Zootaxa 3779 (4): 433–455
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3779.4.2
http://zoobank.org/urn:lsid:zoobank.org:pub:67B05C93-6FBA-4E1A-970A-78B4C79BE934

First report of geophilid centipedes of the genus *Ribautia* (Myriapoda: Chilopoda: Geophilomorpha) from the Atlantic Forest biome, with description of a new miniature species from Misiones Province, Northeastern Argentina

LUIS ALBERTO PEREIRA
National Council for Scientific and Technological Research (CONICET) and National University of La Plata, Natural Sciences Faculty and Museum (Division of Invertebrate Zoology), Paseo del Bosque s/n, (1900) La Plata, Buenos Aires, Argentina.
E-mail: lpereira@fcnym.unlp.edu.ar

Abstract

Ribautia paranaensis **sp. nov**. a new miniature species of geophilid centipede from the Upper Paraná Atlantic Forest (the westernmost of the fifteen ecoregions comprising the Atlantic Forest biome *sensu* Di Bitetti *et al*. 2003), is herein described and illustrated. The new species is characterized by having the coxal organs grouped in clusters (one of these in each coxopleuron of the ultimate leg-bearing segment) and a claw-like pretarsus in the ultimate legs; these traits being shared by three other Neotropical members of the genus, *i.e., R. combinata* Pereira, Uliana & Minelli, 2006 (from the Amazonian rainforest of Peru), *R. jakulicai* Pereira, 2007 (from the Yungas rainforest of Northwestern Argentina), and *R. lewisi* Pereira, 2013 (collected in a gallery forest in the Mesopotamian region, Northeastern Argentina). *R. paranaensis* **sp. nov**. represents the first report of *Ribautia* Brölemann, 1909 in the entire Atlantic Forest biome, and the third confirmed record of the taxon from Argentina.

Key words: Chilopoda, Geophilomorpha, Geophilidae, *Ribautia*, miniature new species, Atlantic Forest biome, Neotropical Region

Introduction

The geophilomorph centipede genus *Ribautia* Brölemann, 1909 is the most species-rich and widespread of the geophilid genera in the Neotropical Region, in which it is currently known from South American mainland. Thirteen species have been recorded from Peru, one from Colombia and Guyana, one from Brazil and Colombia, one from Brazil and French Guiana, five from Brazil only, one from Ecuador, two from Venezuela, one from Bolivia, and two from Argentina (in addition to the new species described below). The taxon also occurs in the Arabian Peninsula, mainland Africa, Madagascar, Australia, New Caledonia, Loyalty Islands and New Zealand (Pereira *et al.* 1997; Minelli 2006; Pereira 2007, 2008, 2010, 2013b; Bonato *et al*. 2009).

Of the Neotropical species included in *Ribautia*, 11 are characterized by having all the coxal organs opening separately; of the 16 remaining taxa, one is distinguished from the others by having an independent, freely opening coxal organ and a cluster of coxal organs in each coxopleuron of the ultimate leg-bearing segment; in the other 15 (in addition to the new species proposed herein) all coxal organs are grouped in clusters (having either, one, two or three of these in each coxopleuron).

The Neotropical members of *Ribautia* can be found in a wide variety of environments, at elevations ranging from low altitudes above sea level (*e.g*., species inhabiting the Amazonian rainforest), up to *ca*. 4000 m a.s.l. (high altitude species living in the Andes).

The purpose of the present contribution is to describe a new miniature species of *Ribautia* from Misiones Province (Mesopotamian region), Northeastern Argentina, which represents the first report of the genus in the Atlantic Forest biome. The Atlantic Forest is one of the most diverse and threatened ecosystems on the Earth, with

Accepted by A. Minelli: 29 Jan. 2014; published: 18 Mar. 2014

only about 7% of its orginal coverage remaining (Morellato & Haddad, 2000; Oliveira-Filho & Fontes 2000). The biome is composed of two major vegetation types, the coastal forest or Atlantic Rainforest *sensu stricto* and the tropical seasonal forest or Atlantic Semidecidous forest (Morellato & Haddad 2000). The Atlantic Rainforest covers mostly low to medium elevations (≤ 1000 m) of the eastern slopes of the mountain chain that runs subparallel and close to the coastline from southern to northeastern Brazil, enjoying a warm and wet climate without a well defined dry season; the Atlantic Semi-deciduous forest extends across the plateau (usually > 600 m) in the centre and southeastern interior of Brazil, with a small portion extending to northeastern Argentina and southeastern Paraguay and presenting a seasonal climate with a relative severe dry season, generally from April to September (Oliveira-Filho & Fontes 2000, Morellato & Haddad 2000). The latter area, in which *Ribautia paranaensis* **sp. nov.** has been collected is also known as Upper Paraná Atlantic Forest or "selva paranaense" and was originally the largest of the 15 ecoregions of the Atlantic Forests Ecoregion Complex, extending from the western slopes of the Serra do Mar in São Paulo State, Brazil, to Eastern Paraguay and Misiones Province in Northeastern Argentina (Di Bitetti *et al.,* 2003).

Little is known of the Atlantic Forest, but what we do know is that this complex biome contains a species diversity higher than most of the Amazon forests, and is characterized by high levels of endemism, averaging nearly 50% overall, and as high as 95% in some groups (Brown & Brown 1992, Morellato & Haddad 2000). According to Hoffman (2000), two genera of chelodesmid millipedes, *Atlantodesmus* Hoffman, 2000 and *Iemanja* Hoffman, 2000 are endemic to it.

Material and methods

The holotype and paratypes designated below are deposited at the Museum of La Plata (MLP), together with other non type material.

Dissections were performed using a stereomicroscope and standard dissecting tools. The specimens were examined and illustrated in detail, using a compound microscope equipped with a drawing tube attachment (the latter was used to delineate the figures and also to draw scales bars at their sides with the aid of a glass stage-micrometer). Temporary mounts have been prepared by direct transfer of the specimens from the preservation liquid (70% ethanol) onto microscope slides, using undiluted 2-phenoxyethanol (CAS # 122-99-6) as a clearing agent and mounting medium. Details of dissection procedures and preparation of microscope slides were described in Pereira (2000), Foddai *et al*. (2002). All measurements are given in mm (taken at once as explained above). Terminology for external anatomy follows Bonato *et al*. (2010). The following abbreviations were used in the text, tables, and legends of the figures: a.a., antennal article/articles; b.l., body length; l.-b.s., leg-bearing segments.

Results

Family Geophilidae

Genus *Ribautia* Brölemann, 1909

Diagnosis. This genus can be distinguished from all other genera currently recognized in the family Geophilidae by the following combination of features. Second maxillae: united by a small coxosternal bridge only; antero-internal corners of coxosternite with a more or less developed process; prominent distally convergent ridges (statuminia *sensu* Crabill 1960) present. Forcipules: pleurocoxosternal sutures extending obliquely to the outer margin; chitin-lines present; medial edge of trochanteroprefemur of telopodites either with a small unpigmented protuberance, with a conspicuous pigmented or unpigmented tooth, with two of these teeth, or without teeth. Sternal pores arranged in a single subcircular or longitudinaly elongate area on the anterior part of the trunk, in a single or two paired areas on the posterior part of the trunk (or even totally absent on the latter). Each coxopleuron of the ultimate leg-bearing segment with coxal organs, distributed in one of the following ways: (1) opening separately, (2) an anterior organ opening separately and all the remaining grouped in a cluster, (3) grouped in one to three clusters. Pretarsus of ultimate legs either claw-like or tubercle-like.

Type species of the genus. *Ribautia bouvieri* Brölemann, 1909, by monotypy.

Remarks. To the list of species currently included in *Ribautia* as listed in Minelli (2006), the following recently described taxa (and the new species described below) must be added:

Ribautia combinata Pereira, Uliana & Minelli, 2006 (from Peru: Loreto: Allpahuayo, *ca.* 30 km S Iquitos)
Ribautia donatellae Pereira, Uliana & Minelli, 2006 (from Brazil: Amazonas: near Manaus)
Ribautia jakulicai Pereira, 2007 (from Argentina: Salta: Orán: Aguas Blancas)
Ribautia roigi Pereira, 2008 (from Bolivia, Rio Vinto, 75 km from Cochabamba)
Ribautia lewisi Pereira, 2013 (from Argentina: Entre Ríos Province: Concordia)

***Ribautia paranaensis* sp. nov.**
(Figs. 1–70)

Diagnosis. A Neotropical species of *Ribautia* with one cluster of coxal organs in each coxopleuron of the ultimate leg-bearing segment and a claw-like pretarsus at the tip of the ultimate legs. Among the Neotropical species currently assigned to the genus, only the present new taxon, *R. combinata* Pereira, Uliana & Minelli, 2006 (from Peru), *R. jakulicai* Pereira, 2007 (from Argentina) and *R. lewisi* Pereira, 2013 (from Argentina) share these two combined traits.

R. paranaensis **sp. nov.** can be differentiated

- from *R. combinata* by means of the following selected traits (the corresponding features in the latter are given in parentheses): all coxal organs grouped in a cluster, Figs. 62–64, 69 (an independent coxal organ anteriorly, a cluster posteriorly, Fig. 75); female with 41 (n=1) or 43 (n=8) leg-bearing segments (female with 55 (n=1)); labrum mid-piece with *ca.* 8 short sharp pointed teeth, Fig. 16 (with *ca.* 17 short round pointed teeth, Fig. 73); shape and relative size of ventral process on antero-internal corners of coxosternite of second maxillae as in Figs. 19–21 (as in Fig. 74); some pore-fields divided in two subsymmetrical areas (all pore-fields undivided); posterior limit of pore-field series on penultimate sternite (on antepenultimate sternite); undivided pore-fields of posterior region of the body with shape as in Figs. 47–50 (irregular to subcircular in shape); anal organs absent (present).
- from *R. jakulicai* by means of the following selected traits (the corresponding features in the latter are given in parentheses): female with 41 (n=1) or 43 (n=8), male with 41 (n=4) or 43 (n= 15) leg-bearing segments (female with 55 (n=7) or 59 (n=5), male with 55 (n=2), 57 (n=9) or 59 (n=1)); maximum body length of female and male 12 mm (female: 28 mm, male: 23 mm); dorsal side of a.a. XIII with type *c* sensilla (dorsal side of all a.a. without type *c* sensilla); pore-fields absent on some sternites of midbody (pore-fields in an uninterrupted series all along the trunk); anterior legs with setae of different thickness, Figs. 51, 52 (with setae of uniform thickness).
- from *R. lewisi* by means of the following selected traits (the corresponding features in the latter are given in parentheses): female with 41 (n=1) or 43 (n=8), male with 41 (n=4) or 43 (n=15) leg-bearing segments (female with 45 (n=10) or 47 (n=5), male with (43?), 45 (n=5) or 47 (n=3)); maximum body length of female and male 12 mm (female: 26 mm, male: 20 mm); dorsal side of a.a. XIII with type *c* sensilla (all a.a. without type *c* sensilla); antennae of male proportionally of same length as those of female (proportionally longer than those of female); internal limb of tentorium without sclerotized process, Fig. 16 (bearing a conspicuous sclerotized process directed inwards, Fig. 80); first and second articles of telopodites of second maxillae without a process (with a very small distoectal process, Fig. 81: b); most of single pore-fields of anterior region of the body subovoidal in longitudinal sense, Figs. 33–43 (subcircular); pore-fields of posterior region of the body undivided, remarkably large, Figs. 46–50 (divided in two small areas); anterior legs with setae of different thickness, Figs. 51, 52 (with setae of uniform thickness); sternite of male ultimate leg-bearing segment with very few setae of different lengths distributed all over the surface, Fig. 62 (with numerous very small setae distributed on the posterior half, remaining surface with few setae of different lengths); sternite of female ultimate leg-bearing segment with very few setae of different lengths distributed all over the surface, Fig. 69 (with numerous very small setae in a narrow band near the posterior edge, remaining surface with few setae of different lengths).

