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NEW SPECIES OF *PARACERURA* (COLLEMBOLA: ISOTOMIDAE) FROM THE STATE OF SÃO PAULO, BRAZIL

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ABSTRACT

This paper is part of a study with the goal of describing the diversity of Isotomidae (Collembola) of the State of São Paulo in southeastern Brazil. *Paracerura* Deharveng & Oliveira, 1994 comprises only 6 known species, all of which are restricted to Brazil. Three new species from the Atlantic Rainforest are described and illustrated, in addition an identification key for all of them is provided.

Key Words: taxonomy, springtails, soil, diversity

RESUMEN

Este trabajo es el primer resultado de una investigación dedicada a la fauna Isotomidae (Collembola) del Estado de São Paulo, sureste de Brasil. Antes de la presente contribución *Paracerura* Deharveng y Oliveira, 1994 estaba compuesto sólo por 6 especies restringidas a Brasil. Se describen e ilustran 3 nuevas especies de diferentes localidades y además se proporciona una clave para la identificación de todas que se conocen ahora.

Palabras Clave: taxonomía, colémbolos, suelo, diversidad

The genus *Paracerura* Deharveng & Oliveira (1994) is restricted to Brazil, and its members are recorded from different substrates such as forest litter and soil (Abrantes et al. 2012). Six species belong to this genus, 2 from northern Brazil, *P. virgata* Deharveng & Oliveira 1994 and *P. airesi* Mendonça, Abrantes & Fernandes 2009; and 4 from southeastern Brazil, *P. itatiaiensis* (Arlé 1959), *P. serrana* Mendonça, Abrantes & Fernandes 2009, *P. pindorama* Queiroz & Mendonça, 2010 and *P. gandarela* Mendonça & Silveira 2013. In the present contribution 3 new species are described, increasing to 9 the number of species in *Paracerura*.

The genus is easily recognized by the presence of an elliptical post-antennal organ with chitinous borders, which is separated from the ocular area by a distance equal to twice the diameter of the proximal eye; a distinct pigmentation pattern; medium length (1.0 mm to 2.0 mm); abdominal segments separated; absence of trichobothria; manubrium with posterior and anterior setae; dens crenulate; and mucro with 4 teeth.

MATERIALS AND METHODS

This study is part of an analysis of the springtails deposited in the Entomology Collection of the Museu de Zoologia da Universidade de São Paulo, Brazil (MZSP). Until recently, only 2 species of Isotomidae were known to occur in the State of São Paulo (Abrantes et al. 2012). Herein, 3 new species are described and illustrated: *P. pallida* **sp. nov**. from the "Reserva Biológica do Alto do Paranapiacaba", municipality of Santo André; and *P. cristinae* **sp. nov.** and *P. paulista* **sp. nov.** from the "Serra do Japi", municipality of Jundiaí. An identification key to the species of *Paracerura* is given. All the material is deposited in the Entomology Collection, MZSP.

The terminology in the species descriptions is in accordance with Fjellberg (2007) and Mendonça et al. (2009). The following abbreviations are used in the text: abd. – abdominal segment, accp – accessory posterior row sensillum, ant. –antennal segment, as – anterosubmedial sensillum.

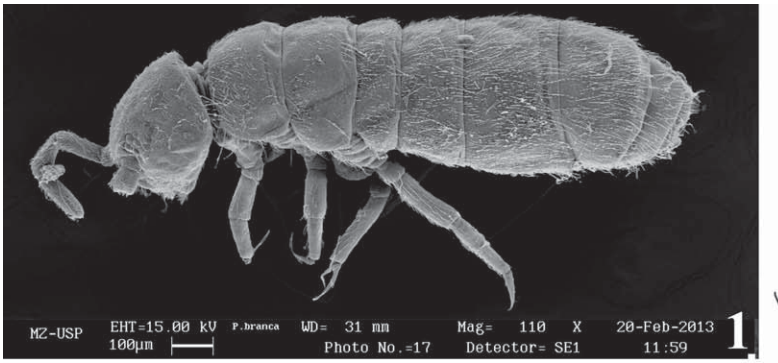
RESULTS AND DISCUSSION

Paracerura pallida **sp. nov.** (Figs. 1-7)

