ZOOLOGIA 31 (5): 489–495, October, 2014
http://dx.doi.org/10.1590/S1984-46702014000500009

A new species of *Seira* (Collembola: Entomobryidae: Seirini) from Northern Brazil, with the addition of new chaetotaxic characters

Nikolas Gioia Cipola[1,3], José Wellington de Morais[1] & Bruno Cavalcante Bellini[2]

[1] *Laboratório de Sistemática e Ecologia de Invertebrados do Solo, CPEN, Instituto Nacional de Pesquisas da Amazônia. Avenida André Araújo 2936, Aleixo, Caixa Postal 478, 69011-970 Manaus, AM, Brazil.*
[2] *Programa de Pós-graduação em Sistemática e Evolução, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte. Rodovia BR 101, Lagoa Nova, Campus Universitário, 59072-970 Natal, RN, Brazil.*
[3] *Corresponding author: Email: nikolasgc@gmail.com*

ABSTRACT. *Seira caerucinerea* **sp. nov.**, a new species of springtail from the Cerrado domain, state of Tocantins, Brazil, is described and illustrated. The new species is mainly characterized by bluish-gray coloration and dorsal chaetotaxy presenting macrochaeta S7 on head, three macrochaetae (a6, m6 and p6) on margin of metathorax and 4+4 macrochaetae (a1, m2, m3 and m4i) on abdomen I. Characteristics of maxillary and labial papillae, chaetotaxy of subcoxae, collophore, ventral region of head, ventral and lateral region of abdomen IV and V, which are usually omitted in species descriptions within the genus, are also provided. This is the first species of *Seira* described from the Cerrado domain, as well as the first record of the genus from the state of Tocantins.

KEY WORDS. Biodiversity; Cerrado; Seirinae; taxonomy; Tocantins.

Seira Lubbock, 1870 includes epiedaphic springtails found mostly in litter, from low vegetation to canopy and over uncovered top soils, primarily in tropical landscapes (Christiansen & Bellinger 2000). It is the fourth most diverse genus of Entomobryidae and the most diverse taxon among the Seirini, comprising around 200 described species worldwide (Bellinger *et al*. 2014). In the Americas 60 species of the genus have been recorded (Christiansen & Bellinger 2000), half of them from Brazil, mostly from the Northeastern Region of the country (Godeiro & Bellini 2014). From the Northern Region of Brazil, only *S. nigrans* (Arlé, 1959) and *S. xinguensis* (Arlé, 1959) were recorded until now (Godeiro & Bellini 2014, Cipola *et al*. 2014).

The closest genus to *Seira* is possibly *Tyrannoseira* Bellini & Zeppelini, 2011, and both taxa share similar mucronal morphology, overall dorsal chaetotaxy, and habitus. On the other hand, *Seira* presents a more variable dorsal chaetotaxy, with macrochaetae M1 and M2 present or absent on head; first abdominal segment with or without macrochaetae (absent in *Tyrannoseira*); and the first pair of legs of males devoid of any clear dimorphic structures (Bellini & Zeppelini 2011).

Herein we present a new species of Neotropical *Seira* from the Cerrado Phytogeographic Domain, state of Tocantins, Northern Region of Brazil. The description also presents some data usually omitted in descriptions for the genus.

MATERIAL AND METHODS

The specimens were collected from leaf litter, preserved in 80% ethanol, clarified with potassium dichromate ($K_2Cr_2O_7$) and hydrochloric acid (HCl), and mounted on glass slides with Hoyer medium following the procedures described by Arlé & Mendonça (1982) and Christiansen & Bellinger (1998). One specimen was photographed in ethanol gel using a stereomicroscope (M165C) attached to a DFC420 digital camera. Photographs were digitally corrected using Leica Application Suite V3.4.1. The general chaetotaxy system used in the descriptions follows Jacquemart (1974) modified by Christiansen & Bellinger (2000); labial chaetotaxy follows Fjellberg (1999); maxillary palp follows Mari Mutt (1986); and detailed dorsal chaetotaxy follows Szeptycki (1979) and Soto-Adames (2008). Symbols used to depict the chaetotaxy are: large empty circles refer to macrochaetae; small empty circles to mesochaetae; small black circles to microchaetae; large empty circles with a small black dot inside to micro or macrochaetae; line over circles to chaeta present or absent; large black circles with two cross lines to pseudopores; two cross lines to scales; small curved seta to microsensillum; long multiciliated setae to bothriotricum; and triangle near bothriotricum to fan-shaped microchaetae. The material examined is deposited in the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus.