TABLE 1. Differential characters of *Ribautia paranaensis* **sp. nov.**, *R. combinata* Pereira, Uliana & Minelli, 2006, *R. jakulicai* Pereira, 2007, and *R. lewisi* Pereira, 2013.

	R. paranaensis	*R. combinata*	*R. jakulicai*	*R. lewisi*
Number of leg-bearing segments	♀: 41 (n=1), 43 (n=8) ♂: 41 (n=4), 43 (n=15)	♀: 55 (n=1) ♂: ?	♀: 57 (n=7), 59 (n=5) ♂: 55 (n=2) , 57 (n=9), 59 (n=1)	♀: 45 (n=10), 47 (n=5) ♂: (43?), 45 (n=5), 47 (n=3)
Maximum body length	12 mm (♀ and ♂)	9 mm (♀)	28 mm (♀), 23 mm (♂)	26 mm (♀), 20 mm (♂)
Lateral margins of cephalic plate showing a small concavity anteriorly	yes, vestigial, (Figs. 12, 13: a)	no	no	yes, conspicuous
Dorsal side of a.a. bearing type *c* sensilla	yes, on a.a. XIII (Fig. 11)	yes, on a.a. IX and XIII	no	no
Antennae of male proportionally longer than those of female	no	?	no	yes
Ratio of length of male antennae to length of cephalic plate	2.4: 1	?	*ca.* 2.4: 1	*ca.* 4.0: 1
Labrum mid-piece	with *ca.* 8 short sharp-pointed teeth (Fig. 16)	with *ca.* 17 short, round-pointed teeth on the middle and *ca.* 2+3 long hyaline filaments on their sides (Fig. 73)	with *ca.* 5 short, round-pointed teeth on the middle and *ca.* 2+2 hyaline filaments on their sides (Fig. 77)	with *ca.* 7 sharp-pointed teeth (Fig. 80)
Internal limb of tentorium bearing a conspicuous sclerotized process directed inwards	no (Fig. 16)	no (Fig. 73)	no (Fig. 77)	yes (Fig. 80)
Shape and relative size of ventral process on antero-internal corners of coxosternite of second maxillae	as in Figs. 19-21	as in Fig. 74	as in Fig. 78	as in Fig. 81
First and second article of telopodites of second maxillae with a very small distoectal process	no (Figs. 19, 22)	no	no	yes (Fig. 81)
Denticles on central part of anterior border of forcipular coxosternite, each provided with an apical seta	no (Fig. 26)	no	yes (Fig. 79)	yes

……continued on the next page

TABLE 1. (Continued)

	R. paranaensis	*R. combinata*	*R. jakulicai*	*R. lewisi*
Apical medial edge of forcipular trochanteroprefemur	with a small slightly pigmented tooth (Figs. 26, 27, 29)	with a conspicuous subtriangular and slightly pigmented tooth	with a small unpigmented protuberance	with a conspicuous round-tipped unpigmented tooth
Ratio of maximum length/maximum width of forcipular trochanteroprefemur	*ca.* 1.52: 1	*ca.* 1.27: 1	*ca.* 1.70: 1	*ca.* 1.60: 1
Pore-fields distributed in an uninterrupted series along all the body	no, fields lacking on some midbody sternites	yes	yes	no, fields lacking on some midbody sternites
All pore-fields undivided	no, those of midbody divided in two areas	yes	no, those of midbody divided in two areas	no, those on middle and posterior regions of the body divided in two areas
Shape of single pore-fields of anterior region of the body	conspicuously subovoidal in longitudinal sense (Figs. 33-43)	subcircular to slightly subovoidal in longitudinal sense	conspicuously subovoidal in longitudinal sense	subcircular
Posterior limit of ventral pore-field series	penultimate	antepenultimate sternite	penultimate sternite	penultimate sternite
Anterior legs with setae of different thickness	yes, on legs of pairs 1 to 10-11 (Figs. 51, 52)	yes, on legs of pairs 1 to 9-10 (Fig. 76)	no	no
Chaetotaxy of sternite of male ultimate leg-bearing segment	with very few setae of different lengths distributed all over the surface (Fig. 62)	?	with few setae of different lengths distributed all over the surface	with numerous very small setae distributed on the posterior half, remaining surface with few setae of different lengths
Chaetotaxy of sternite of female ultimate leg-bearing segment	with very few setae of different lengths distributed all over its surface (Fig. 69)	with few setae of different lengths distributed all over its surface (a little more numerous near the posterior edge)	with very few setae of different lengths distributed all over its surface	with numerous very small setae in a narrow band near the posterior edge, remaining surface with few setae of different lengths
Lateral edges of sternite of female ultimate leg-bearing segment	straight to very slightly convex on anterior portion, straight on posterior half	conspicuosly convex	slightly concave	very slightly convex on anterior portion, concave on posterior half
Ratio of length of telopodite of ultimate legs to length of sternite of female ultimate leg-bearing segment	*ca.* 3.94: 1	*ca.* 3.6: 1	*ca.* 3.75: 1	*ca.* 4.0: 1
Coxal organs in each coxopleuron	all grouped in a cluster (Figs. 62-64, 69)	an independent opening organ anteriorly, a cluster posteriorly (Fig. 75)	all grouped in a cluster	all grouped in a cluster
Anal organs	absent	present	absent	absent

Other morphological traits included in Table 1 differentiate *R. paranaensis* **sp. nov.** from *R. combinata*, *R. jakulicai* and *R. lewisi.*

Remarks. For characters differentiating *R. paranaensis* **sp. nov**. from other Neotropical species of *Ribautia*, see comments on morphological similarities, below.

Type material examined. ARGENTINA: Misiones Province: Iguazú Department: Puerto Iguazú, 14 December 2007, L. A. Pereira legit: holotype ♂, 41 l.-b.s., b.l. 12 mm; paratype A (♀), 41 l.-b.s., b.l. 10 mm; paratype B (♀), 43 l.-b.s., b.l. 9 mm; paratype C (♀), 43 l.-b.s., b.l. 10 mm; paratype D (♀), 43 l.-b.s., b.l. 10 mm; paratype E (♀), 43 l.-b.s., b.l. 10.5 mm; paratype F (♀), 43 l.-b.s., b.l. 12 mm; paratype G (♂), 41 l.-b.s., b.l. 9 mm; paratype H (♂), 41 l.-b.s., b.l. 10 mm; paratype I (♂), 41 l.-b.s., b.l. 10 mm; paratype J (♂), 43 l.-b.s., b.l. 8 mm; paratype K (♂), 43 l.-b.s., b.l. 8 mm; paratype L (♂), 43 l.-b.s., b.l. 8.5 mm; paratype M (♂), 43 l.-b.s., b.l. 9 mm; paratype N (♂), 43 l.-b.s., b.l. 9 mm; paratype O (♂), 43 l.-b.s., b.l. 10 mm; paratype P (♂), 43 l.-b.s., b.l. 10 mm; paratype Q (♂), 43 l.-b.s., b.l. 10 mm; paratype R (♂), 43 l.-b.s., b.l. 10 mm; paratype S (♂), 43 l.-b.s., b.l. 10 mm; paratype T (♂), 43 l.-b.s., b.l. 10 mm; paratype U (♂), 43 l.-b.s., b.l. 10 mm; paratype V (♂), 43 l.-b.s., b.l. 11 mm.

Depository of types: MLP.

Other material examined: 3 ♀♀ subadult, 43 l.-b.s., b.l. 7, 8, and 9.5 mm; 2 ♂♂ subadult 43 l.-b.s., b.l. 7 and 9 mm. All specimens from the same locality, date and collector as the type series (MLP).

Description. Male holotype. Forty-one leg-bearing segments, body length 12 mm, maximum body width 0.45 mm, maximum width of cephalic plate 0.29 mm, length of cephalic plate 0.44 mm, maximum width of forcipular coxosternite 0.36 mm. Colour (of preserved specimen in alcohol) pale yellow, forcipular segment a little darker (pale ochreous).

Antennae. Relatively short, *ca*. 2.4 times as long as the cephalic plate, distally attenuate (Figs. 1, 2), ratio of width of a.a. II/width of a.a. XIV *ca*. 1.47: 1. A.a. I nearly as long as wide, remaining a.a. longer than wide. Ventral chaetotaxy: setae on a.a. I-VII of various lengths and relatively few in number; those of a.a. VIII-XIV progressively shorter and more numerous towards the tip of the appendage (Figs. 1, 2). Dorsal chaetotaxy: similar to the ventral side. A.a. XIV with *ca*. 10 claviform sensilla on apical half of the external and internal margins; distal end of this a.a. with *ca*. 5 very small hyaline specialized sensilla apparently not split apically (Fig. 3). Ventral and dorsal surface of a.a. II, V, IX and XIII with very small specialized sensilla. On the ventral side these sensilla are placed in the internal latero-apical area and are represented by two different types: *a* and *b.* Type *a* sensilla are very thin and not split apically (Fig. 5: a); type *b* sensilla (Fig. 5: b) are very similar to those on the apex of a.a. XIV. Specialized sensilla on dorsal side restricted to a middle and external latero-apical areas and represented by three different types: *a* and *b* similar to *a* and *b* of ventral side (Fig. 11: a, b), type *c* sensilla similar in shape to type *b*, a little larger, not divided apically and slightly darker (pale brownish–ochreous in color) (Fig. 11: c). Number and distribution of specialized sensilla on ventral and dorsal sides of a.a. II, V, IX and XIII, as in Table 2.

TABLE 2. Number of type *a, b and c* sensilla on antennal articles II, V, IX and XIII in the male holotype of *Ribautia paranaensis* **sp. nov**.

	ventral		dorsal			Figs.
	a	b	a	b	c	
II	-	1	1	-	-	4, 8
V	1	1	1	-	-	5, 9
IX	1	1	1	2	-	6, 10
XIII	1	1	1	2	1	7, 11

Cephalic plate. Distinctly longer than wide (length/width ratio *ca.* 1.48: 1). Lateral margins slightly convergent posteriorly, anteriorly with a very small inconspicuous concavity (Figs. 12, 13: a). Anterior margin slightly concave on the middle; posterior margin straight. Shape and chaetotaxy as in Fig. 12.

Clypeus With four setae located on the clypeal area; 1+1 anterior-lateral setae, posterior to the latter; and two central setae (Fig. 13). Clypeal area with very densely areolated surface (Figs. 14, 15).

Labrum. Mid-piece well developed and pigmented, with 8 sharp-pointed teeth. Side pieces with 13+12 filaments of different size (Fig. 16).

Mandible. Pectinate lamella with *ca.* 10 hyaline teeth.

First maxillae. Coxosternite and telopodites with very small lappets (Figs. 17, 18: a, b). Coxosternite devoid of setae; coxal projections subtriangular, round-tipped and provided with 4+4 setae (Fig. 19). Article II of telopodites with 2+2 large setae on ventral side (Fig. 19), and 1+1 small sensilla on dorsal side near the external edge (Figs. 17, 18: c).