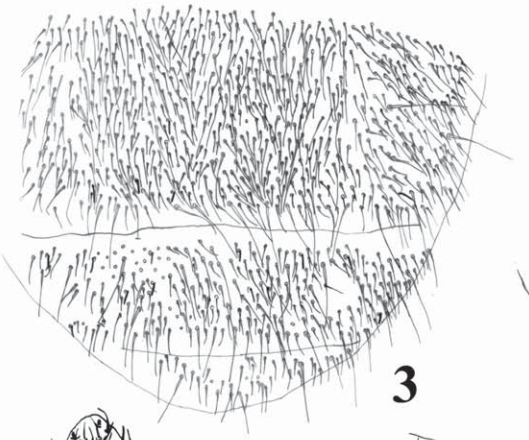
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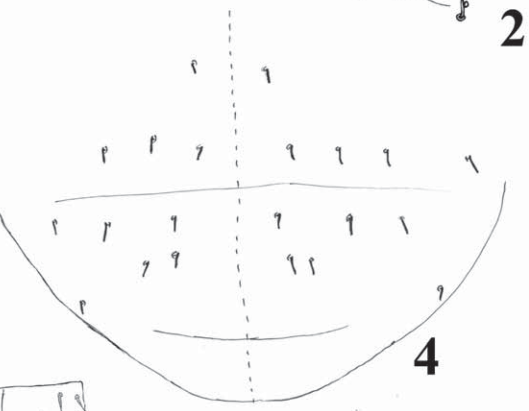
HOLOTYPE female: BRAZIL, São Paulo, Santo André, Biological Reserve Paranapiacaba, 21-VIII-2010, cols. Moll & Nihei, deposited at MZSP under number 0032. PARATYPES: 7 males and 9 females, same data as Holotype, deposited at MZSP under number 0032.

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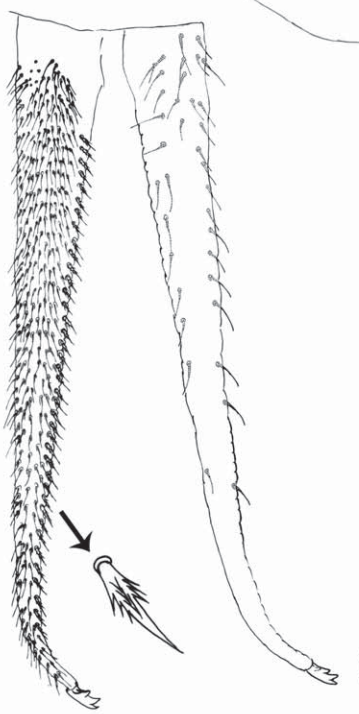




Fig. 1-7. *Paracerura pallida* **sp. nov.** 1, habitus; 2, Post-antennal organ and eyes; 3, tergal chaetotaxy of abdominal segments IV-VI; 4, tergal sensilla of abdominal segments IV-V; 5, Antennal segments III-IV; 6, Dens and mucro, with detail to the foil setae; 7, male genital opening.

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Description

Body length of holotype: 1.5 mm, body length range of paratypes 1.5–2.1 mm. Habitus typical of the genus (Fig. 1). Body tegument granulate, without craters. Pale, with dark pigment in the eye patch and on the posterior borders of abdominal segments IV-VI.

Body Chaetotaxy. Smooth setae abundant, those on the borders of abdominal segments V and VI longer, macrochaetotaxy not clearly differentiated. Head with short setae in the interocular area and longer setae between the antennae and along the lateral and posterior borders (Fig. 3). Axial setae without defined pattern. Sensillary chaetotaxy by half tergite following the formula: 4,4/3,3,3,5,6; macrosensilla long and slender (Fig. 4), abd. IV-V with 1, 3 accp and 4, 3 as, respectively.

Head. Eyes 8+8 in pigmented, elongated patch (Fig. 2). Post-antennal organ elliptical with chitinous borders and 9 contiguous setae (Fig. 2). Antennae slightly shorter than the head diagonal, covered by numerous acuminate setae of different sizes. Ratio antennae: head diagonal = 1.3:1. Ant. IV plurichaetotic, with tubuliform subapical organite, 1 dorsolateral microsensillum, protected by 1 curved seta and some sensilla poorly differentiated from the numerous setae; apical vesicle absent (Fig. 5). Ant. III with about 140 setae, several of then very slender, sensory organ composed by 2 broad sensilla partially hidden by an integumentary fold, 3 broad guard sensilla, 1 lateral microsensillum and 1 dorsolateral microseta (Fig. 5). Ant. II with about 150 setae, 1 lateral proximal sensillum, 4 basal microsetae (1 dorsolateral, 1 outer lateral, 1 inner lateral and 1 ventral). Ant. I with about 30 setae and 4 basal microsetae (1 dorsal and 3 ventral). Ratio of antennal segments I: II: III: IV = 1:2,2:2,1:2,6. Chewing mouth parts. Labrum with 4 prelabral setae and 5,5,4 labral setae, inserted on papillae. Maxillary outer lobe trifurcate, with 4 stout sublobal hairs and 1 basal seta. Labial palp with 5 papillae and 1 lateral process surpassing the E papilla. Linea ventralis with 4+4 setae.

