

Two new species of *Proisotoma* Börner, 1901 from Southeastern Brazil (Collembola: Isotomidae)

Maria Cleide de Mendonça*, Gabriel Costa Queiroz and Tatiana Cristina da Silveira

Departamento de Entomologia, Museu Nacional, Universidade Federal do Rio de Janeiro. Quinta da Boa Vista s/n, São Cristóvão, 20940-040, Rio de Janeiro, RJ, Brasil

* Corresponding author, e-mail: cleidecollembola@gmail.com

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Abstract

Two new species of *Proisotoma* from different Biological Conservation Unities of southeastern Brazil are described: *P. douglasi* sp. nov., found in Parque Nacional de Itatiaia (Rio de Janeiro State) and *P. copiosa* sp. nov., from Sooretama Biological Reserve (Espírito Santo State). We observed a presence of spine chaetae on antennae of males and 2 chaetae inserted on papillae laterally on tibiotarsus III in males and females in *P. copiosa* sp. nov.

Keywords Atlantic Forest | Biodiversity | Brazilian Páramos | Taxonomy

1. Introduction

The genus *Proisotoma* sensu Börner, 1901 is one of the most widely distributed among Isotomidae, with about 75 species, among which several are taxonomically inconsistent. From Brazil, two species, *P. ramosi* Arlé, 1959 and *P. oliveirae* Deharveng, 1984 were described and four others, *P. minuta* (Tullberg, 1871), *P. tenella* (Reuter, 1895), *P. minima* (Absolon, 1901) and *P. subminuta* Denis, 1931 were recorded so far (Arlé 1970, Mari-Mutt & Bellinger 1990, Mendonça & Reis 1990, Mendonça & Reis 1991, Abrantes et al. 2012).

During expeditions to different Biological Conservation Unities of Atlantic Forest in the Brazilian Southeast Region, samples were taken by the second author, aiming to increase the knowledge of its collembolan fauna. The examination of the Isotomidae fauna revealed two new species of *Proisotoma* sensu Potapov, 2006, which are described in the present paper. The first, *Proisotoma douglasi* sp. nov. was collected in a plateau at about 2500 m a.s.l. of the mountainous range from Parque Nacional de Itatiaia (Rio de Janeiro State). The second, *Proisotoma copiosa* sp. nov., belonging to *P. minuta* group, was

found in lowland areas of Atlantic Forest at Sooretama Biological Reserve (Espírito Santo State).

We observed in *P. copiosa* sp. nov. a presence of spine chaetae on antennae of males and 2 chaetae inserted on papillae laterally on tibiotarsus III in males and females.

2. Material and methods

The material was extracted through Berlese Tullgren funnels, sorted using a stereo-microscope and mounted on glass slides according to usual methodology. Illustrations and measurements were made with an optical microscope and ocular micrometer. The type material was deposited in the Collembola Collection at Departamento de Entomologia, Museu Nacional/UFRJ, Rio de Janeiro-RJ, Brazil, under the acronym CM/MNRJ.

Abbreviations used in the description: Abd – Abdominal, Ant – antennal segments, a.s.l. – above sea level, ICMBio – Instituto Chico Mendes de Conservação da Biodiversidade, m – meter(s), mm – millimeter(s), PAO – postantennal organ, Th – Thorax, Tita – Tibiotarsus.

3. Results

Proisotoma douglasi sp. nov.

(Figs 1–16, Table 1)

Description. Habitus slender and cylindrical, typical of the genus. Color general violet with darker stripes between body segments; buccal cone, sternites, ventral tube and furca pale (Fig. 1). Integument with primary granulation. Body size of holotype 0.84 mm.

Head (210 µm) subequal to antennae (210.6 µm). Eyes 7+7 (10 µm each) in dark pigmented eye patch (Fig. 2). Postantennal organ oval (20 µm length), about 2 times as long as eye diameter, with constriction, chitinous borders and with 3 surrounding chaetae (Fig. 3). Ant IV with about 20 sensilla weakly differentiated and with one globular subapical organite. Ant III with about 28 chaetae, two bended and exposed sensorial rods, two thin guard sensilla and one minute lateral sensillum (Fig. 4). Ant II with about 27 chaetae, 1 minute lateral sensillum and 2 basal microchaetae, 1 dorsolateral and 1 ventral. Ant I with about 16–17 chaetae, 2 small ventral sensilla and 2 small basal microchaetae, 1 dorsal and 1 ventral (Fig. 5). Antennal segments length I: II: III: IV: 35 µm: 45 µm: 59 µm: 77 µm. Outer maxillary lobe with bifurcate palp and with 4 sublobal hairs (Fig. 6). Labral formula as 4/5,5,4 chaetae; chaetae in two more apical rows inserted in papillae. Ventral side of head with 4+4 chaetae along *linea ventralis*.