Second maxillae. Coxites medially joined through a narrow, hyaline and non-areolate membranous isthmus and provided with 4+4 setae near the internal margin (Fig. 19). Process of ventral antero-internal corners of coxosternites with shape and relative size as in Figs. 19–21: a. Telopodites with setae of different thickness; articles without a distoectal process (Figs. 19, 22); apical claw of telopodite well developed, tip curved inwards (Figs. 19, 22–25). Chaetotaxy of coxosternites and telopodites as in Figs. 19, 22.

Forcipular segment. When closed, the telopodites project slightly beyond the anterior margin of the head. Forcipular tergite trapeziform; chaetotaxy represented by an irregular transverse row of *ca*. 10 setae of different lengths near the posterior margin and a few smaller setae distributed as in Fig. 12. Coxosternite with incomplete chitin-lines (Fig. 26: a); middle part of anterior border bearing 1+1 small unpigmented denticles devoid of setae, aspect and relative size as in Figs. 26–28. Telopodites: medial edge of trochanteroprefemur apically with a small slightly pigmented round-tipped tooth; proximally near the vestigial suture between trochanter and prefemur with a rudimentary unpigmented round-pointed projection (Figs. 26, 27, 29). Femur and tibia without denticles. Tarsungulum basally with a well-developed and slightly pigmented subtriangular denticle (Figs. 26, 29, 30); medial ventral edge of tarsungulum slightly serrate (Figs. 26, 29, 30). Relative size of poison glands as in Figure 29, calyx of poison gland palm-shaped (Figs. 30, 31: a). Chaetotaxy of coxosternite and telopodites as in Figs. 12, 26.

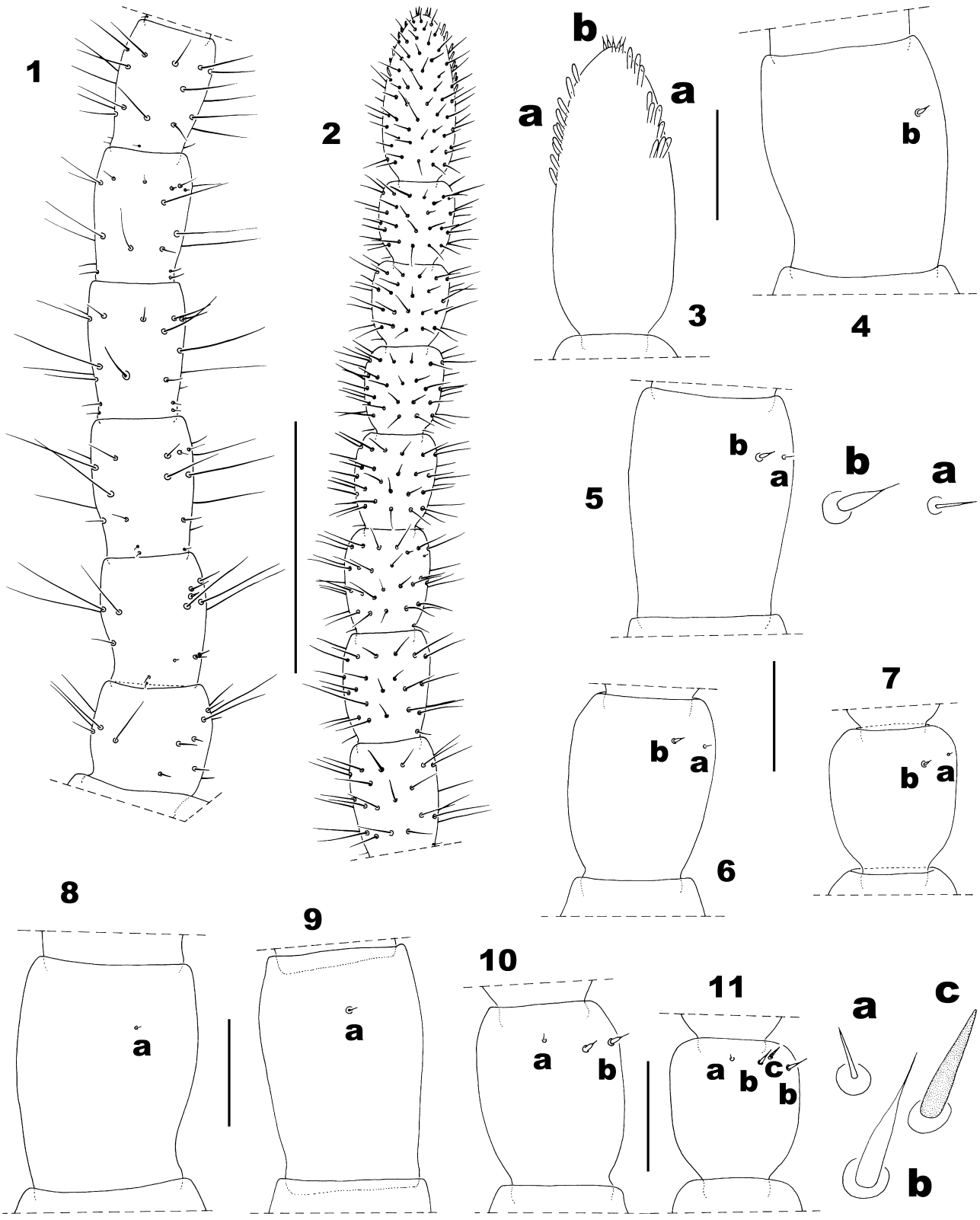
Sternites of leg-bearing segments 1 to penultimate. Pore-fields present on sternite 2–15, 18, 20–23, 25, 26, 28–31, and 33–40 (penultimate); totally absent on sternites 1, 16, 17, 19, 24, 27 and 32. Sternites 2–12 (Figs. 33–43) and 36–40 (Figs. 46–50) with distinct undivided pore-fields; sternite 13 (Fig. 44) with a few central pores; sternites 14, 15 with a single central pore; sternites 22, 25, 28, 33, 34, 35 (Fig. 45) with a few pores distributed in two subsymmetrical areas; sternites 18, 20, 21, 26, with a few pores on the right side only. Pore-fields conspicuously subovoidal in longitudinal sense on sternites 2–12 (Figs. 33–43), subcircular in shape on sternite 36 (Fig. 46), subtriangular and remarkably large on sternites 37–40 (Figs. 47–50). Number of pores as follows: sternite 2 (35); 3 (66); 4 (64); 5 (75); 6 (73); 7 (69); 8 (76); 9 (63); 10 (60); 11 (44); 12 (32); 13 (4); 14 (1); 15 (1); 18 (1+0); 20 (1+0); 21 (1+0); 22 (1+1); 23 (2+1); 25 (1+1); 26 (1+0); 28 (1+2); 29 (1+0); 30 (2+0); 31 (1+0); 33 (2+2); 34 (1+1); 35 (3+2); 36 (63); 37 (114); 38 (142); 39 (165); 40 (140).

Legs (pair 1 to penultimate). First pair shorter than the second (ratio *ca*. 0.85: 1). Legs of pairs 1 to 10–11 with setae of different thickness, which is more evident on pairs 1 to 5 (Figs. 51, 52) than in pairs 6 to 10–11 (Figs. 53, 54), legs of remaining pairs bearing setae of similar thickness (Figs. 55–57). Distribution, number and relative size of setae as in Figs. 51–57. Claws with two thin small and pale accessory spines ventrobasally, one anterior and one posterior, of similar size (Figs. 58–60: a, b).

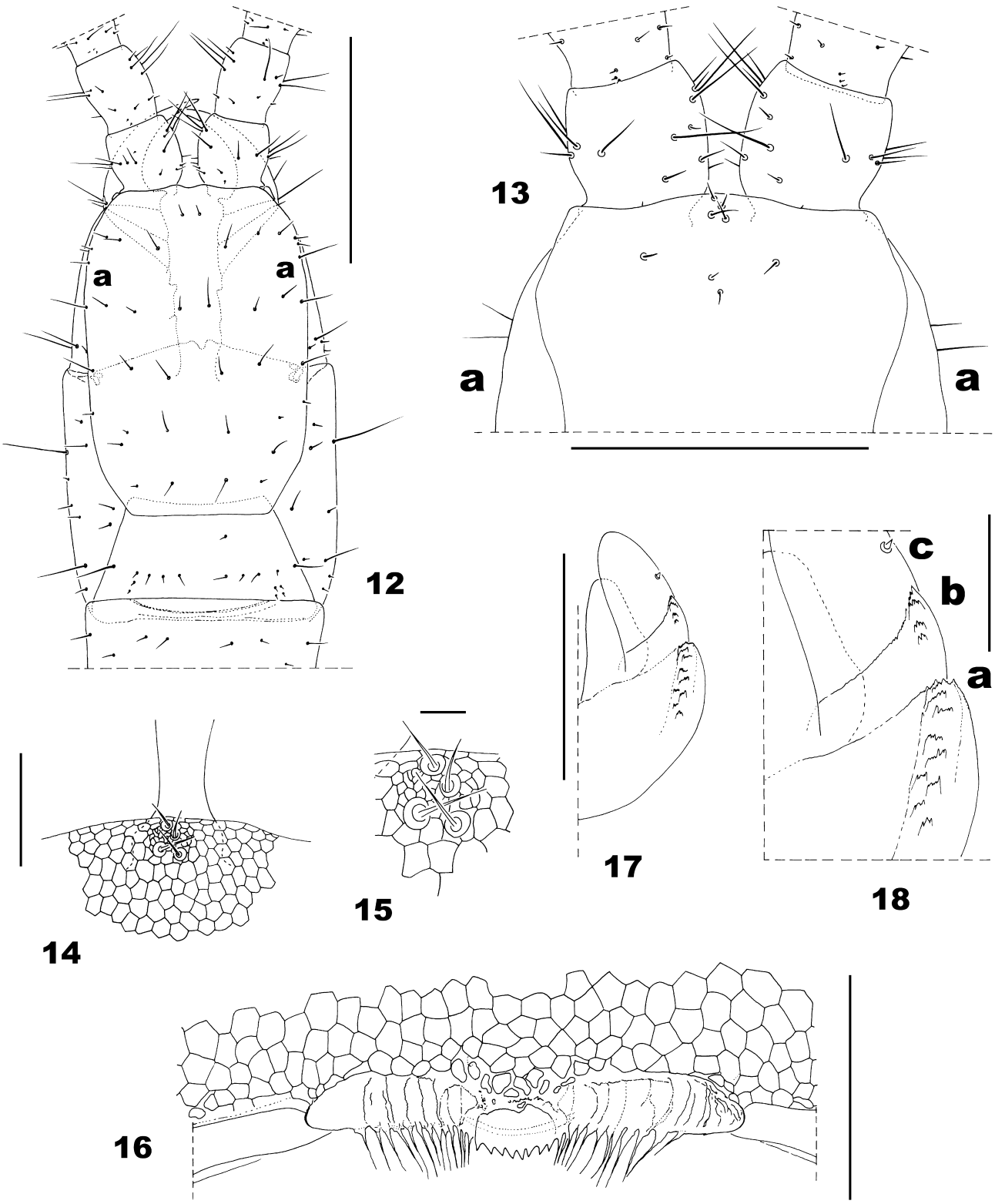
Ultimate leg-bearing segment. Intercalary pleurites absent at both sides of the ultimate pretergite (Fig. 61); ultimate presternite divided along the sagittal plane (Fig. 62). Length/width ratio of tergite, *ca*. 0.71: 1; length/width ratio of sternite, *ca*. 0.70: 1. Shape and chaetotaxy of tergite and sternite as in Figs. 61, 62. Coxopleura very slightly protruding at their distal-internal ventral ends, setae small and numerous on the internal ventral area, the remaining coxopleural surface with very few larger setae (Figs. 61, 62). Each coxopleuron with all coxal organs grouped in a cluster opening in the membrane between coxopleuron and sternite, partially or totally covered by the latter (Figs. 62–64). Each cluster with 5 organs arranged as in Figs. 63, 64. Ultimate legs moderately inflated, composed of seven articles. Ratio of length of telopodites of ultimate legs/length of sternite *ca*. 4.61: 1. Shape and chaetotaxy of ultimate legs as in Figs. 61, 62. Ultimate pretarsus unguiform, relatively smaller than those of the preceding legs, bearing a single internal spine ventrobasally (Fig. 65: a).

