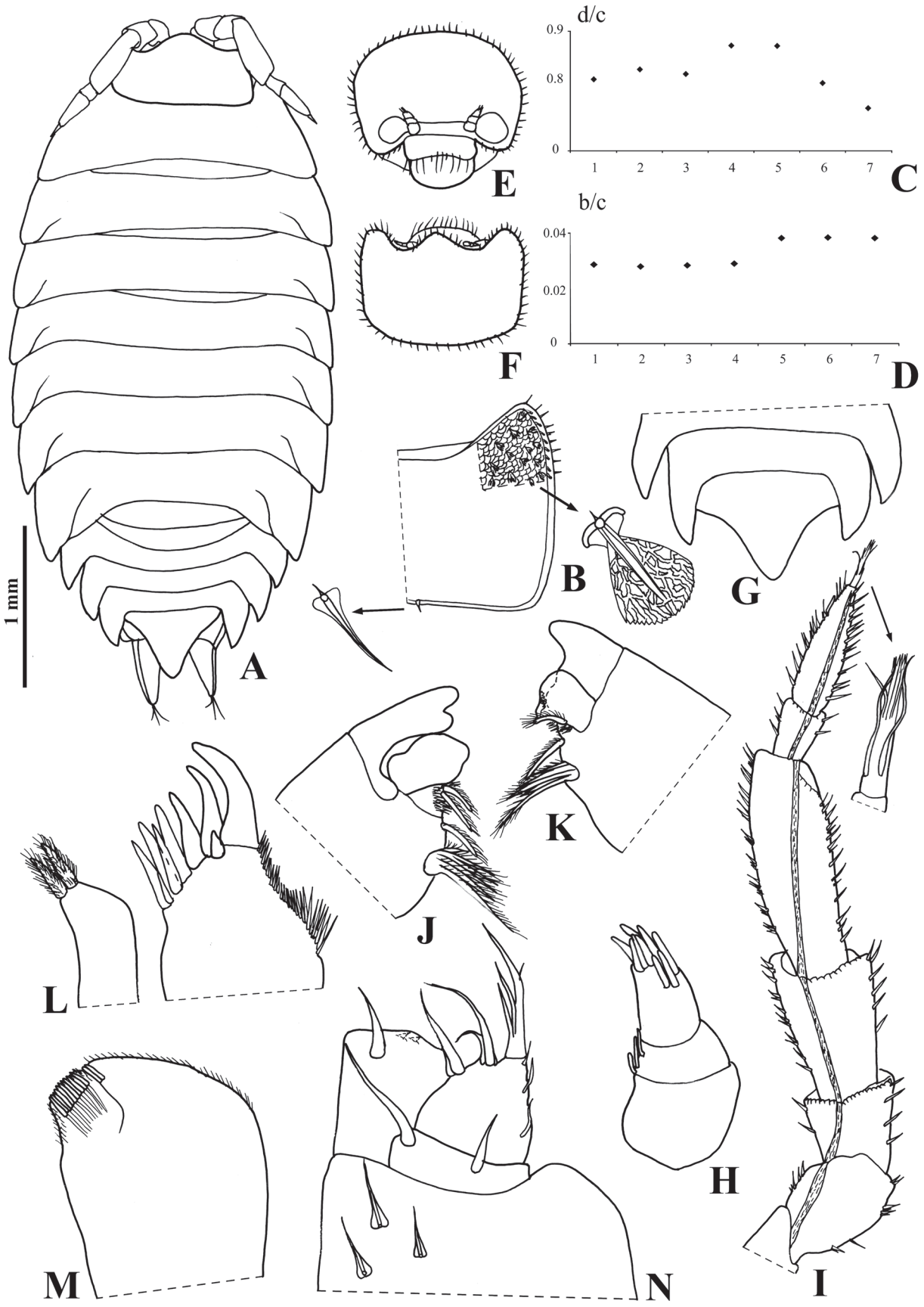

Figure 2. *Trichorhina kaingangi* n. sp. (male paratype). A, habitus; B, pereonite 1, scale-seta and *nodulus laterales*; C, *noduli laterales* d/c coordinates; D, *noduli laterales* b/c coordinates; E, cephalothorax, frontal view; F, cephalothorax, dorsal view; G, pleonites 4, 5 and pleotelson; H, antennula; I, antenna; J, left mandible; K, right mandible; L, maxillula; M, maxilla; N, maxilliped.