Appendages. Tibiotarsi I, II and III with 29-36, 30-42, 47-66 setae, respectively; tenent hair pointed. Unguis long and slender, with 1 inner, 1+1 lateral and 1 dorsal teeth (95 µm); unguiculus long and slender (47 µm), without apical filament. Ventral tube with 4+4 distal, 4+4 anterior and 4+4 posterior setae. Retinaculum (40 µm) with 4 teeth and 8-10 setae on corpus. Subcoxa furcalis anteriorly with about 50 setae and posteriorly with about 30 setae. Manubrium with about 25 basal, no medial, 44+44 central proximal and about 40 lateral setae. Dens robust and crenulate (Fig. 6), with more than 300 dorsal, 24-29 ventral setae and 37-43 foil setae (ciliated spiniform setae) in the inner row (Fig. 6). Mucro quadridentate, without seta. Ratio manubrium: dens: mucro = 8.1:19:1. Male plates as in Fig. 7.

Discussion

Paracerura pallida **sp. nov.** shares with *P. gandarela* and other species herein described the dark pigment on the posterior borders of Abd. IV-VI, and the small number of sensilla on Abd. IV; but differs in having 5 instead of 6 sensilla, and a pale tegument, contrasting with the yellowish tegument of the other two new species. Regarding the presence of foil setae on the dens, shared with *P. pindorama, P. gandarela* and the other two species described in this paper, the new species has 37 foil setae, in comparison with 18-24, 21, 15-17 and 32 foil setae in the other species, respectively. Also, the new species shares a strong polychaetosis with *P. serrana* and the last species described in this paper, but differs from them and other species of the genus (Table 1) by the sensillary pattern of the abdominal segments.

Etymology

The name *pallida* is from the Latin word *pallidus* which means pale, an allusion to the appearance of the tegument.

Paracerura cristinae **sp. nov.** (Figs. 8-14)

Type material

HOLOTYPE female: BRAZIL, São Paulo, Jundiaí, Serra do Japi, 8-IX-2009, cols. Bertani et al., deposited at MZSP under number 0008. PARATYPES: 15 males and 3 females, same data as Holotype, deposited at MZSP under number 0008.

Description

Body length of holotype: 1.1 mm, body length range of paratypes 1.0–1.4 mm. Habitus typical of the genus (Fig. 8). Body tegument granulate, without craters. Color blue, with dark-pigmented eye patch.

Body Chaetotaxy. Smooth setae abundant, those on the borders of abdominal segments V and VI longer, macrochaetotaxy not clearly differentiated (Fig. 9). Head chaetotaxy with short setae along the interocular area (Fig. 10) and longer between the antennae and along the lateral and posterior borders. Axial setae without defined pattern. Sensillary chaetotaxy by half tergite following the formula: 4,4/3,3,3,8,7; macrosensilla long and slender (Fig. 11), Abd. IV-V with 4, 4 accp and 4, 3 as respectively (Fig. 11).

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TABLE 1. DIAGNOSTIC CHARACTERS OF *PARACERURA* SPECIES.