Appendages. Tibiotarsus I with 22 chaetae and one clavate tibiotarsal tenent hair (Fig. 7). Tibiotarsus II with 24 chaetae and one clavate tibiotarsal tenent hair (Fig. 8). Tibiotarsus III with 31 chaetae and one pointed tibiotarsal tenent hair (Fig. 9). Unguis of normal shape (18 µm) without inner teeth; unguiculus lanceolate (7 µm) with extremity slightly curved (Fig. 9). Ventral tube with 4+4–6+6 laterodistal and 4 posterior chaetae; without anterior chaetae (Fig. 10). Tenaculum with 4+4 teeth and 2–4 chaetae (Figs 11, 12, 16). Anterior furcal subcoxae with 10–27 chaetae and posterior furcal subcoxae with 9–12 chaetae (Fig. 13). Manubrium (80 µm) with 38–40 chaetae on posterior side; 1+1 lateral chaetae and 2+2 ventral chaetae. Dens crenulated (105 µm) with 34–35 ventral and 14 dorsal chaetae. Mucro bidentate (12 µm) with anteapical tooth bigger than apical (Fig. 14). Female genital plate as in Figure 15.

Body chaetotaxy composed of short and smooth ordinary chaetae, some of them slightly longer on Abd V and VI. Macrosensillary and microsensillary formula as 3,3/2,2,2,3,5 and 1,1/1,1,1 by half tergite, respectively (Fig. 16). Axial chaetae pattern from Th II to Abd III as 8,7/4,4,4; axial chaetae of Abd IV disposed irregularly, without defined pattern.

Type material. Southeast Brazil, State of Rio de Janeiro, Parque Nacional de Itatiaia, in soil and dead foliage from ‘campos de altitude’, a high altitude ecosystem that belongs to the Atlantic Forest biome, Itatiaia municipality, 22° 22’ 31.90” S 44° 41’ 58.37” W, 2447 meters a.s.l. Holotype: female on slide 1996a CM/MNRJ, Southeast Brazil, 14.III.2011, Queiroz, G. C. leg. Paratypes: 2 males on slide 1996d CM/MNRJ and 1996g CM/MNRJ, and 3 females on slide 1996b CM/MNRJ, 2 females on slide 1996c CM/MNRJ, 1 female on slide 1996j CM/MNRJ, 14.III.2011, Queiroz, G. C. leg.

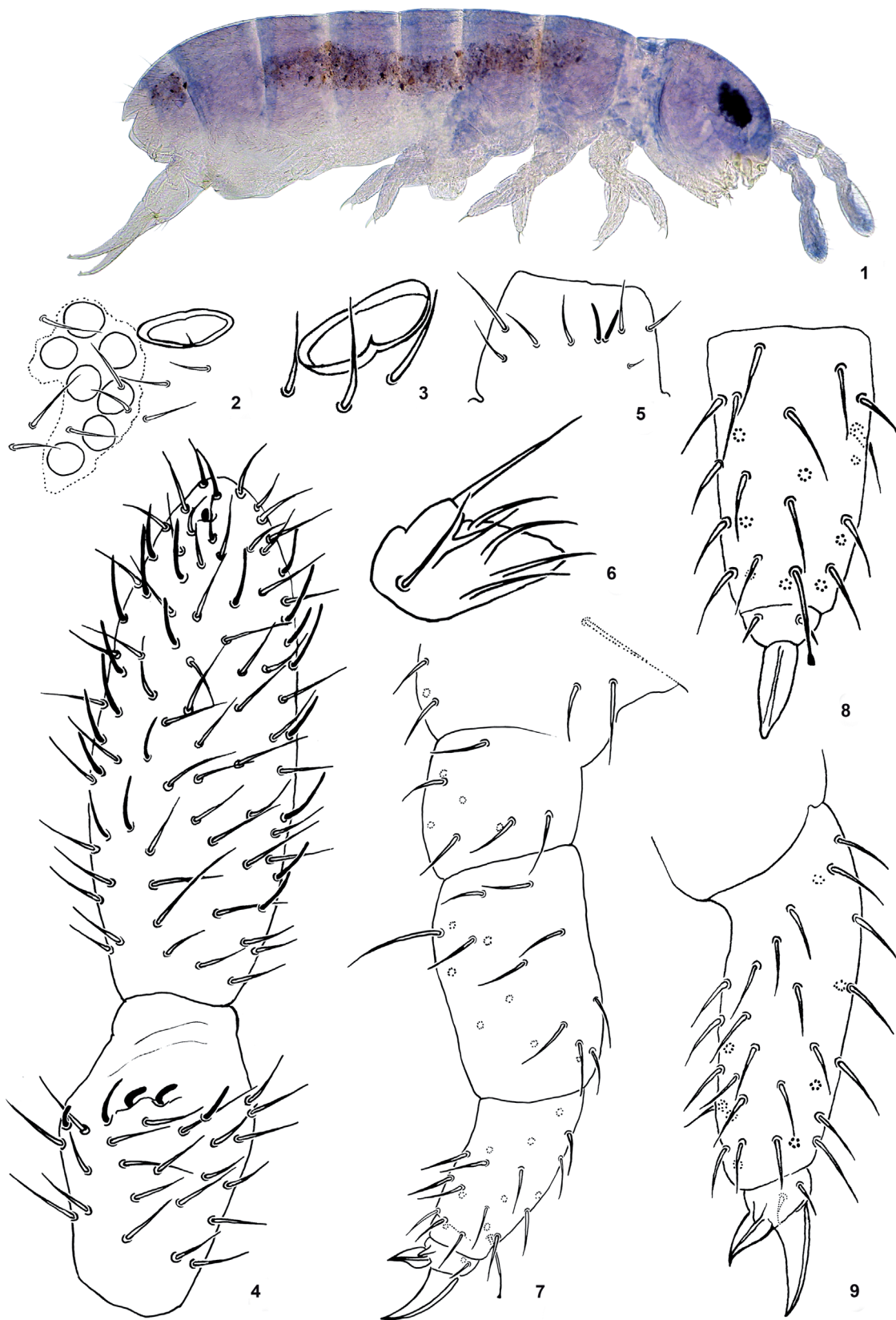
Etymology. The name of the species is homage to our great friend, Douglas Zeppelini, Professor at Universidade Estadual da Paraíba (UEPB), Paraíba State, Northeastern Brazil, a collembologist dedicated to the study of our fauna.

