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

RESULTS AND DISCUSSION

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

Type Material

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.

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.
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.
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; macroseta 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 cuticular 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 organs, 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 them 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 dorsolateral, 1 outer lateral, 1 inner lateral and 1 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 trichurcete, 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, Jun-diaí, 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; macrosensillum long and slender (Fig. 11), Abd. IV-V with 4, 4 accp and 4, 3 as respectively (Fig. 11).
### Table 1. Diagnostic Characters of *Paracerura* species.

<table>
<thead>
<tr>
<th>Features</th>
<th><em>airesi</em></th>
<th><em>serrana</em></th>
<th><em>itatiaiensis</em></th>
<th><em>virgata</em></th>
<th><em>gandarela</em></th>
<th><em>pindorama</em></th>
<th><em>cristinae</em></th>
<th><em>paulista</em></th>
<th><em>pallida</em></th>
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</thead>
<tbody>
<tr>
<td>Body length (mm)</td>
<td>1.43</td>
<td>1.58</td>
<td>up to 1.10</td>
<td>0.7 – 1.1</td>
<td>1.09</td>
<td>1.25</td>
<td>1.1</td>
<td>1.6</td>
<td>1.65</td>
</tr>
<tr>
<td>Color pattern</td>
<td>bluish</td>
<td>brownish</td>
<td>violaceous</td>
<td>yellowish</td>
<td>yellowish</td>
<td>yellowish</td>
<td>bluish</td>
<td>yellowish</td>
<td>white</td>
</tr>
<tr>
<td>At. IV subapical microsensilla</td>
<td>+</td>
<td>—</td>
<td>?</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td>Ant. IV subapical organite</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>—</td>
<td>+</td>
<td>+</td>
<td>—</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ant. III organ sensilla</td>
<td>partially covered</td>
<td>covered</td>
<td>covered</td>
<td>long/exposed</td>
<td>partially covered</td>
<td>partially covered</td>
<td>partially covered</td>
<td>covered</td>
<td>partially covered</td>
</tr>
<tr>
<td>Ant. I microseta</td>
<td>3 d/2 v</td>
<td>4 d/3 v</td>
<td>?</td>
<td>2 d/2 v</td>
<td>2 d/3 v</td>
<td>2 d/3 v</td>
<td>2 d/4 v</td>
<td>2 d/3-4 v</td>
<td>1 d/3 v</td>
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<td>Plurichaetosis</td>
<td>-</td>
<td>+</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+</td>
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<tr>
<td>Tergal sensillay formula</td>
<td>4,4/3,3,8,5</td>
<td>4,4/3,3,12,9</td>
<td>?</td>
<td>4,4/3,3,12,7</td>
<td>4,4/3,3,2,6,7</td>
<td>4,4/3,3,3,12-14,7</td>
<td>4,4/3,3,3,8,7</td>
<td>4,4/3,3,3,6,6</td>
<td>4,4/3,3,3,5,6</td>
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<tr>
<td>Abd IV-V accp sensillae</td>
<td>5, 2</td>
<td>9, 4</td>
<td>?</td>
<td>8, 3</td>
<td>6, 5</td>
<td>7, 2</td>
<td>4, 4</td>
<td>3, 4</td>
<td>1, 3</td>
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<td>Abd IV-V as sensillae</td>
<td>3, 3</td>
<td>3, 5</td>
<td>?</td>
<td>4, 4</td>
<td>0, 2</td>
<td>5, 5</td>
<td>4, 3</td>
<td>3, 2</td>
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<td>Unguiculus apical filament</td>
<td>—</td>
<td>+</td>
<td>+</td>
<td>—</td>
<td>—</td>
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<td>—</td>
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<tr>
<td>Ventral tube setae</td>
<td>4+4 d</td>
<td>7+7 d</td>
<td>?</td>
<td>3+3 d</td>
<td>6+6 d</td>
<td>3,4+3,4 d</td>
<td>3+3 d</td>
<td>4+4 d</td>
<td>4+4 d</td>
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<td>Retinaculum setae</td>
<td>4-6</td>
<td>7-10</td>
<td>?</td>
<td>4-5</td>
<td>5-6</td>
<td>4-7</td>
<td>6-7</td>
<td>9</td>
<td>8-10</td>
</tr>
<tr>
<td>Furcal subcoxa setae</td>
<td>9-17 a</td>
<td>31-36 a</td>
<td>?</td>
<td>14-18 a</td>
<td>16 a</td>
<td>16 a</td>
<td>13 a</td>
<td>65 a</td>
<td>52 a</td>
</tr>
<tr>
<td>Dens setae</td>
<td>5+5-6-6 d</td>
<td>24+24 d</td>
<td>6+6 d</td>
<td>3+3-4+4 d</td>
<td>25+25 d</td>
<td>19+19 d</td>
<td>5+5 d</td>
<td>44+44 d</td>
<td>44+44 d</td>
</tr>
<tr>
<td>Dens spiny setae</td>
<td>75-80 a</td>
<td>240 a</td>
<td>≤ 50 a</td>
<td>56-59 a</td>
<td>90 a</td>
<td>125 a</td>
<td>55 a</td>
<td>250 a</td>
<td>250 a</td>
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<tr>
<td>Brazilian distribution</td>
<td>Tendercins</td>
<td>Minas Gerais</td>
<td>Rio de Janeiro</td>
<td>Amazonas</td>
<td>Minas Gerais</td>
<td>Espirito Santo</td>
<td>Sao Paulo</td>
<td>Sao Paulo</td>
<td>Sao Paulo</td>
</tr>
</tbody>
</table>

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.
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 (ciiated 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.

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 tegrite 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 setae, 1 proximolateral sensillum, 4 basal microsetae and 1 tympanal organ (accessible by 1 curved seta and some poorly differentiated sensilla from the common setae); apical vesicle absent (Fig. 12). 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 setae, 1 proximolateral sensillum, 4 basal microsetae and 1 tympanal organ (accessible by 1 curved seta and some poorly differentiated sensilla from the common setae); apical vesicle absent (Fig. 12). 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 setae, 1 proximolateral sensillum, 4 basal microsetae and 1 tympanal organ (accessible by 1 curved seta and some poorly differentiated sensilla from the common setae); apical vesicle absent (Fig. 12). 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 setae, 1 proximolateral sensillum, 4 basal microsetae and 1 tympanal organ (accessible by 1 curved seta and some poorly differentiated sensilla from the common setae); apical vesicle absent (Fig. 12).
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.
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 subcoxeter 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 accep 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.*

Acknowledgments

EAA thanks the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for a Post-Doctoral fellowship (process number 2012/12959-8). Our thanks to all the staff members of the Museu de Zoologia da Universidade de São Paulo for their help with the Collembola collection, especially to Lara Maria Guimarães for her technical support during image processing with SEM and MSc Anderson Muñoz Quintero for his help revising the Spanish version of our abstract. To Letizia Migliore from Butantan for the triage of collembolans from Serra do Japi. To Dr. Maria Cleide de Mendonça (Museu Nacional, Universidade Federal do Rio de Janeiro) for her constant and crucial scientific support.
provided during many years as advisor of the senior author, and to all collaborators of the Laboratory of Collembola of the Museu Nacional/Universidade Federal do Rio de Janeiro. The second author has been supported by a CNPq fellowship (process number 305905/2012-0). To Dr. Janet W. Reid from Virginia Museum of Natural History for the English review of the manuscript.

To the anonymous reviewers for providing valuable suggestions for this paper.

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