Features	*airesi*[1]	*serrana*[2]	*itatiaiensis*[3]	*virgata*[4]	*gandarela*[5]	*pindorama*[6]	*cristinae* **sp.nov.**	*paulista* **sp.nov.**	*pallida* **sp.nov.**
Body length (mm)	1.43	1.58	up to 1.10	0.7 – 1.1	1.09	1.25	1.1	1.6	1.65
Color pattern	bluish	brownish	violaceous	yellowish, violaceous	yellowish with dark pigment	yellowish	bluish	yellowish with dark pigments	white with dark pigments
At. IV subapical microsensilla	+	—	?	—	—	—	—	—	+
Ant. IV subapical organite	+	+	?	—	+	+	+	+	+
Ant. III organ sensilla	partially covered	covered	covered	long/exposed	partially covered	partially covered	partially covered	covered	partially covered
Ant. I microseta	3 d/ 2 v	4 d/ 3 v	?	2 d/ 2 v	2 d/ 3 v	2 d/ 3 v	2 d/ 4 v	2 d/ 3-4 v	1 d/ 3 v
Plurichaetosis	-	+	—	—	—	—	—	+	+
Tergal sensillay formula	4,4/3,3,3,8,5	4,4/3,3,3,12,9	?	4,4/3,3,3,12,7	4,4/3,3,2,6,7	4,4/3,3,3,12-14,7	4,4/3,3,3,8,7	4,4/3,3,3,6,6	4,4/3,3,3,5,6
Abd IV-V accp sensillae	5, 2	9, 4	?	8, 3	6, 5	7, 2	4, 4	3, 4	1, 3
Abd IV-V as sensillae	3, 3	3, 5	?	4, 4	0, 2	5, 5	4, 3	3, 2	4, 3
Tibiotarsi I, II, III setae	26, 26, 39	32,30,54	?	21, 21, ?	26, 27, 50	23, 23, 38	20, 22, 34	23, 28, 57	29-36, 30-42, 47,66
Unguiculus apical filament	—	+	+	—	—	—	—	—	—
Ventral tube setae	4+4 d	7+7 d	?	3+3 d	6+6 d	3,4+3,4 d	3+3 d	4+4 d	4+4 d
	3+3 a	7+7-8+8 a		2+2-3+3 a	6+6 a	3+3 a	4+4 a	3+3 a	4+4 a
	2+2 p	?		2+2 p	8 p	2+2 p	3+3 p	3+3 p	4+4 p
Retinaculum setae	4-6	7-10	?	4-5	5-6	4-7	6-7	9	8-10
Furcal subcoxa setae	9-17 a	31-36 a	?	14-18 a	16 a	16 a	13 a	65 a	52 a
	12-13 p	13 p		9-12 p	33 p	33 p	11 p	about 40 p	28 p
Manubrium anterior setae	10-16 p	21 p	?	5-6 p	16 p	15 p	10 p	24 p	23 p
	5+5-6+6 d	24+24 d	6+6 d	3+3-4+4 d	25+25 d	19+19 d	5+5 d	44+44 d	44+44 d
Dens setae	75-80 a	240 a	≤ 50 a	56-59 a	90 a	125 a	55 a	250 a	250 a
	10-13 p	22-31 p	?	11-12 p	20-25 p	20 p	8 p	28 p	24 p
Dens spiny setae	absent	22-31 smooth	about 15 smooth	absent	21 foil setae	18-28 foil setae	15-17 foil setae	32 foil setae	37 foil setae
Brazilian distribution	Tocantins	Minas Gerais	Rio de Janeiro	Amazonas	Minas Gerais	Espírito Santo	São Paulo	São Paulo	São Paulo

Data obtained from: [1,2]Mendonça et al. (2009); [3]Arlé (1959); [4]Deharveng & Oliveira (1994); [5]Mendonça & Silveira (2013); [6]Queiroz & Mendonça (2010).