Discussion. The new species, *P. douglasi* sp. nov., shares sensillary pattern, quadridentate tenaculum with 1–2 chaetae and bidentate mucro with *P. ripicola* Linnaniemi, 1912 and *P. biseta* Rapoport, 1963. The new species is also similar to *P. paronai* Börner, 1907 due to bidentate mucro and number of anterior chaetae on dens. But *P. douglasi* sp. nov. moves away by 7+7 eyes and 2+2 chaetae on anterior side of manubrium vs 8+8 eyes and 3+3 anterior chaetae in *P. paronai*. The brief description of last species omits important characteristics as sensillar pattern not permitting a better comparison. The same occurs when the new species is compared with *P. koepcke* Winter, 1967 described from Peru. They are similar, however, show different numbers of eyes and chaetae on anterior side of manubrium. Main differences among these species are summarized in Table 1.

P. douglasi sp. nov. is similar to *P. tenella* by 4 prelabral chaetae, 3,3/2,2,2,3,5 macrosensilla on tergites, quadridentate tenaculum, dens longer than manubrium and bidentate mucro (Potapov et al. 2006: 67–68). However, ongoing studies by us about the recharacterization of *P. tenella* show maxillary palp simple and 3 sublobal hairs, unlike *P. douglasi* sp. nov. which has maxillary palp bifurcate and 4 sublobal hairs.

The species *P. biseta* is close to *P. douglasi* sp. nov., nonetheless *P. biseta* presents 8+8 eyes, 3+3 chaetae on manubrium and 47–55 anterior chaetae on dens. Moreover, adults of *P. douglasi* sp. nov. (0.84 mm) are half the size of *P. biseta* adults (1.86 mm).

Among these species, referred to above, *P. douglasi* sp. nov. is more similar to *P. ripicola* according the redescription of Fjellberg (1991: 83) by 4 prelabral chaetae, bifurcate maxillary palp with 4 sublobal hairs, 3,3/2,2,2,3,5 macrosensilla on tergites, tenaculum with 2 chaetae on corpus, bidentate mucro and unguis without inner tooth. However, *P. douglasi* sp. nov. can be distinguished by a set of characters, such as 7+7 eyes,



Figures 1–9. *Proisotoma douglasi* sp. nov. Habitus (1), ocellar field and PAO (2), PAO (3), dorsal view of Ant III–IV (4), ventral view of Ant I (5), maxillary palp and sublobal hairs (6), leg I (7), tibiotarsus and unguis II (8), tibiotarsus and unguis III (9).



Figures 10–16. *Proisotoma douglasi* sp. nov. Ventral tube, posterior view (10), tenaculum of different specimens (11–12), subcoxa furcalis chaetotaxy (13), anterior view of manubrium, anterior (left) and posterior (right) views of dens (14), lateral view of female genital plate (15), sensillary pattern of the body (16).

Table 1. Main characteristics of species of *Proisotoma ripicola* group according to Potapov et al. (2006).