Postpedal segments. Intermediate tergite with posterior margin convex (Fig. 61), intermediate sternite with posterior margin slightly concave (Fig. 62). Posterior margin of first genital sternite concave in the middle and at the level of gonopods (Fig. 62). Gonopods apparently uniarticulate (suture between the presumptive basal and distal articles not evident), bearing *ca*. 8–9 setae (Figs. 62, 66); penis dorsally with 1+1 apical setae (Fig. 67). Anal organs absent.

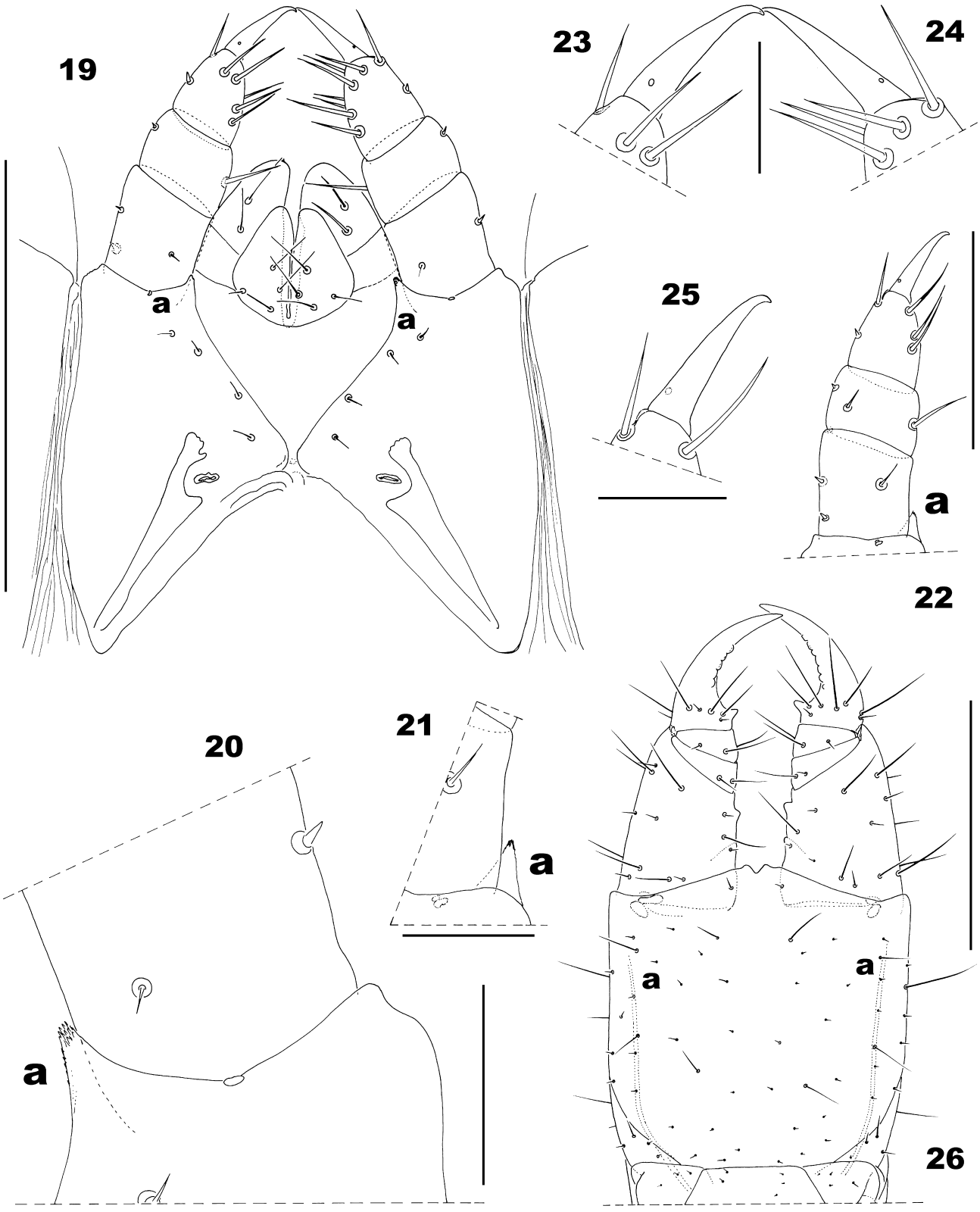
Female (paratype A). Forty-one leg-bearing segments, body length 10 mm, maximum body width 0.36 mm. Features similar to those in the male except for the shape and pilosity of the ultimate leg-bearing segment and postpedal segments.



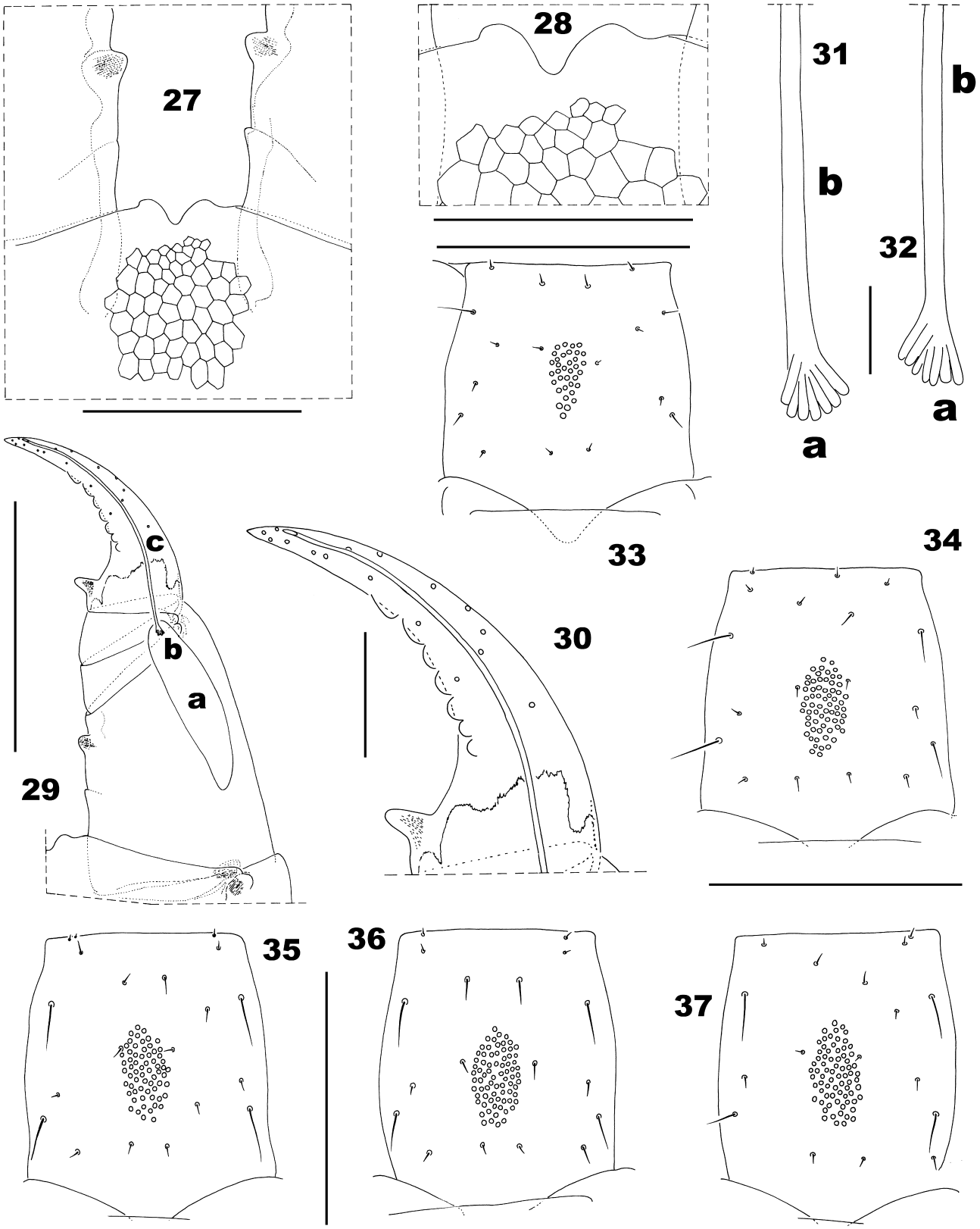
FIGURES 1–11. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (1) Right a.a. I–VI, ventral. (2) Right a.a. VII–XIV, ventral. (3) Right a.a. XIV, dorsal (a: claviform sensilla, b: apical specialized sensilla). (4) Right a.a. II, ventral (b: *b* type sensilla). (5) Right a.a. V, ventral (a, b: *a, b* type sensilla). (6) Right a.a. IX, ventral (a, b: *a, b* type sensilla). (7) Right a.a. XIII, ventral (a, b: *a, b* type sensilla). (8) Right a.a. II, dorsal (a: *a* type sensilla). (9) Right a.a. V, dorsal (a: *a* type sensilla). (10) Right a.a. IX, dorsal (a, b: *a, b* type sensilla). (11) Right a.a. XIII, dorsal (a, b, c: *a, b, c* type sensilla). Scale bars: 0.05 mm (3–11); 0.2 mm (1, 2).