TAXONOMY

Seira caerucinerea **sp. nov.** Cipola & Bellini

Figs 1-33

Diagnosis. Distinguished by bluish-gray coloration (Fig. 1), head dorsal chaetotaxy with macrochaeta **A5** present in Jacquemart's region 1; 3+3 macrochaetae (M4, S6 and S7) in Jacquemart's region 3; seven to eight macrochaetae (M1, M2, S0, S1, S2, S3, S4 and S5) in Jacquemart's region 4, S5 as macro or microchaeta; 1+1 (Pa5) in Jacquemart's region 5, mesothorax with 30+30 to 34+34 macrochaetae (a3a+, a3e+, a4+, a4i, a5i, a5i2, a5p, a5, m1ia, m1i, m2i2, m2i, m1, m2, m4i, m4p, m4, p1, p1p, p1i, p1i2, p1ip, p1i2p, p2, p2a, p2p, p2e, p2ep, p2ep2, p3 and p3p), a3a+, a3e+ and m2 present or absent and a4i as macro or microchaeta; metathorax with 12+12 to 13+13 macrochaetae (m1i, a2, p1i, p1, p2, p2a, p2ia, p3, a4, a5, p6, a6 and m6), p2ia as macro or microchaeta; abdomen I with 4+4 macrochaetae (a1, m2, m3, and m4i); abdomen II with 4+4 to 5+5 macrochaetae (a2, m3, m3ei, m3e, and m5), m3ei as macro or microchaeta; abdomen III with 6+6 macrochaetae (m3, am6, pm6, p6, a7, p7i and p7); abdomen IV with 25+25 to 29+29 macrochaetae (A3a, A3, A4, A5, Ae7, B3, B4, B5, B6, C1, C4, E2, E2p, E3, E4, E4p, E4p2, Ee10, F1, F1p, F2, F2p, F3, F3p, Fe2, Fe3, Fe4, Fe5, and Fe6), Ee10, F2p and F3p present or absent and E4p2 as macro or microchaeta; abdomen V with 10+10 macrochaetae (a5, m2, m3, m5, m5e, p1, p3, p4, p5 and one extranumerary) (Figs 21, 23-29, 32).

Description. Total length of the holotype 2.39 mm. Habitus typically entomobryid (Fig. 1). Specimen with bluish-gray color covering the entire body and segments; eye patches area black (Fig. 1). Striated, apically rounded brownish scales covering antennae I and II, basal half of antennae III, head, thorax, abdomen, all segments of legs (except over empodia), collophore, both faces of manubrium and anterior face of dens. Fourth antennal segment not annulated, with a bilobed apical bulb, and smooth and ciliated setae (Fig. 2). Eye patches oval, with largest ocelli A and B and smallest ocellus H, with six interocular setae (Fig. 3). Four prelabral ciliated setae and 14 labral smooth setae (5/5/4), four anterior (a1 and a2), five median (m0, m1 and m2) and five posterior (p0, p1 and p2) (Fig. 4). Labial region with seta r reduced, M1, M2, E, L1 and L2 ciliated, A1, A2, A3, A4 and A5 smooth (Fig. 5). Labium with five smooth proximal setae. Labial palp with five papillae (A-E), A and C simple, B with three smooth setae (b1, b3 and b4), D with four smooth setae (d1, d2, d3 and d4), and E with lateral process (l.p.) smaller than the papilla and four smooth setae (e1, e2, e3 and e6) (Fig. 6). Maxillary palp with one smooth apical seta (a.s.) and one basal seta (b.s.) the same length (Fig. 7). Left mandible with four incisive teeth, right mandible with five; both mandibles with five molar teeth (Fig. 8). Maxillae with three teeth and one basal spine (Fig. 9). Head ventral chaetotaxy as in Fig. 10. First subcoxa with a row of five to six ciliated macrochaetae and two anterior pseudopori; second subcoxa with an anterior row (a) of eight macrochaetae, posterior row (p) of five macrochaetae and four pseudopori; third subcoxa with a row of 12 anterior macrochaetae plus two posterior macrochaetae and two anterior pseudopori (Figs 11-13). Trochanteral organ V-shaped with approximately 30 spine-like setae (Fig. 14). Pro-, meso- (Fig. 15, same morphology) and metaungues (Figs 16, 17) with four inner teeth, one pair at the base and two unpaired teeth at the apex. Unguiculi trilamelate, acuminate, with two smooth edges and one serrate. Tenent hairs capitate with slightly serrated edges. Tibiotarsus III with a smooth distal seta with enlarged base, near the empodium (Fig. 16). Collophore anterior side with six long ciliated setae; lateral side with seven smooth setae, and twelve ciliated setae; and posterior side with four ciliated setae (Fig. 18). Subapical ventral setae of manubrium with 8+8 subapical setae, 7+7 of them on transversal line, one posterior; complete ventral chaetotaxy of manubrium as in Fig. 19. Dens with two rows distally of ciliated setae and mucro typically falcate (Fig. 20). General distribution pattern of dorsal macrochaetae (head and trunk) is shown in Fig. 21.