Characteristics	<i>P. tenella</i>	<i>P. ripicola</i>	<i>P. biseta</i>	<i>P. douglasi</i> sp.nov.
Body size (mm)	0.90	0.95	1.86	0.84
Color	grayish	gray bluish pale	violet	violet
Number of eyes	8+8	8+8	8+8	7+7
Labral chaetae	4/5,5,4	4/5,5,4	?	4/5,5,4
Maxillary palp/sublobal hairs	simple/3	bifurcate/4	?	bifurcate/4
Ventral chaetae on thorax	?	absent	?	absent
Tergal macrosensilla	3,3/2,2,2,3,5	3,3/2,2,2,3,5	?	3,3/2,2,2,3,5
Tibiotarsal tenent chaetae	Tita I clavate Tita II clavate Tita III clavate	Tita I–III acuminate	Tita I clavate Tita II clavate Tita III clavate	Tita I clavate Tita II clavate Tita III pointed
Unguis inner tooth	present	absent	absent	absent
Ventral tube chaetae	?	5+5 distal 2+4 posterior	?	4+4–6+6 distal 2+2 posterior none anterior
Tenaculum teeth/chaetae	quadridentate/1	quadridentate/2	quadridentate/2	quadridentate/2–4
Manubrium anterior chaetae	3+3	1+1	3+3	2+2
Dens chaetae	23 anterior 9–10 posterior	many 12–14 posterior	47–55 anterior 14–22 posterior	34–35 anterior 14 posterior

presence of chaetae on thoracic sternite, tibiotarsal tenent chaetae clavate, tenaculum with 2–4 chaetae and 2+2 anterior chaetae on manubrium vs 8+8 eyes, absence of chaetae on thoracic sternite, tenent chaetae acuminate, tenaculum with 2 chaetae and 1+1 anterior chaetae on manubrium in *P. ripicola*.

***Proisotoma copiosa* sp. nov.**
(Figs 17–34, Table 2)

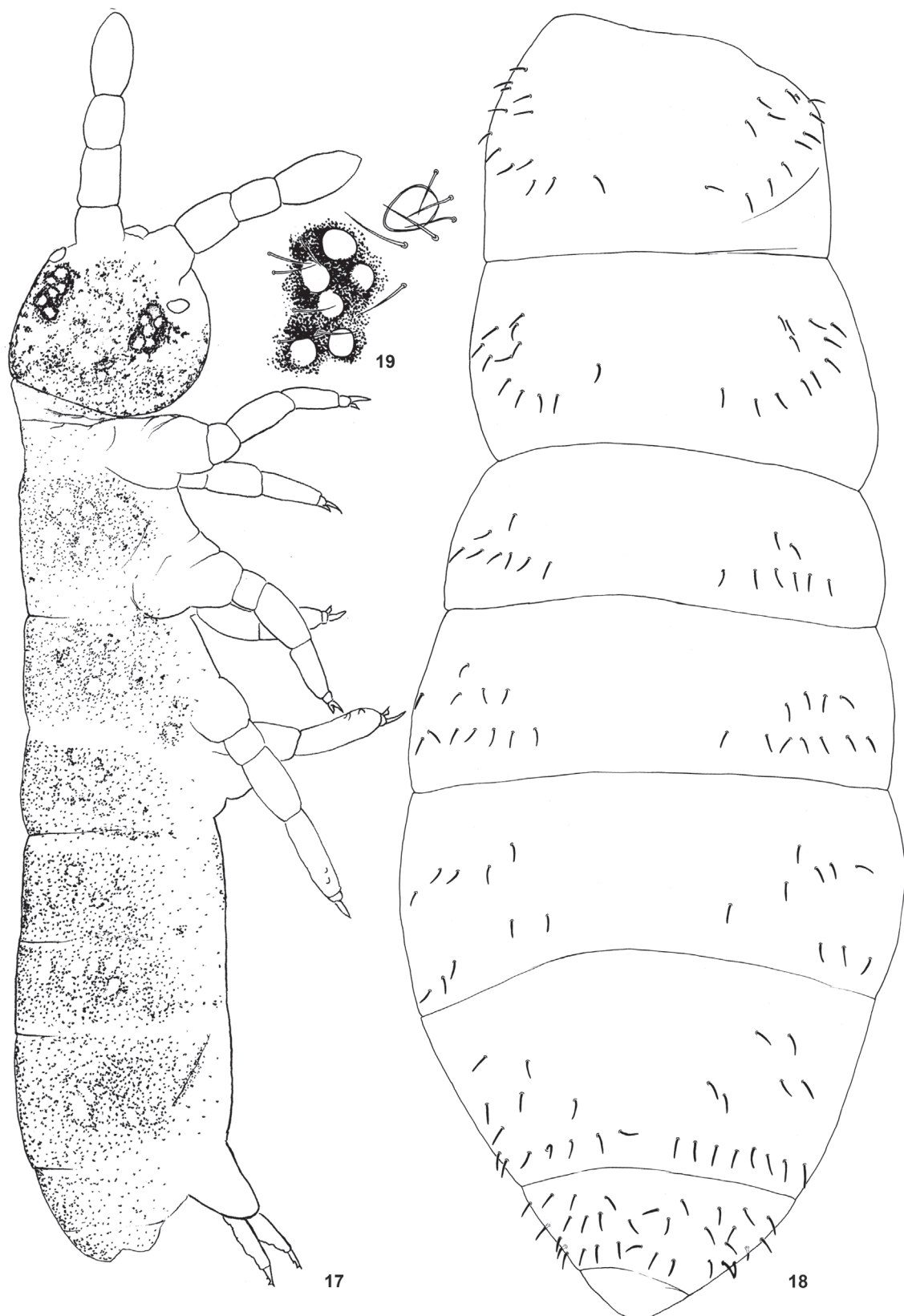
Description. Habitus slender and cylindrical, typical of the genus. Color general lightly gray with diffuse spots; ventral side of abdomen, legs and furca paler (Fig. 17). Integument with granulation, of primary type. Male body size 1.0 mm and female body size 1.6 mm.