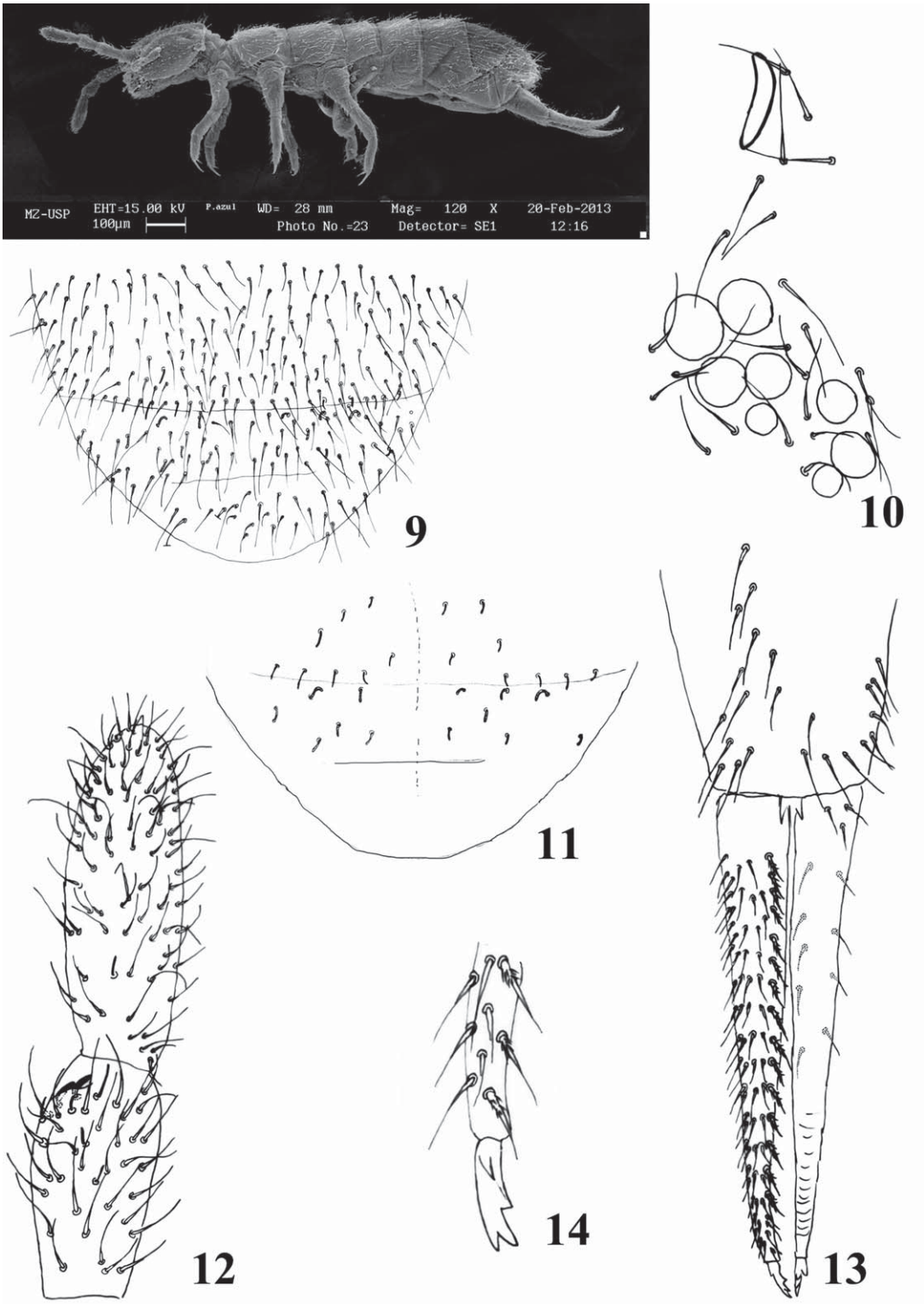


Fig. 8-14. *Paracerura cristinae* **sp. nov**. 8, habitus; 9, Post-antennal organ and eyes; 10, tergal chaetotaxy of abdominal segments IV-VI; 11, tergal sensilla of abdominal segments IV-V; 12, Antennal segments III-IV; 13, furca; 14, mucro.

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Head. Eyes 8+8 in pigmented, elongated patch (Fig. 10). Post-antennal organ elliptical with chitinous borders, 5-8 surrounding setae (Fig. 10). Antennae slightly shorter than the head diagonal, covered by numerous acuminate setae of different sizes. Ratio antennae: head diagonal = 1.3:1. Ant. IV plurichaetotic, with tubuliform subapical organite, 1 dorsolateral microsensillum, protected by 1 curved seta and some poorly differentiated sensilla on the common setae; apical vesicle absent (Fig. 12). Ant. III with about 45 setae, sensory organ composed by 2 broad sensilla partially hidden by an integumentary fold, 2 guard sensilla, 1 lateral microsensillum and 1 dorsolateral microseta (Fig. 12). Ant. II with about 50 setae, 1 proximolateral sensillum, 4 basal microsetae (1 dorsolateral, 1 outer lateral, 1 inner lateral and 1 ventral). Ant. I with 13-15 setae, 6 basal microsetae (3 dorsal and 3 ventral). Ratio of antennal segments I: II: III: IV = 1:2.1:1.9:2.9. Chewing mouth parts. Labrum with 4 prelabral setae and 5,5,4 labral setae, inserted on papillae. Maxillary outer lobe trifurcate with 4 stout sublobal hairs and 1 basal seta. Labial palp with 5 papillae and 1 lateral process surpassing the **E** papilla. Linea ventralis with 4+4 setae.