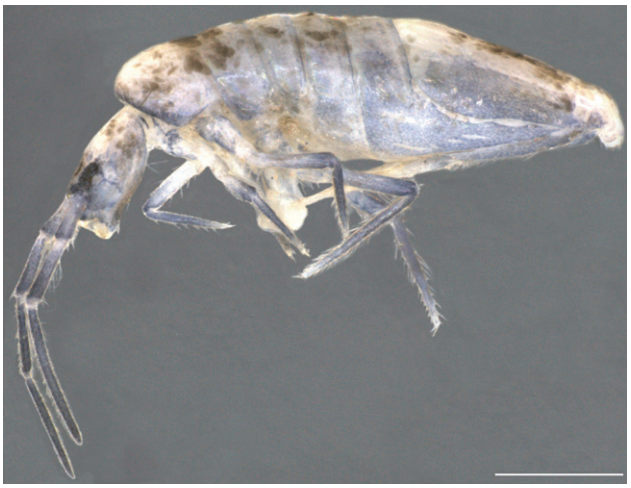
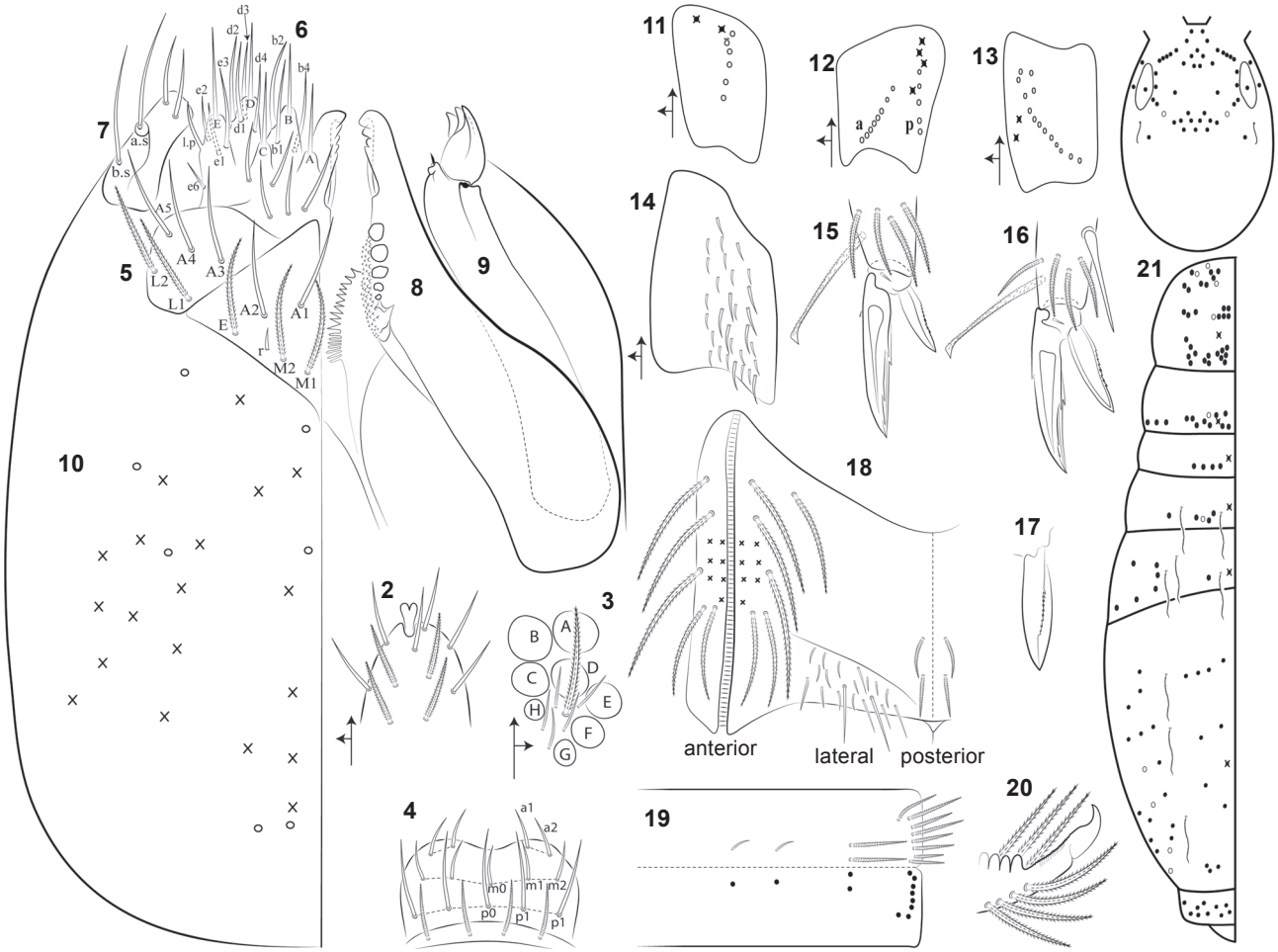