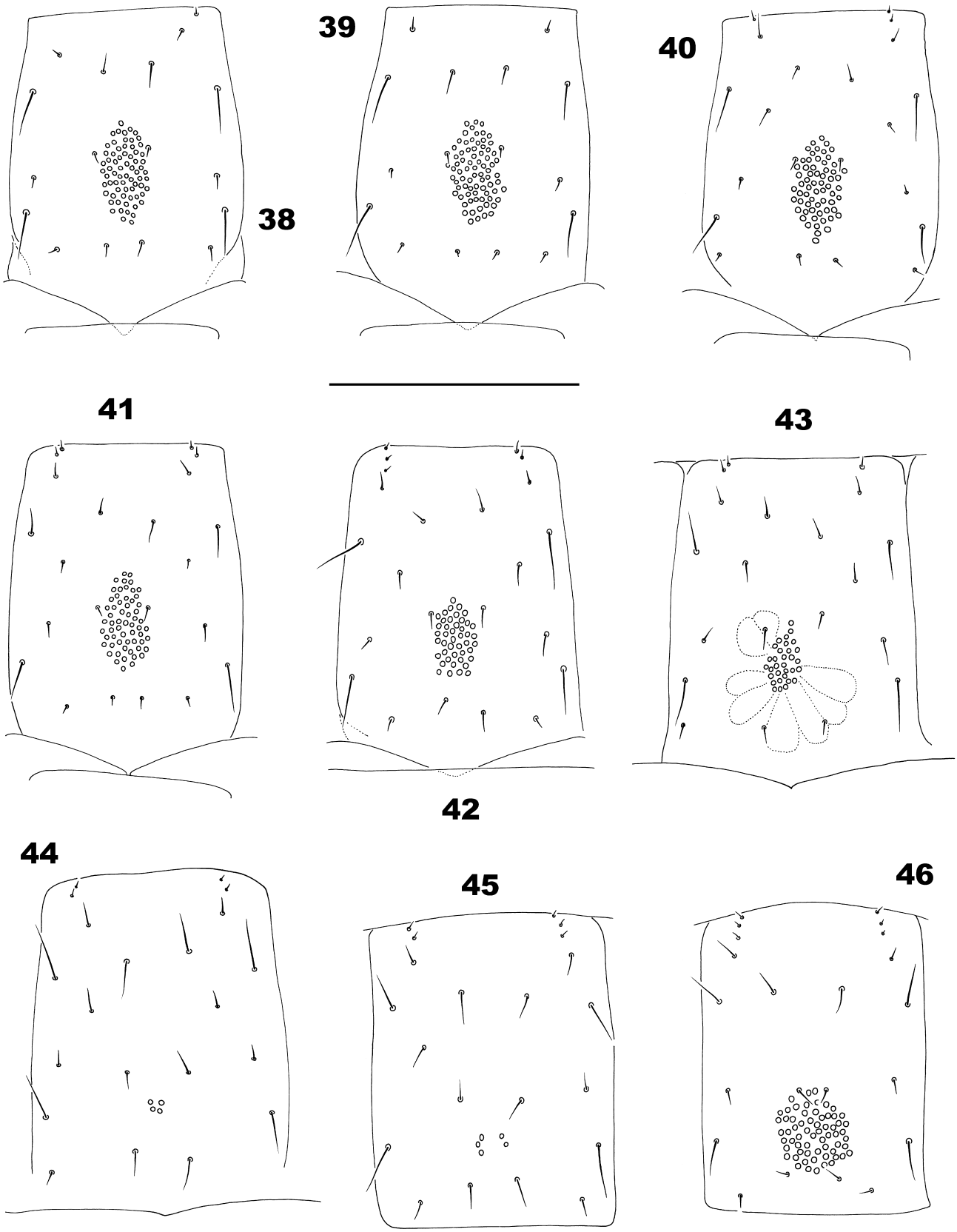
FIGURES 12–18. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (12) Dorsal view of anterior region of the body, showing cephalic plate, bases of antennae, forcipular segment, and anterior portion of leg-bearing segment 1 (a: vestigial concavity on lateral margins of cephalic plate). (13) Clypeus and bases of antennae (a: vestigial concavity on lateral margins of cephalic plate). (14) Anterior central part of clypeus showing clypeal area. (15) Detail of clypeal area. (16) Labrum. (17) Right side of first maxillae, dorsal. (18) Detail of lappets in right side of first maxillae, dorsal (a: lappet of coxosternite, b: lappet of telopodite, c: sensilla of telopodite). Scale bars: 0.01 mm (15); 0.03 mm (18); 0.05 mm (14, 16); 0.1 mm (17); 0.2 mm (13); 0.3 mm (12).



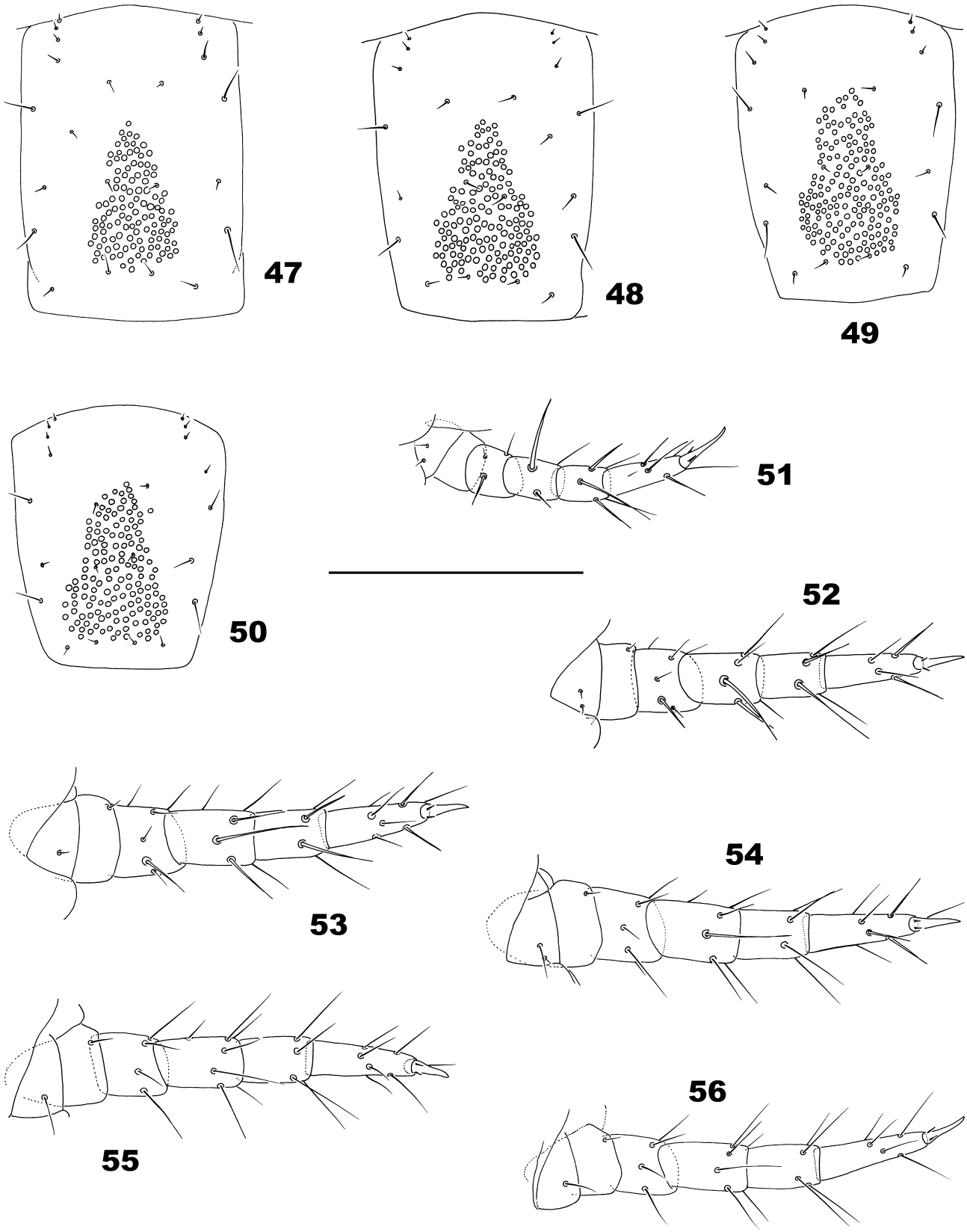
FIGURES 19–26. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (19) First and second maxillae, ventral (a: process of antero-internal corners of coxosternite). (20) Detail of process in antero-internal corner of coxosternite, left side of second maxillae, ventral (a: process of coxosternite). (21) Detail of process in antero-internal corner of coxosternite, left side of second maxillae, dorsal (a: process of coxosternite). (22) Left telopodite of second maxillae, dorsal (a: process of coxosternite). (23) Claw of right telopodite of second maxillae, ventral. (24) Claw of left telopodite of second maxillae, ventral. (25) Claw of left telopodite of second maxillae, dorsal. (26) Forcipular segment, ventral (a: Scale bars: 0.03 mm (20, 21, 23–25), 0.1 mm (22), 0.2 mm (19), 0.3 mm (26).



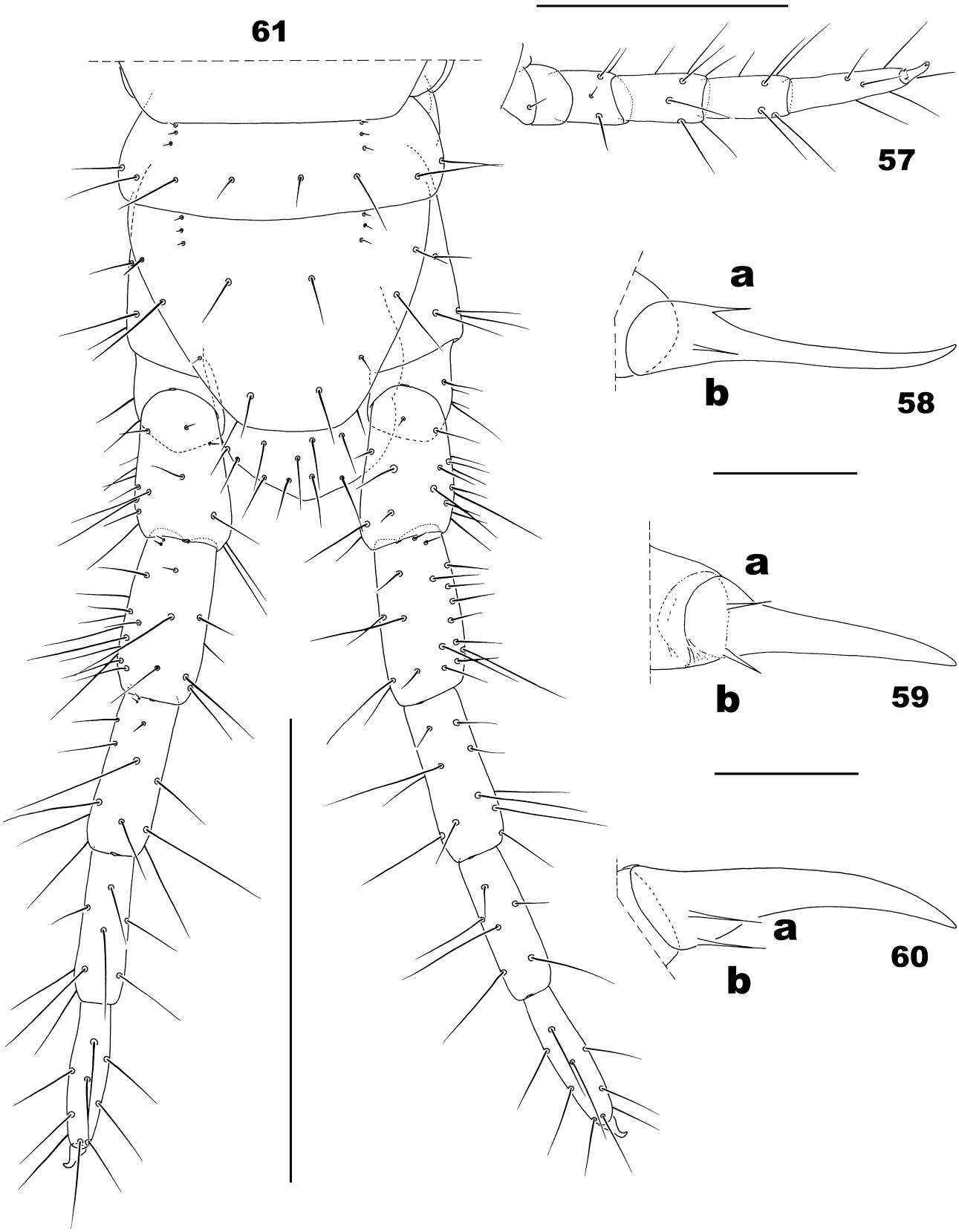
FIGURES 27–37. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (27) Middle part of anterior border of forcipular coxosternite showing unpigmented denticles, ventral. (28) Detail of unpigmented denticles on middle part of anterior border of forcipular coxosternite. (29) Detail of poison gland (a), calyx (b), and duct (c) of venom apparatus in left forcipular telopodite, ventral. (30) Detail of left forcipular tarsungulum, showing medial ventral edge slightly serrate. (31) Detail of calyx of poison gland in left forcipular telopodite, ventral (a: calyx, b: duct). (32) Detail of calyx of poison gland in right forcipular telopodite, ventral (a: calyx, b: duct). (33) Sternite 2. (34) Sternite 3. (35) Sternite 4. (36) Sternite 5. (37) Sternite 6. Scale bars: 0.01 mm (31, 32); 0.05 mm (30); 0.06 mm (28); 0.1 mm (27); 0.2 mm (29, 33–37).