Appendages. Tibiotarsi I, II and III respectively with 20, 22, 34 setae, tenent hair pointed. Unguis long and slender, with 1 inner, 1+1 lateral and 1 dorsal teeth (56 µm); unguiculus long and slender (15 µm), without apical filament. Ventral tube with 4+4 distal, 3+3 anterior and 3+3 posterior setae. Retinaculum (50 µm) with 4+4 teeth and 5 setae on corpus. Subcoxa furcalis anteriorly with 13 setae and posteriorly with 11 setae. Manubrium with 5+5 basal, no medial, 10 central proximal and 6 lateral setae. Dens robust and crenulate (Fig. 13), with about 55 dorsal, 8 ventral, and about 16 foil setae (ciliated spiniform setae) in the inner row. Mucro quadridentate, without seta (Fig. 14). Ratio manubrium: dens: mucro = 5.9:11.8:1.

Discussion

Paracerura cristinae **sp. nov.** resembles *P. airesi* and *P. pindorama* in bluish body color and small size, up to 1.4 mm long; but differs from *P. airesi* in having smooth spiniform setae on the dens, and 4 microsetae on antennal segment I, instead of 5 as in *P. airesi*; and differs from *P. pindorama* in the number of sensilla of the Abd. IV, 8 in the new species and 12-14 in the latter. Also, the sensillary chaetotaxy of the new species is unique among congeners (Table 1).

Etymology

This species is dedicated to the wife of the senior author, Cristina Schoch Vianna.

Paracerura paulista **sp. nov.** (Figs 15-21)

Type Material

HOLOTYPE female: BRAZIL, São Paulo, Jundiaí, Serra do Japi, 8-IX-2009, cols. Bertani et al., deposited at MZSP under number 0008. PARATYPES: 2 males and 5 females, same data as Holotype, deposited at MZSP under number 0008.

Description

Body length of holotype: 1.6 mm, body length range of paratypes 1.5–2.1 mm. Habitus typical of the genus (Fig. 15). Body tegument granulate, without craters. Color yellow, with darker eye patch, 1 small spot on the mid-posterior part of the head (Fig. 16) and small spots along the posterior borders of abdominal segments IV-VI.

Body Chaetotaxy. Smooth setae abundant with different sizes, some of them slightly longer on the borders of abdominal segments V and VI, macrochaetotaxy not clearly differentiated (Fig. 17). Head chaetotaxy with short setae in the interocular area and longer setae between the antennae and along the lateral and posterior borders (Fig. 16). Axial setae without defined pattern. Sensillary chaetotaxy by half tergite following the formula: 4,4/3,3,3,6,6; macrosensilla long and slender (Fig. 18), Abd. IV-V with 3, 4 accp and 3, 2 as respectively.

Head. Eyes 8+8 in pigmented, elongated patch (Fig. 19). Post-antennal organ elliptical with chitinous borders, 10 surrounding setae (Fig. 19). Antennae slightly shorter than the head diagonal, covered by numerous acuminate setae of different sizes. Ratio antennae: head diagonal = 1.2:1. Ant. IV plurichaetotic, with tubuliform subapical organite, 1 dorsolateral microsensillum, protected by 1 curved seta and some sensilla poorly differentiated from the common setae; apical vesicle absent (Fig. 20). Ant. III with about 110 setae, sensory organ composed by 2 broad sensilla partially hidden by an integumentary fold, 2 guard sensilla, 1 lateral microsensillum and 1 dorsolateral microseta (Fig. 20). Ant. II with about 120 setae, 1 proximolateral sensillum, 4 basal microsetae (1 dorsolateral, 1 outer lateral, 1 inner lateral and 1 ventral). Ant. I with 46 setae, 3 ventral basal microsetae. Ratio of antennal segments I: II: III: IV = 1:2.4:2.2:2.7. Chewing mouth parts. Labrum with 4 prelabral setae and 5,5,4 labral setae, inserted on papillae. Maxillary outer lobe trifurcate. Labial palp with 5 papillae and 1 lateral process surpassing the **E** papilla. Linea ventralis with 4+4 setae.