Head. Subequal to antennae; length head: antennae = 320 µm: 250 µm. Eyes 6+6 in pigmented eye patch (Fig. 19). Postantennal organ oval (23 µm) about 1.5 times as large as an eye diameter (15 µm), with chitinous borders, 5 surrounding chaetae, without constriction. Ant IV with about 12 sensilla weakly differentiated from surrounding ordinary chaetae, 5 spines and one subapical globular organite on dorsal side. Ant III with about 40 chaetae, 2 bended and exposed sensorial rods, 2 guard sensilla, one minute lateral sensillum and one spine. Ant II with about 22 chaetae, 2 basal microchaetae, one dorsal and one ventral, and one spine on dorsal side. Ant I with about 11 chaetae, one spine chaeta on dorsal side (Figs 20, 21); ventral side with 2 thin sensilla of different sizes and one basal microchaeta (Fig. 22). Length of antennal segments

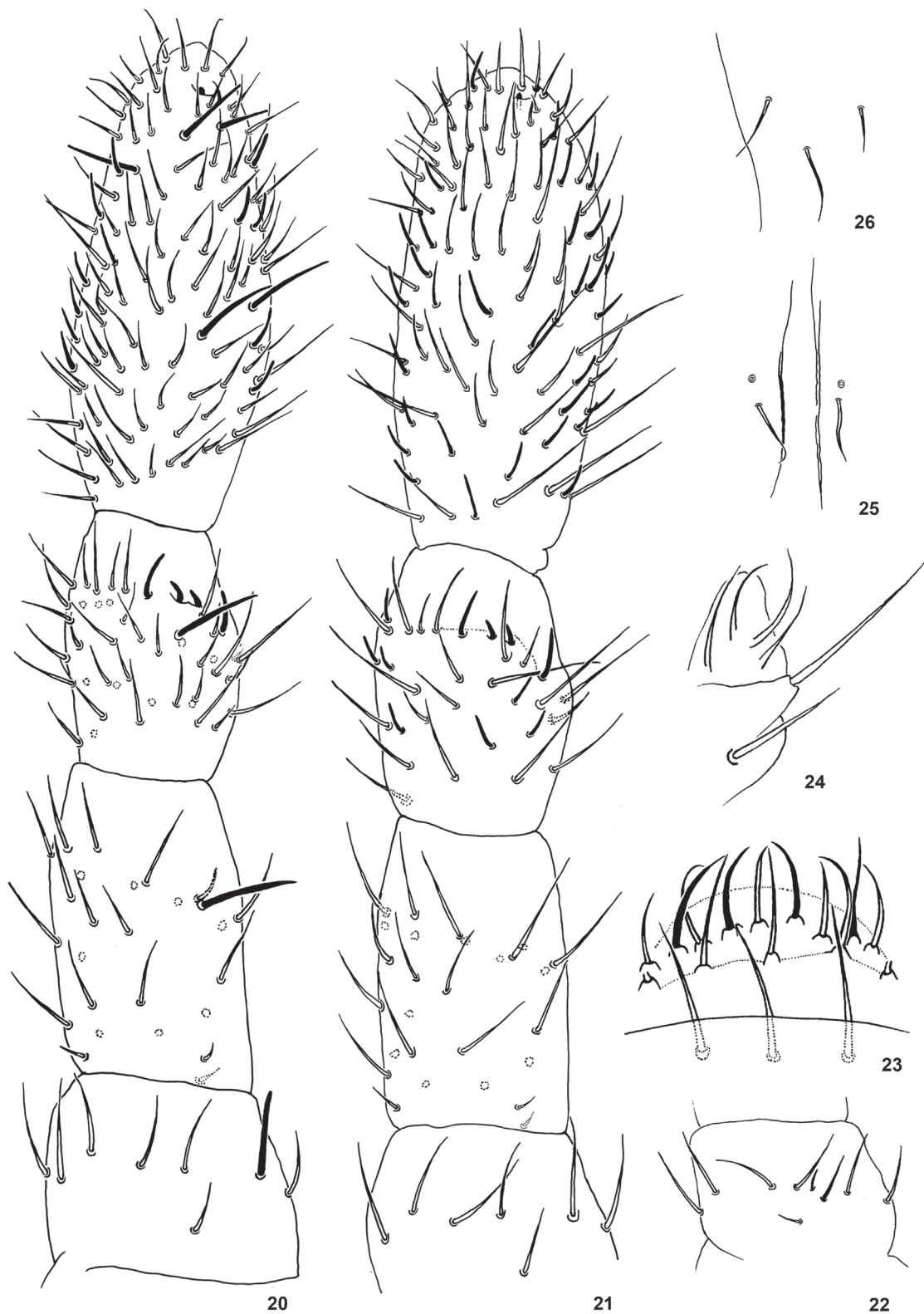
I:II:III:IV: 35 µm: 60 µm: 56 µm: 90 µm respectively. Labral formula as 3/5,5,4 all chaetae inserted in papillae (Fig. 23). Maxillary outer lobe with simple palp and with 4 sublobal hairs (Fig. 24). Ventral side of head with 4+4 chaetae along *linea ventralis*. Sternite of Th II with 1+1–2+2 chaeta (Fig. 25), sternite of Th III with 2+2–3+3 chaetae (Fig. 26) and sternite of Abd II with some chaetae.