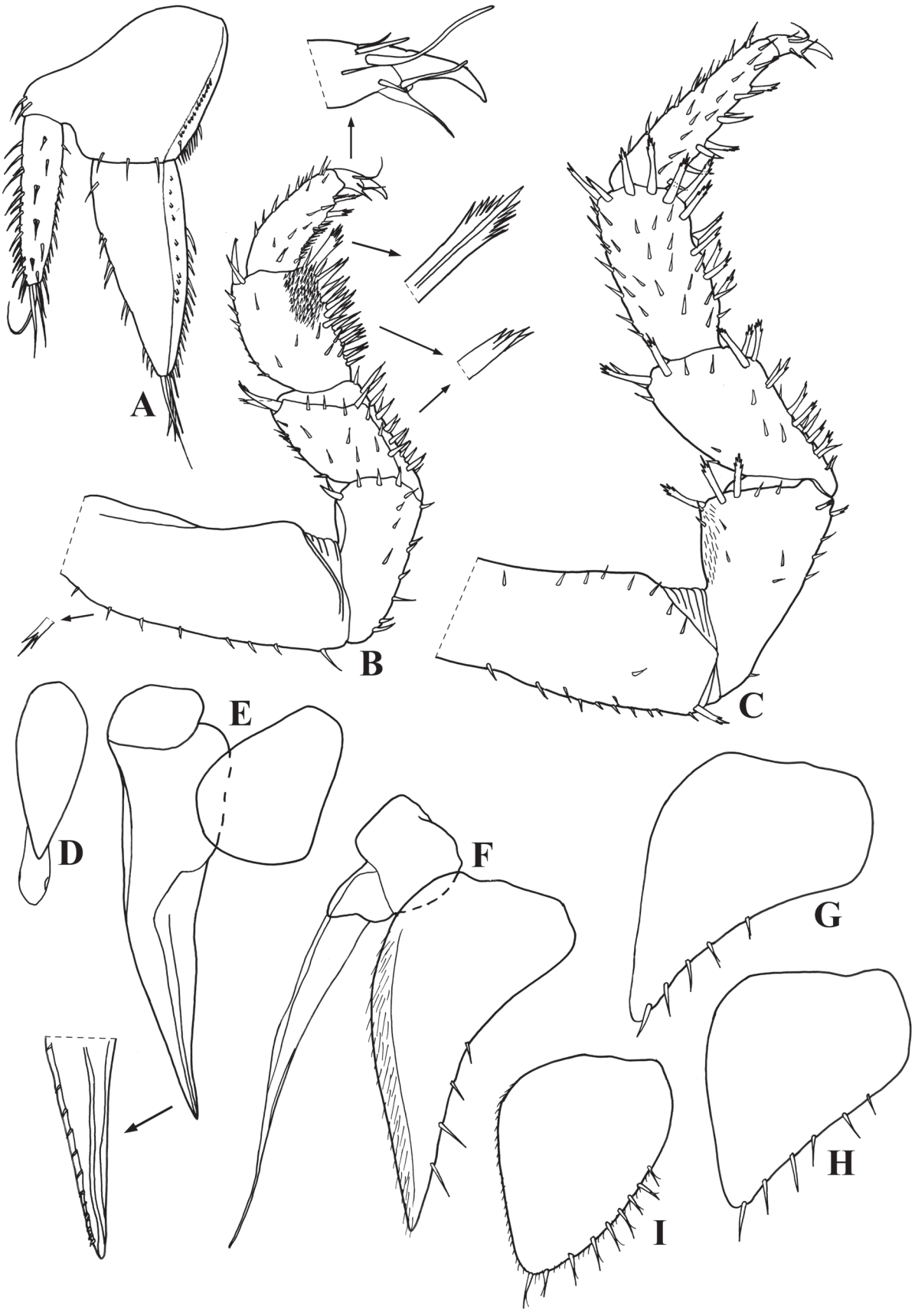

Figure 3. *Trichorhina kaingangi* n. sp. (male paratype). A, uropod; B, pereopod; C, pereopod 7; D, genital papilla; E, pleopod 1; F, pleopod 1; G, pleopod 3 exopod; H, pleopod 4 exopod; I, pleopod 5 exopod.

Remarks. In the absence of eyes *Trichorhina kaingangi* n. sp. resembles *Trichorhina caeca* Vandel, 1952 (Venezuela: El Junquito), *Trichorhina anhanguera* (Brazil: state of Pará) and *Trichorhina brasilensis* Andersson, 1960 (Brazil: state of Santa Catarina). It is distinguished from all these species by the stout body shape, different shape of dorsal scale-setae (fan-shaped with anastomosed surface vs. rib-shaped surface) and different shape of the male pleopod 1 exopod; from *T. caeca* also in the shape of the pleotelson (lateral margins concave and acute apex vs. lateral margins slightly convex and rounded apex); from *T. anhanguera* in the mandible with molar penicil dichotomized (vs. simple); and from *T. brasilensis* and *T. caeca* in the maxillular outer endite with simple teeth (vs. cleft) on the inner set.