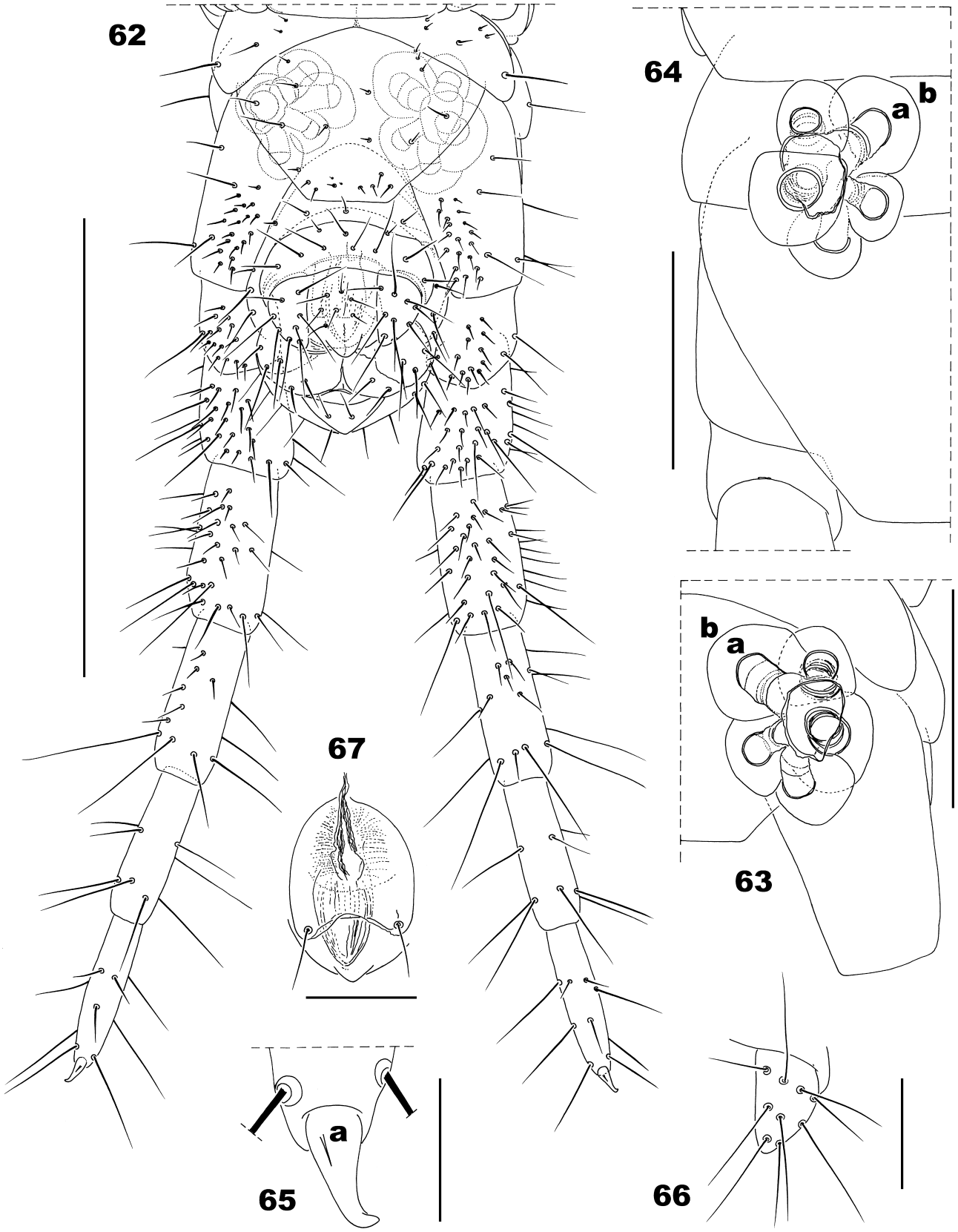
FIGURES 38–46. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (38) Sternite 7. (39) Sternite 8. (40) Sternite 9. (41) Sternite 10. (42) Sternite 11. (43) Sternite 12. (44) Sternite 13. (45) Sternite 35. (46) Sternite 36. Scale bar: 0.2 mm.



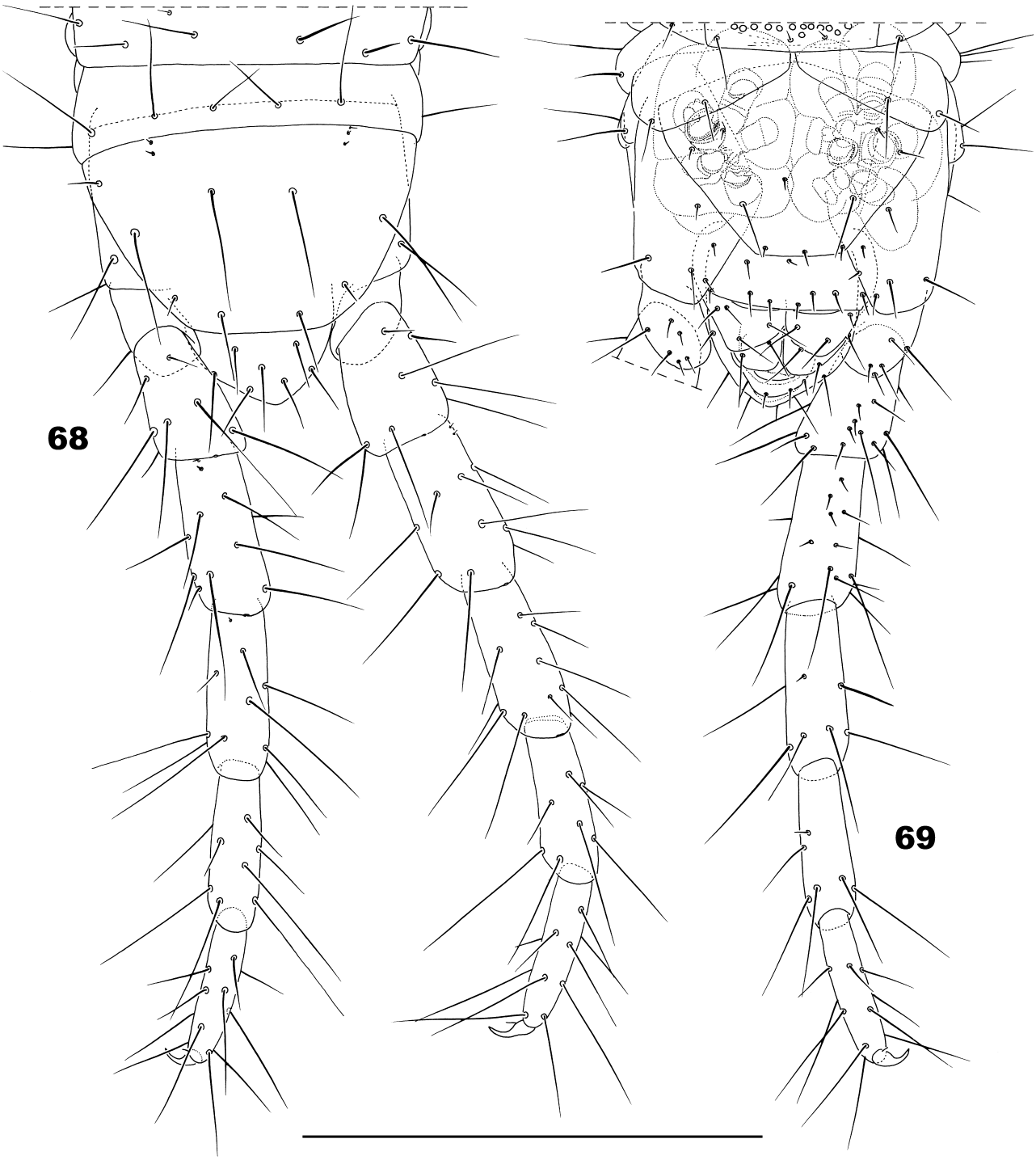
FIGURES 47–56. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (47) Sternite 37. (48) Sternite 38. (49) Sternite 39. (50) Sternite 40. (51) Left leg (pair 1), ventral. (52) Left leg (pair 2), ventral. (53) Left leg (pair 6), ventral. (54) Left leg (pair 10), ventral. (55) Left leg (pair 14), ventral. (56) Left leg (pair 30), ventral. Scale bar: 0.2 mm.



FIGURES 57–61. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (57) Left leg (pair 40), ventral. (58) Claw of the left leg (pair 1), posterior-ventral view (a: anterior spine, b: posterior spine). (59) Claw of the left leg (pair 2), ventral view (a: anterior spine, b: posterior spine). (60) Claw of the left leg (pair 20), anterior-ventral view (a: anterior spine, b: posterior spine). (61) Ultimate leg-bearing segment and postpedal segments, dorsal. Scale bars: 0.02 mm (58–60); 0.2 mm (57); 0.3 mm (61).