Sensillary chaetotaxy consisting of increased number of sensilla on all tergites as 12,12/8,11,9–10,13–14,14–15; the number of sensilla is asymmetrical on tergites III–V (Fig. 18). Body chaetotaxy consisting of short and smooth ordinary chaetae, some of them a little longer on Abd V and VI. Axial chaetae pattern from Th II–Abd IV as 9,7–8/5,5,5–6,7–8.

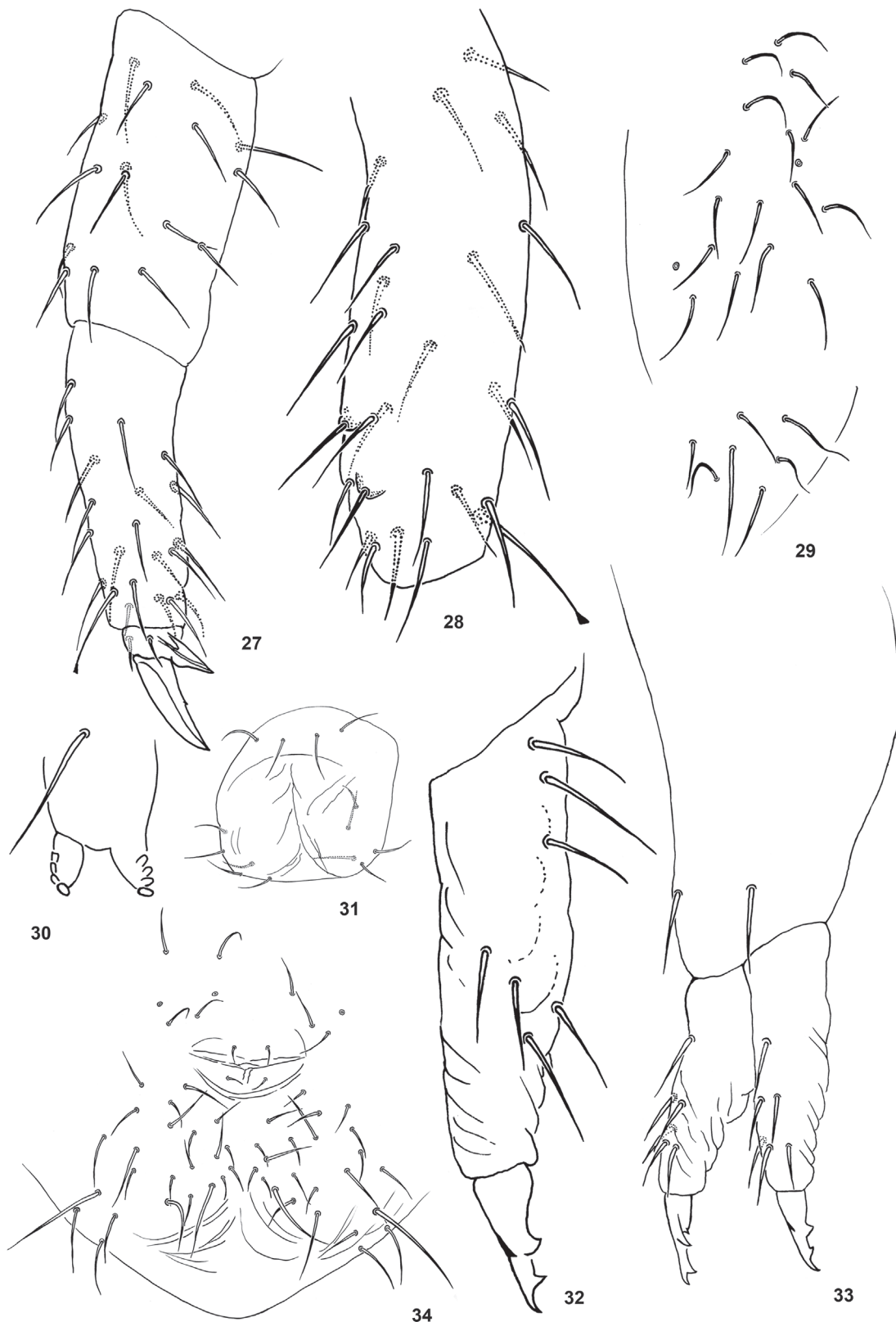
Appendages. Each tibiotarsus with one clavate tenent chaeta. Tibiotarsi I, II and III with 21, 23, and 24 chaetae, respectively (Figs 27, 28). Tibiotarsus III with 2 thick lateral chaetae inserted on papilla (Fig. 28) in both sexes. Unguis (35 µm) of normal shape, with median inner tooth. Unguiculus lanceolate, with broad lamella (15 µm) (Fig. 27). Ventral tube (86 µm) with 5+5 laterodistal and 4 posterior chaetae; anteriorly without chaetae (Fig. 29). Tenaculum with 4+4 teeth and one chaeta on corpus (Fig. 30). Anterior furcal subcoxae with 18 chaetae and posterior furcal subcoxae with 7, one longer chaeta (Fig. 31). Manubrium (90 µm) with about 13+13–16+16 chaetae on posterior side, 1 lateral chaeta and 1+1 anterior chaeta. Dens (54 µm) with 6 chaetae on anterior side arranged in three rows as 1, 2, 3 from basal to apical part, and 7 posterior chaetae in two groups (3 and 4), and with about 3–4 notches. Mucro (20 µm) with 4 teeth, one