Appendages. Tibiotarsi I, II and III respectively with 23, 28, 57 setae, tenent hair pointed. Unguis long and slender, with 1 inner, 1+1 lateral and 1 dorsal teeth (90 µm); unguiculus long and slender (36 µm), without apical filament. Ventral

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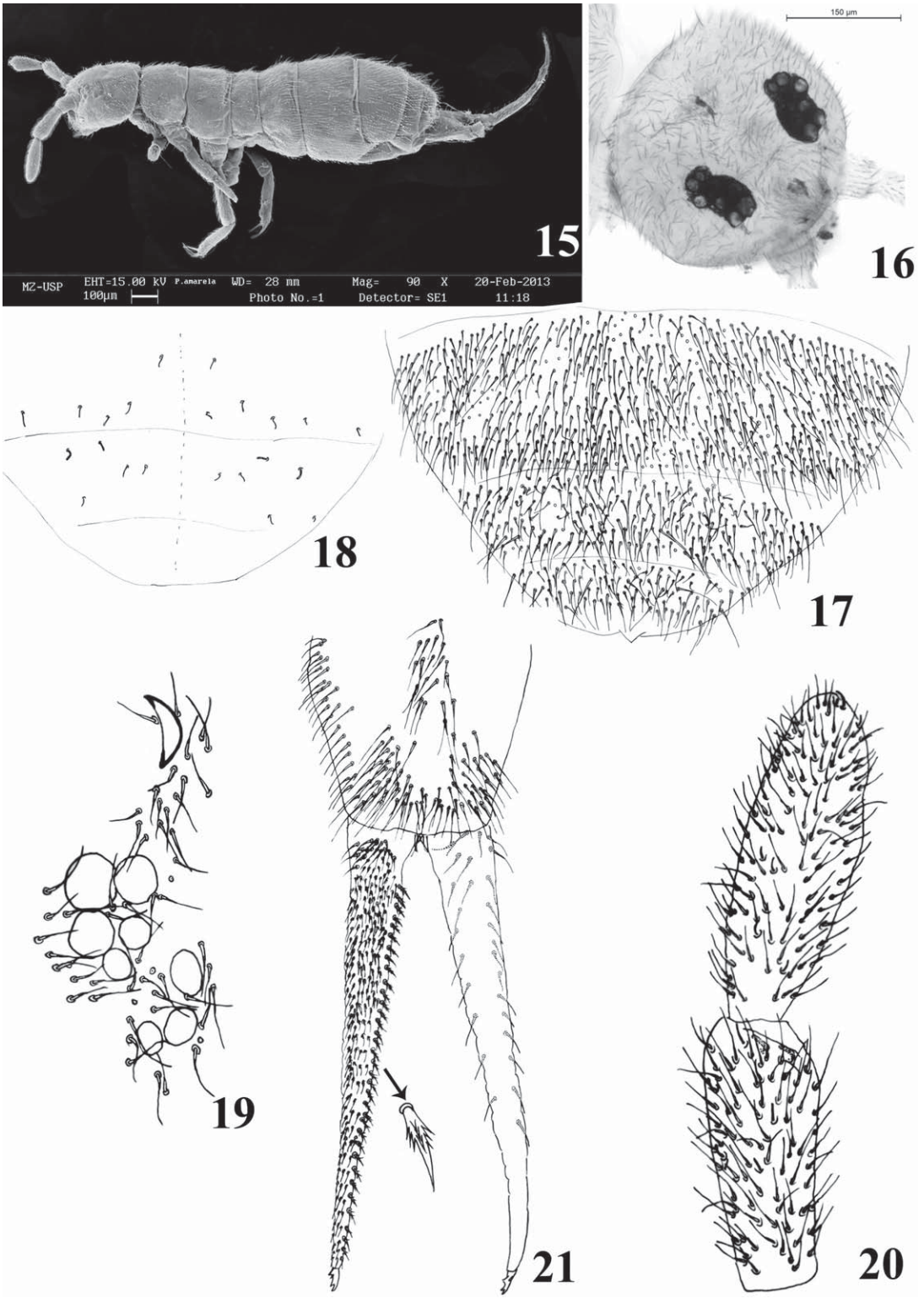


Fig. 15-21. *Paracerura paulista* **sp. nov.** 15, habitus; 16, head; 17, tergal chaetotaxy of abdominal segments IV-VI; 18, tergal sensilla of abdominal segments IV-V; 19, Post-antennal organ and eyes; 20, antennal segments III-IV; 21, furca, with detail to the foil setae.