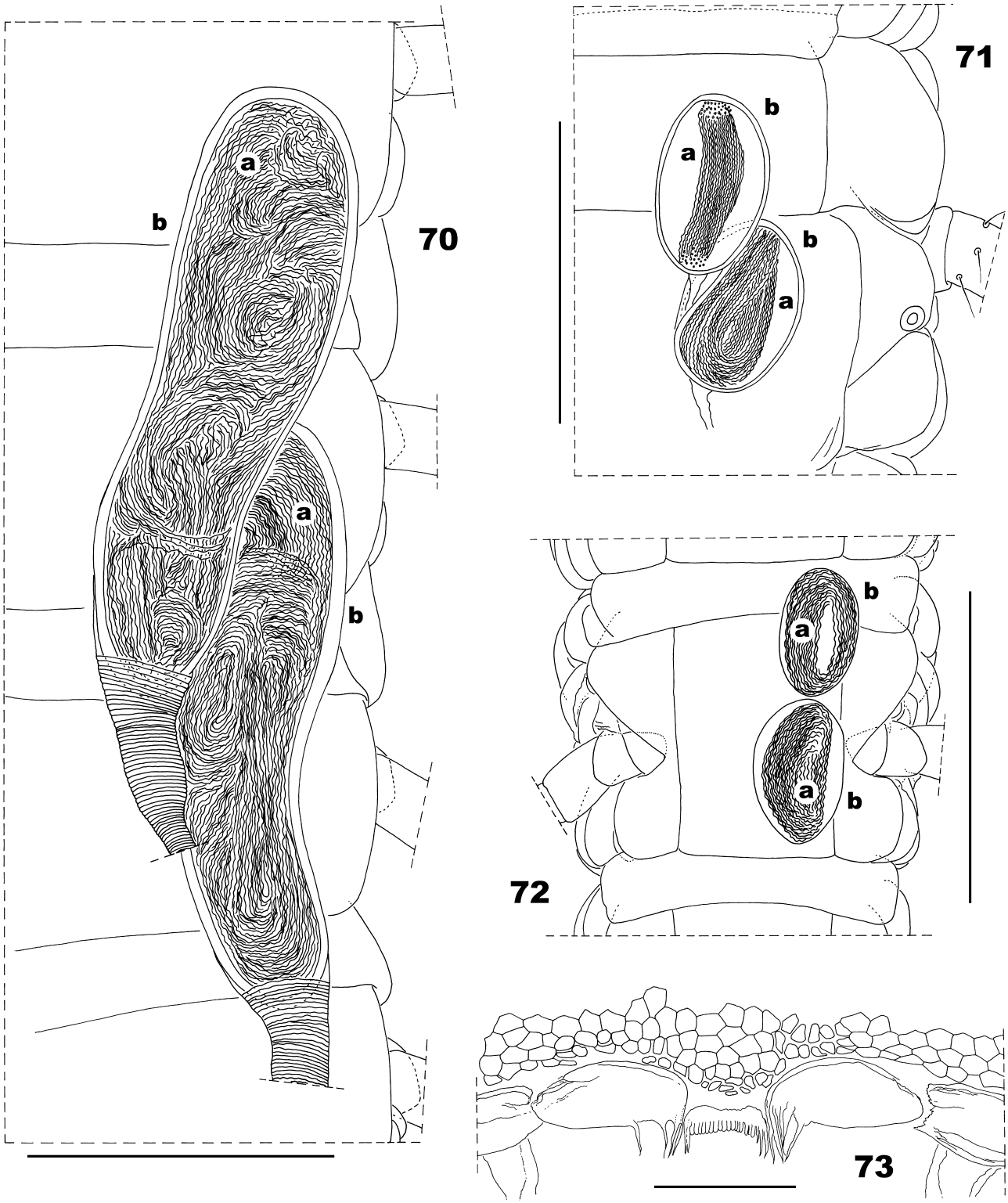


FIGURES 62–67. *Ribautia paranaensis* **sp. nov.** (male holotype; ARGENTINA: Misiones Province: Puerto Iguazú): (62) Ultimate leg-bearing segment and postpedal segments, ventral. (63) Left cluster of coxal organs, ventral (a: mucous layer, b: outline of lobe). (64) Left cluster of coxal organs, dorsal (a: mucous layer, b: outline of lobe). (65) Claw of left ultimate leg, ventral (a: single internal spine). (66) Left gonopod, ventral. (67) Penis, dorsal. Scale bars: 0.02 mm (65); 0.05 mm (66, 67); 0.1 mm (63, 64); 0.3 mm (62).



FIGURES 68–69. *Ribautia paranaensis* **sp. nov**. (female paratype (A); ARGENTINA: Misiones Province: Puerto Iguazú): (68) Ultimate leg-bearing segment and postpedal segments, dorsal. (69) Ultimate leg-bearing segment and postpedal segments, ventral. Scale bar: 0.3 mm.

Ultimate leg-bearing segment. Tergite and sternite trapezoidal, length/width ratio of tergite, *ca*. 0.74: 1; length/width ratio of sternite, *ca.* 0.70: 1. Shape and chaetotaxy of tergite and sternite as in Figs. 68, 69. Coxopleura very slightly protruding at their distal-internal ventral ends, chaetotaxy represented by very few setae of different lengths distributed as in Figs. 68, 69. Left cluster of coxal organs with 6 organs, right cluster with 5 organs (Fig. 69). Articles of ultimate legs not inflated, trochanter, pre-femur, femur and tibia comparatively thinner than those of the male. Ultimate legs proportionally as long as those of the male, shape and chaetotaxy as in Figs. 68, 69.



FIGURES 70–73. (70). *Ribautia paranaensis* **sp. nov**. (female paratype (C); ARGENTINA: Misiones Province: Puerto Iguazú): Anterior and posterior spermathecae at level of leg-bearing segments 39–42, dorsal (a: spermatozoa, b: outline of spermatheca). (71). *Ityphilus bonatoi* Pereira, 2013 (female holotype; BRAZIL: RJ: Ilha Grande): Anterior and posterior spermathecae at level of leg-bearing segment 38, dorsal (a: spermatozoa, b: outline of spermathecae) (from Pereira, 2013d). (72). *Schendylops ramirezi* Pereira, 2013 (female holotype; BRAZIL: RJ: Ilha Grande): Anterior and posterior spermathecae at level of leg-bearing segment 25, ventral (a: spermatozoa, b: outline of spermathecae) (from Pereira, 2013c). (73). *Ribautia combinata* Pereira, Uliana & Minelli, 2006 (female holotype; PERU: Loreto: Allpahuayo, *ca*. 30 Km S Iquitos): Labrum (from Pereira *et al*., 2006). Scale bars: 0.05 mm (73); 0.2 mm (70–72).

Postpedal segments. Intermediate tergite with posterior margin strongly convex (Fig. 68), intermediate sternite seemingly covered by the sternite of the ultimate leg-bearing segment, posterior border of first genital sternite very slightly convex (Fig. 69). Gonopods uniarticulate, very poorly developed, vestigial (Fig. 69).

Remarks. The adult condition of all type specimens is indicated by mature spermatozoa in the tubula seminifera of the males and spermatozoa in the spermathecae of the females (Fig. 70).

All specimens examined without anal organs.

Etymology. This species is named after the "selva paranaense" (*i.e.*, Upper Paraná Atlantic Forest), ecoregion of the Atlantic Forest biome in which the type material was collected.

Ecology. The specimens were found in the soil (at a depth of about 10–30 cm) in a subtropical semi-deciduous seasonal forest environment, located close to the confluence of the Iguazú and Paraná rivers in the north-westernmost area of Misiones Province (adjacent to Brazil and Paraguay), Northeastern region of Argentina.

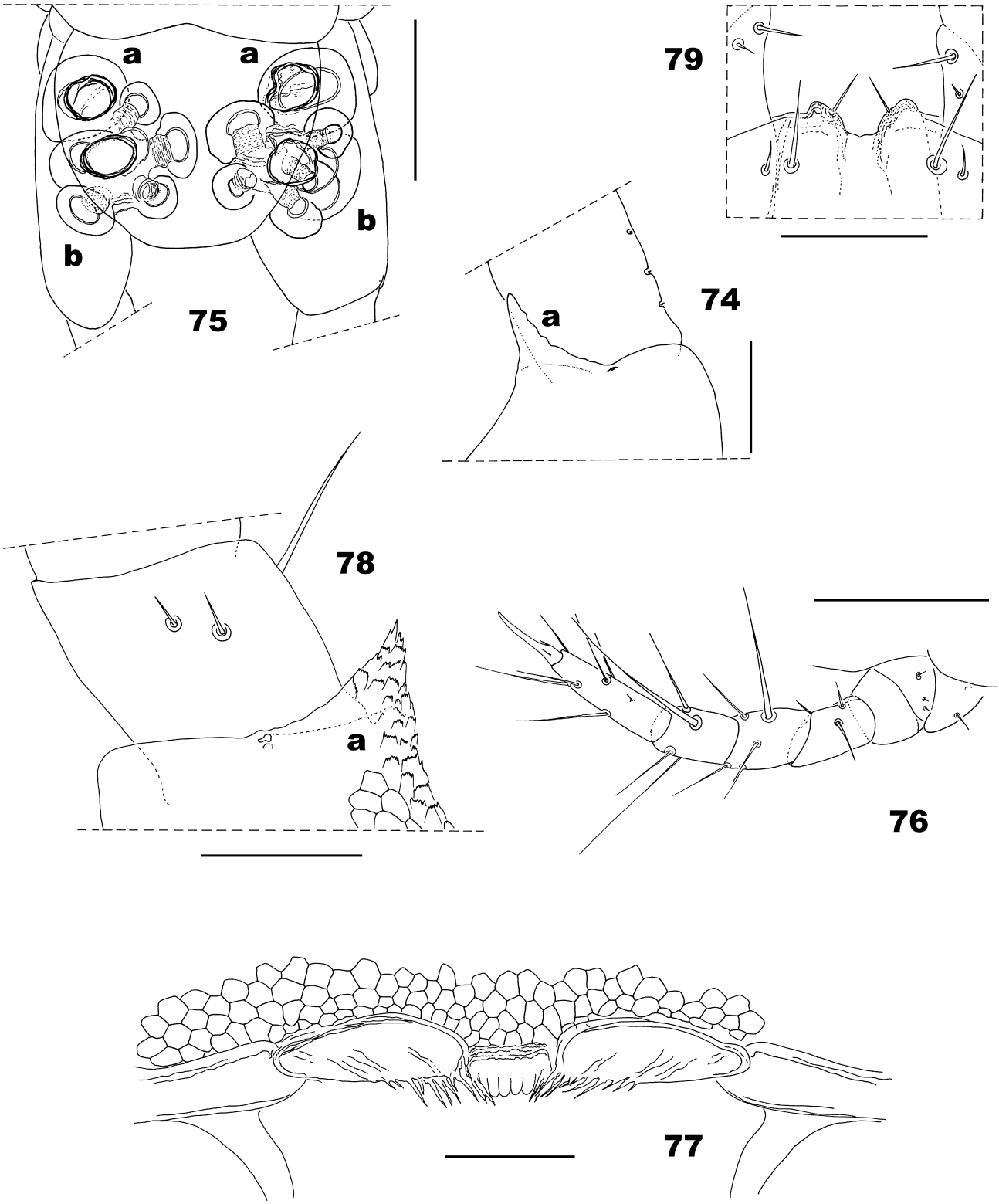
Type locality. ARGENTINA: Misiones Province: Puerto Iguazú.

Known range. Only known from the type locality.