Figures 17–19. *Proisotoma copiosa* sp. nov. Habitus (17), sensillary pattern of body (18), ocellar field and PAO (19).



Figures 20–26. *Proisotoma copiosa* sp. nov. Dorsal view of male Ant I–IV (20), dorsal view of female Ant I–IV (21), ventral view of Ant I (22), labral chaetotaxy (23), maxillary palp and sublobal hairs (24), ventral chaetae on Th II (25), ventral chaetae on Th III (26).



Figures 27–34. *Proisotoma copiosa* sp. nov. Femur, tibiotarsus and unguis I (27), tibiotarsus III (28), subcoxa furcalis chaetotaxy (29), tenaculum (30), ventral tube, posterior view (31), lateral view of dens and mucro (32), anterior view of furca (33), anal valves and female genital plate (34).

apical, 2 median and one very small laterally (Figs 32, 33). Anal valves and female genital plate as in Figure 34.

Type material. Reserva Biológica de Sooretama (ICMBio), in dead foliage and soil from areas of forest restoration in the largest remnants of the Brazilian Atlantic Rain Forest, Sooretama municipality, State of Espírito Santo, Brazil, Local coordinates 19° 3' 12 19" S 40° 8' 50.35 W, about 90 m a.s.l. Holotype: male on slide 1968b CM/MNRJ. Queiroz, G. C. leg. 19.XI.2008. Paratypes: 1 male and 1 female on slide 1968a CM/MNRJ and 1 female on slide 1968c CM/MNRJ, Queiroz, G. C., leg., 19.XI.2008.

Etymology. The name *copiosa* from Latin means abundant and refers to the remarkably great number of sensilla on tergites displayed by the new species.

Discussion. *Proisotoma copiosa* sp. nov. belongs to *minuta* group together with other species, described from Neotropics and Mexico as *P. subminuta* Denis, 1931, *P. oliveirae* Deharveng, 1984, *P. santosorum* Palacios-Vargas & Arbea, 2009 and *P. turikana* Palacios-Vargas & Arbea, 2009 due to a set of characteristics such as: basal microchaetae on Ant III missing, labral formula 3/5,5,4, quadridentate tenaculum with 1 chaeta, manubrium with 1+1 chaeta on anterior side, dens with low number of chaetae on anterior and posterior side. However, *P. copiosa* sp. nov. deviates from *P. minuta* group by anomalous presence of 4 teeth on mucro while the above mentioned species shows 3 teeth. The main characteristics of this group of species are summarized in Table 2.