As mentioned by Campos-Filho *et al.* (2014), the assumption of troglobiotic condition in species of *Trichorhina* is complicated, because most representatives have an endogean way of life, with similar morphological adaptations to troglobiotic forms, i.e. eye reduction/absence and body depigmentation. It is well known that convergent or parallel phenotypic evolution exists between animals living in deep soil and in caves, which can obscure taxonomic relationships (Wilkens and Strecker, 2003; Juan *et al.*, 2010; Campos-Filho *et al.*, 2014). The new species has been found in caves, but more extensive collections in contiguous endogean habitats, which are not usually performed properly in biospeleological surveys, may prove their occurrence outside caves, suggesting a troglophilic rather than a troglobiotic condition.

The Brazilian laws (BRASIL, 1990; 2008) guarantee cave preservation when a cave reaches the maximum relevance, and this is only possible when there are rare or endemic troglobiotic species (e.g. Cardoso *et al.*, 2014; Campos-Filho *et al.*, 2014). Thus, although laws protect at least part of the obligate cave fauna, conservation acts cannot come into effect if species remain undescribed. For this reason, taxonomic studies of subterranean species in Brazil are of crucial importance for the preservation of both the environment and the species, and any delay in taxonomic research in caves may yield permanent loss of biodiversity, even before the species are discovered and described (e.g. Bichuette and Trajano, 2005; Fišer *et al.*, 2013; Campos-Filho *et al.*, 2014).

Ecological considerations. In Ermida Paiol do Alto the species occurs throughout the cave, from photic to aphotic zones. The specimens were found on the cave floor and over bat guano, in rainy and dry seasons (Fig. 4). In Água Boa cave the specimens were collected at the entrance and twilight zones, on the cave floor and over decomposing vegetable matter, both in rainy and dry seasons. *Trichorhina kaingangi* n. sp. was collected together with the introduced species *Miktoniscus medcofi* (Van Name, 1940) (1♀, MHNCI 4881), which is widely distributed from southern and central USA, Mexico, and Brazilian states of Amapá, Pará, Rio de Janeiro, São Paulo and Rio Grande do Sul (Lemos de Castro, 1971; Araujo and Bueno, 1998; Campos-Filho *et al.*, 2014).

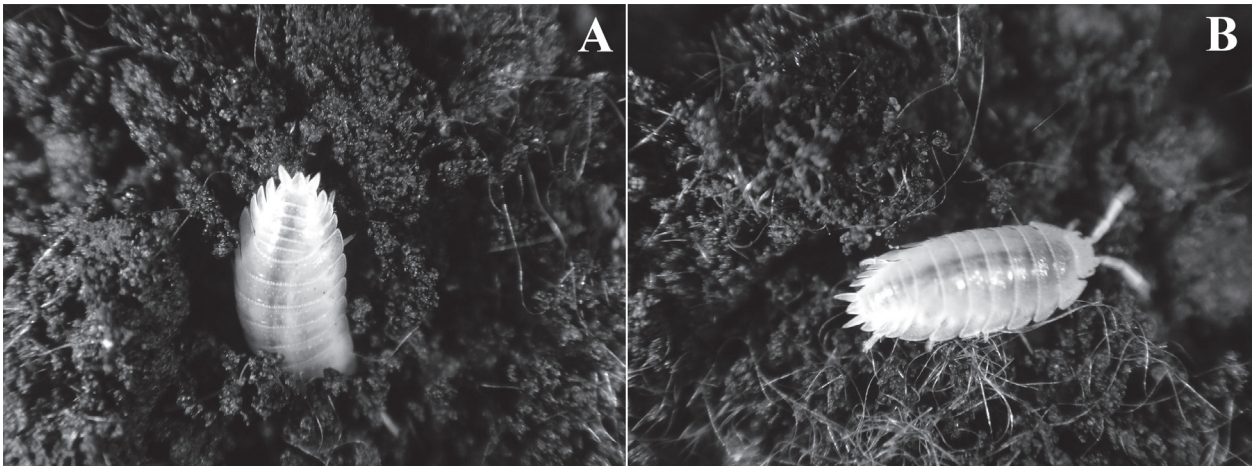

Figure 4. *Trichorhina kaingangi* n. sp.. A, B, specimens from Gruta Ermida Paiol do Alto, Adrianópolis, Paraná.

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