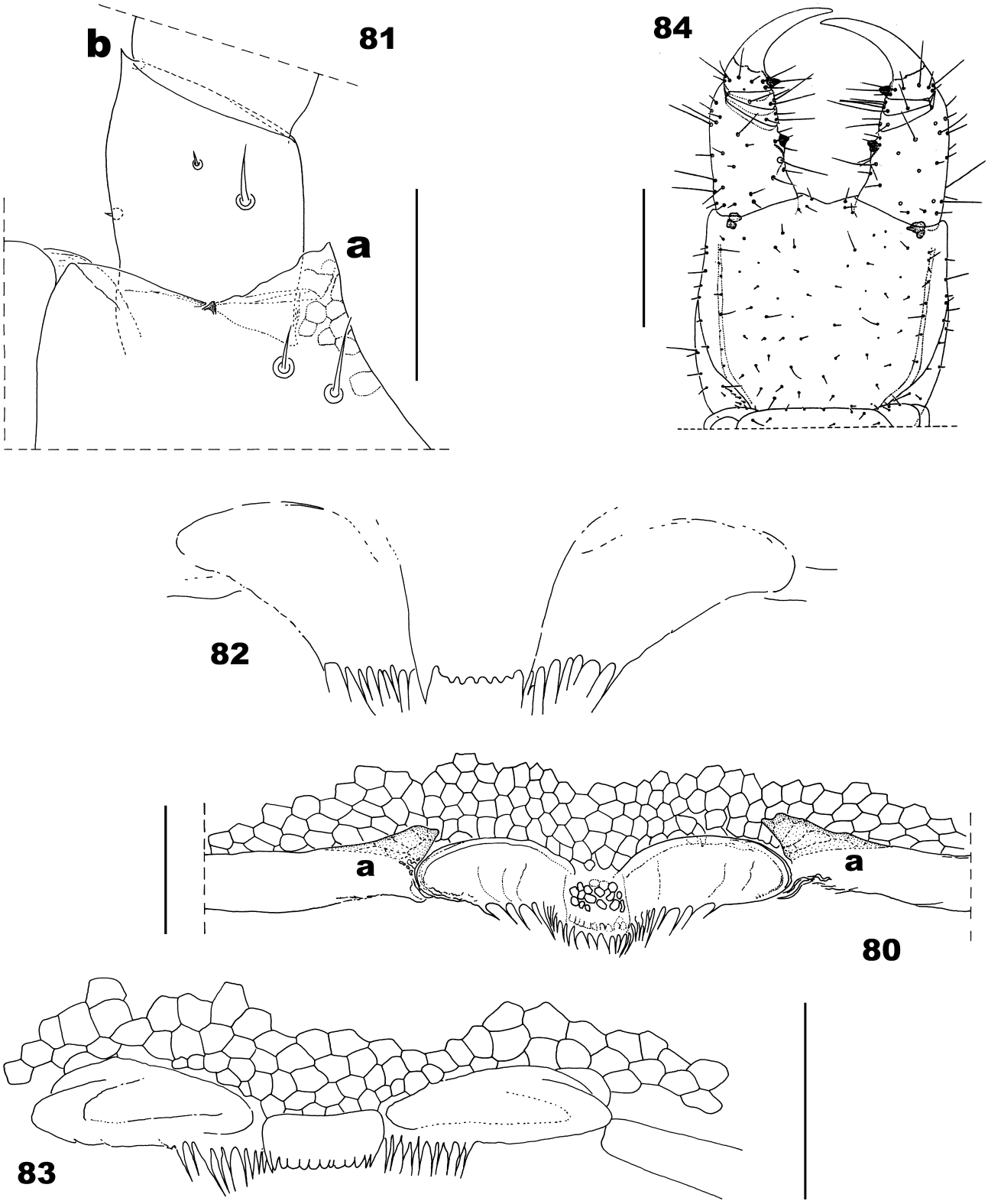
Neotropical members of *Ribautia* morphologically similar to *R. paranaensis* sp. nov. In the differential diagnosis above, the new species has been compared in detail with *R. combinata* Pereira, Uliana & Minelli, 2006 (from the Amazonian rainforest of Peru), *R. jakulicai* Pereira, 2007 (from the Yungas rainforest of Northwestern Argentina), and *R. lewisi* Pereira, 2013 (collected in a gallery forest in the Mesopotamian region, Northeastern Argentina). As *R. paranaensis* **sp. nov**., all of them are distributed East of the Andes, and share with it a claw-like pretarsus in the ultimate legs and the presence of a cluster of coxal organs in each coxopleuron of the ultimate leg-bearing segment. The other two Neotropical members provided with 1+1 clusters of coxal organs, *i.e*., *R. limaensis* Kraus, 1957 and *R. silvana* Kraus, 1954, occur West of the Andean chain, in Peru, and have a tubercle-like rather than a claw-like ultimate pretarsus. The new species can be also confidently differentiated from these two species by means of the following additional selected traits (the corresponding features for *R. paranaensis* are given in parentheses); see also Table 3.

TABLE 3. Differential characters of *Ribautia paranaensis* **sp. nov**., *R. limaensis* Kraus, 1957 and *R. silvana* Kraus, 1954 (characters of *R. limaensis* after the original description, those of *R. silvana* after the original description and redescription by Pereira *et al*., 1995).

	R. paranaensis	*R. limaensis*	*R. silvana*
Number of leg-bearing segments	♀: 41, 43 ♂: 41, 43	♂: 55	♂: 49
Body length	12 mm (♀ and ♂)	25 mm (♂)	14 mm (♂)
Shape of labrum	as in Fig. 16	as in Fig. 82	as in Fig. 83
Lappets of telopodites of first maxillae	present, very small (Figs. 17, 18)	absent	absent
Anterior border of forcipular coxosternite	with two small unpigmented denticles devoid of setae (Figs. 26–28)	with two very small protuberances ("zwei sehr undeutliche und hyaline Höcker")	completely unarmed (Fig. 84)
Apical medial edge of forcipular trochanteroprefemur	with a small slightly pigmented tooth (relative size as in Figs. 26, 27, 29)	with a small unpigmented protuberance	with a well-developed and deeply pigmented tooth (Fig. 84)
All pore-fields undivided	no, some of them divided in two areas	yes	yes
Anterior legs with setae of different thickness	yes (Figs. 51, 52)	?	no
Shape of pretarsus of ultimate legs	claw-like	tubercle-like	tubercle-like
Anal organs	absent	?	present



FIGURES 74–79. (74–76). *Ribautia combinata* Pereira, Uliana & Minelli, 2006 (female holotype; PERU: Loreto: Allpahuayo, *ca*. 30 Km S Iquitos): (74) Detail of process in antero-internal corner of coxosternite, left side of second maxillae, ventral (a: process of coxosternite). (75) Coxal organs, ventral (a: independent opening organ, b: cluster of organs). (76) Right leg (pair 1), postero-ventral view (from Pereira *et al*., 2006). (77–79). *Ribautia jakulicai* Pereira, 2007 (male holotype; ARGENTINA: Salta: Orán: *ca*. 25 Km northwest of Aguas Blancas): (77) Labrum. (78) Detail of process in antero-internal corner of coxosternite, right side of second maxillae, ventral (a: process of coxosternite). (79) Detail of denticles on middle part of anterior border of forcipular coxosternite (modified from Pereira, 2007). Scale bars: 0.05 mm (74, 77, 78); 0.1 mm (75, 76, 79).



FIGURES 80–84. (80). *Ribautia lewisi* Pereira, 2013 (female paratype (M); ARGENTINA: Entre Ríos Province: Concordia Department): Labrum (a: sclerotized process on internal limb of tentorium) (from Pereira, 2013b). (81). *Ribautia lewisi* Pereira, 2013 (male holotype; ARGENTINA: Entre Ríos Province: Concordia Department): Detail of process in antero-internal corner of coxosternite, right side of second maxillae, ventral (a: process of coxosternite, b: distoectal process of telopodite) (from Pereira, 2013b). (82). *Ribautia limaensis* Kraus, 1957 (male holotype; PERU: Lomas de Atocongo): Labrum (from Kraus, 1957). (83–84). *Ribautia silvana* Kraus, 1954 (male holotype; PERU: Hacienda Monteseco (6°50'S 79°10´W)): (83) Labrum. (84) Forcipular segment, ventral (from Pereira *et al*., 1995). Scale bars: 0.05 mm (80, 81, 83); 0.3 mm (84); no scale available for 82.

R. limaensis: male with 55 leg-bearing segments; body length of male 25 mm; telopodites of first maxillae without lappets; all pore-fields undivided. (*R. paranaensis:* male and female with 41 or 43 leg-bearing segments; body length of male and female 12 mm; telopodites of first maxillae with lappets; some pore-fields of mid-body divided in two areas).

R. silvana: male with 49 leg-bearing segments; telopodites of first maxillae without lappets; anterior border of forcipular coxosternite completely unarmed (Fig. 84); apical medial edge of forcipular trochanteroprefemur with a well developed and deeply pigmented tooth (Fig. 84); all pore-fields undivided; anal organs present. (*R. paranaensis*: male and female with 41 or 43 leg-bearing segments; telopodites of first maxillae with lappets; anterior border of forcipular coxosternite with two small unpigmented denticles devoid of setae (Figs. 26–28); apical medial edge of forcipular trochanteroprefemur with a small slightly pigmented tooth (Figs. 26, 27, 29); some pore-fields of mid-body divided in two areas; anal organs absent).

Discussion

The geophilomorph genera, *Pectiniunguis* Bollman, 1889, *Schendylops* Cook, 1899 (Schendylidae), and *Orphnaeus* Meinert, 1870 (Oryidae) are currently recorded from both, the coastal forest (or Atlantic Rainforest *sensu stricto*) and the Upper Paraná Atlantic Forest; *Ityphilus* Cook, 1899 (Ballophilidae), *Mecistocephalus* Newport, 1843 (Mecistocephalidae), and *Sogona* Chamberlin, 1912 (Geophilidae) are only reported from the first area; *Aphilodon* Silvestri, 1909, *Mecophilus* Silvestri, 1909 (Aphilodontidae), and *Ballophilus* Cook, 1896 (Ballophilidae) only from the second. Of the mentioned nine genera, *Mecophilus* is the only genus not reported outside the Atlantic Forest, to which it is possibly endemic. The discovery of the new species described herein represents the first record of the genus *Ribautia* in the entire Atlantic Forest biome complex (Fig. 85).

FIGURE 85. Type locality of *Ribautia paranaensis* **sp. nov.**, in the Upper Paraná Atlantic Forest ecoregion ("selva paranaense") of the Atlantic Forest complex.

R. paranaensis **sp. nov**. (distributed in the Paranaense biogeographical province) is only the third confirmed report of *Ribautia* from Argentina, the others correspond to *R. jakulicai* from Northwestern region, collected in a

rain forest environment (Yungas biogeographical province) and *R. lewisi* from Northeastern region, collected in a gallery forest in the Mesopotamia (within the Pampean biogegraphical province). A further very poorly known nominal species from this country, originally described by Filippo Silvestri in the genus *Orinophilus* Cook, 1896 (*i.e.*, *O. platensis* Silvestri, 1898, from Buenos Aires Province), could possibly belong to *Ribautia*, but no definite generic allocation is possible without the examination of the type material (Foddai *et al*. 2000; Pereira 2007, 2013b).

As is the case for *Ribautia paranaensis* **sp. nov.** (with 12 mm body length), a few other Neotropical species of *Ribautia* have a similar small body size: *R. combinata* Pereira, Uliana & Minelli 2006 (9 mm long); *R. onychophaena* Pereira, Foddai & Minelli, 2000 (13 mm long); *R. ducalis* Pereira, Minelli & Barbieri, 1995; *R. tropica* (Brölemann, 1898); and *R. silvana* Kraus, 1954 (all 14 mm long). Several other occurrences of species with reduced body size are known for the Geophilomorpha; besides the Geophilidae, this is known to occur in some genera of the Aphilodontidae, Ballophilidae, Linotaeniidae, Macronocophilidae, Mecistocephalidae, and Schendylidae (see Foddai & Minelli 1999; Foddai *et al.* 2003; Minelli 2003; Minelli *et al.* 2000; Pereira 2009, 2011, 2012, 2013a, 2013c, 2013d; Pereira *et al*. 2000; Uliana *et al*. 2007).

The spermathecae of *R. paranaensis* **sp. nov**. are conspicuously elongated (Fig. 70), while those of two other miniature geophilomorph species, *e.g. Ityphilus bonatoi* Pereira, 2013 (Ballophilidae) (Fig. 71) and *Schendylops ramirezi* Pereira, 2013 (Schendylidae) (Fig. 72), are subovoidal in shape and proportionally much smaller. Relative accumulation of spermatozoa and their arrangement are also different in *R. paranaensis* (Fig. 70) in respect to *I. bonatoi* (Fig. 71) and *S. ramirezi* (Fig. 72). Possible significance of these aspects in sperm transfer and fertilization process remains to be investigated.

Acknowledgements

Alessandro Minelli (University of Padova) and an anonymous referee contributed with accurate reviews to improve the final version of the manuscript. Hernán Lucas Pereira and José Luis Pereira (La Plata) helped digitizing and editing the original figures.

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