The remarkable large amount of sensilla on tergites puts *P. copiosa* sp. nov. together with some problematic species of *Proisotoma* complex *sensu* Potapov et.al. (2006). Among this group, the new species is similar to *P. minuta* by a simple maxillary palp with 4 sublobal hairs, 1+1 anterior chaetae on manubrium, 6 chaetae (3,2,1) on anterior side of dens, 4+4 teeth on tenaculum. But *P. copiosa* sp. nov. presents 6+6 eyes, 7 posterior chaetae on dens and 4 posterior and 5+5 laterodistal chaetae on ventral tube vs 8+8 eyes, 6 posterior and 4+4 laterodistal chaetae on ventral tube on *P. minuta*. Besides this, *P. copiosa* sp. nov. shows a sensillary set composed by 12,12/8,11,9–10,13–14,14–15, sternites of Th II–III with 1+1–2+2 and 2+2–3+3 chaetae, respectively, and some ventral chaetae on Abd II, while *P. minuta* has 4,3/2,2,2,2,4 sensilla on tergites, ventral chaetae are 0+0 on Th II, 1–2 on Th III and some on abdominal segments.

P. subminuta shares with *P. copiosa* sp. nov. 6 anterior chaetae on dens, however, both species can be discerned by the differential characteristics given in Table 2.

The new species also shares the following characteristics with the Brazilian species *P. oliveirae* Deharveng 1986: 6+6 eyes and a small median inner tooth on unguis, but the species from Amazonia presents a very small postantennal organ, dens with 5 chaetae on anterior and 5 on posterior side, different number of chaetae on sternites and different number of tergites sensilla, as indicated in Table 2.

The species *P. santosorum*, from Mexico, shares the same number of eyes (6+6) and of anterior chaetae on

Table 2. Main characteristics of species of *Proisotoma minuta* group.

Characteristics	<i>P. minuta</i>	<i>P. subminuta</i>	<i>P. oliveirae</i>	<i>P. santosorum</i>	<i>P. turikana</i>	<i>P. clavipila</i>	<i>P. copiosa</i> sp. nov.
Body size (mm)	1.10	1.00	1.00	0.75	1.20	1.30	1.00
Color	grayish	grayish	grayish	bluish	bluish	grayish	grayish
Number of eyes	8+8	7+7	6+6	6+6	5+5	8+8	6+6
Maxillary palp/sublobal hairs	simple/4	simple/3	?	simple/3	simple/4	simple/4	simple/4
Number of ventral chaetae	Th II absent Th III 1–2+1–2	absent	Th II 1+1 Th III 2+2	absent	Th II absent Th III 1+1	Th II 2+2–4+4 Th III about 10	Th II 1+1–2+2 Th III 2+2–3+3
Tergal sensilla	4,3/2,2,2,2,4	3,3/2,2,2,2,4	4,3/2,2,2,2,4	3,3/2,2,2,2,4	4,4/3,3,3,3,4	?	12,12/8,11,9–10,13–14,14–15
Tibiotarsal tenent chaetae	pointed	pointed	slightly clavate	clavate	slightly clavate	clavate	clavate
Unguis inner tooth	absent	absent	present	absent	absent	absent	present
Ventral tube chaetae	4+4 distal 6 posterior	4+4 distal 5 posterior	4–5+4–5 distal 4–5+4–5 posterior	4+4 distal 3–4 posterior	4–5 distal 5–6 posterior	4+4 distal 6 posterior	5+5 distal 4 posterior
Tenaculum teeth/chaetae	quadridentate/1	quadridentate/1	quadridentate/1	tridentate/1	quadridentate/1	quadridentate/3–5	quadridentate/1
Dens chaetae	6 anterior 6 posterior	6 anterior 6 posterior	5 anterior 5 posterior	6 anterior 5 posterior	6 anterior 7 posterior	6 anterior 6 posterior	6 anterior 7 posterior
Number of teeth on mucro	tridentate	tridentate	tridentate	tridentate	tridentate	tridentate	quadridentate

dens (6) with *P. copiosa* sp. nov. But *P. santosorum* presents 3 sublobal hairs, 5 posterior chaetae on dens, absence of chaetae on sternites, tibiotarsal tenent chaeta pointed and 3,3/2,2,2,2,4 sensilla on tergites.

P. turikana, described from Venezuela, is similar to *P. copiosa* sp. nov. due to simple maxillary palp and 4 sublobal hairs, 7 posterior and 6 anterior chaetae on dens and tibiotarsi I–III with clavate tenent chaetae. However, these species can be distinguish by tergal sensillae, number of chaetae on ventral tube and number of teeth on mucro.

Comparing the new species with the Palearctic species *P. clavipila* (Axelson, 1903), was verified several differences about the number of eyes, numbers of chaetae on ventral tube and dens, as well as the number of teeth on mucro. Other differential characteristics are given in Table 2.

4. Acknowledgements

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