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tube with 4+4 distal, 3+3 anterior and 4+4 posterior setae. Retinaculum (67 µm) with 4+4 teeth and 9 setae on corpus. Furcal subcoxa anteriorly with 65 setae and posteriorly with about 40 setae. Manubrium with 44+44 basal, no medial, 24 central proximal, and 23+23 lateral setae (Fig. 21). Dens robust and crenulate, with 28 dorsal setae, about 250 ventral setae, and about 32 foil setae (ciliated spiniform setae) in the inner row (Fig. 21). Mucro quadridentate, without seta (Fig. 21). Ratio manubrium: dens: mucro = 8.8:16.8:1.

Discussion.

Paracerura paulista sp. nov. resembles *P. gandarela* and *P. pallida* sp. nov. because of the dark posterior borders of Abd. IV-VI, and the small number of sensilla on Abd. IV, differing from *P. gandarela* by the presence of 6 sensilla on Abd. V, the number of setae on the ventral tube, 3+3 anterior, 4+4 distal and 6 posterior; the other species have 7 sensilla on abdominal segment V and 6+6, 6+6 and 8 setae on the ventral tube, respectively. *Paracerura paulista* sp. nov. differs from *P. pallida* sp. nov. in the number of sensilla on Abd. IV, V, as 3,4 **accp** and 3,2 **as** in the new species and 1,3 and 4,3 respectively. Also, the sensillary chaetotaxy of the new species differs from all congeners (Table 1).

Etymology

The name *paulista* refers to a native of the State of São Paulo.

KEY TO THE SPECIES OF *PARACERURA* DEHARVENG & OLIVEIRA, 1994

1.— Inner margin of dens without spiniform setae 2

1'.— Inner margin of dens with spiniform setae 3

2.— Abdominal segments IV-V with 8 and 5 sensilla, respectively . . . . . *P. airesi*

2'.— Abdominal segments IV-V with 12 and 7 sensilla, respectively . . . . . *P. virgata*

3.— Inner margin of dens without ciliated spiniform setae 4

3'.— Inner margin of dens with foil setae (ciliated spiniform setae) (Fig. 22) 5

4.— Dens with 15 or fewer spiniform setae and fewer than 50 anterior setae . . . . . *P. itatiaiensis*

4'.— Dens with 20 or more spiniform setae and more than 200 anterior setae . . . . . *P. serrana*

5.— Abdominal segment V with 6 sensilla, dens with more than 30 foil setae 6

5'.— Abdominal segment V with 7 sensilla, dens with fewer than 25 foil setae 7

6.— Abdominal segment IV with 6 sensilla, dens with 28 posterior seta and 32 foil setae on inner margin . . . . . *P. paulista* **sp. nov.**

6'.— Abdominal segment IV with 5 sensilla, dens with 24 posterior setae and 37 foil setae on inner margin . . . . . .*P. pallida* **sp. nov.**

7.— Abdominal segment IV with more than 10 sensilla . . . . . *P. pindorama*

7'.— Abdominal segment IV with 8 sensilla or fewer 8

8.— Abdominal segment IV with 6 sensilla, dens with 90 anterior and 20-25 posterior setae . . . . . .*P. gandarela*

8'.— Abdominal segment IV with 8 sensilla, dens with about 55 anterior and 8 posterior setae . . . . . *P. cristinae* **sp. nov.**

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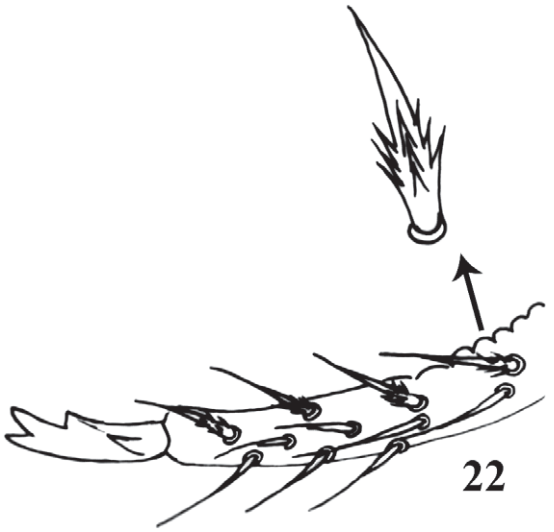


Fig. 22. Foil setae (ciliated spiniform setae) of dens.

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