Figure 1. *Seira caerucinerea* **sp. nov.**: habitus of a specimen in ethanol. Scale bar: 0.5 mm.

Dorsal head chaetotaxy (Fig. 23). Antennal series 'An' with 11+11 to 12+12 setae, An1a, An1, An2, An2p, An2p2, An3a2, An3a, An3 as macrochaetae and An2a, An3i, An3i2 (present or absent) and An3p as microchaetae; anterior series 'A' with A0, A2, A3 and A5 as macrochaetae and A1 and A4 as microchaetae; medio-ocellar series 'M' with 5+5 setae, M1, M2 and M4 as macrochaetae, M3 and M4i as microchaetae and one extranumerary microchaeta near M4; sutural series 'S' with S0, S1, S2, S3, S4, S6 and S7 as macrochaetae and S5 as macro or microchaeta; interocular series with 6+6 setae, p as macrochaeta and r, t, q, s and one extranumerary (?) as microchaetae; post-sutural series 'Ps' with 3+3 microchaetae (Ps2, Ps3 and Ps5) and Ps4 absent (typical of *Seira*); postoccipital anterior series 'Pa' with 6+6 setae, Pa5 as macrochaeta, Pa1,



Figures 2-21. *Seira caerucinerea* **sp. nov.**: (2) apical bulb of the fourth antennal segment; (3) eye patch (right); (4) prelabral and labral chaetotaxy; (5) labial region (left); (6) labial palp; (7) maxillary palp; (8) mandible; (9) maxilla (right); (10) head ventral chaetotaxy; (11) subcoxa I; (12) subcoxa II; (13) subcoxa III; (14) trochanteral organ; (15) foot I complex; (16) foot III complex; (17) metaunguiculus (posterior view); (18) collophore chaetotaxy; (19) manubrium chaetotaxy (ventral view); (20) distal dens and mucro; (21) general distribution of dorsal macrochaetae on head and trunk.

Pa2, Pa3 and Pa4 as microchaetae and Pa6 as bothriotricum; postoccipital median series 'Pm' with 2+2 microchaetae (Pm1 and Pm3), Pm2 absent (typical of *Seira*); postoccipital posterior 'Pp' series with 6+6 microchaetae (Pp1, Pp2, Pp3, Pp4, Pp5 and Pp6); postoccipital external series 'Pe' with microchaeta Pe3 present.

Dorsal mesothorax chaetotaxy (Fig. 24). Anterior series 'a' with 11+11 to 13+13 setae, a3e+ complex (one chaeta can be absent), a3a+ complex (one seta can be absent), a4+, a5i2, a5i, a5p and a5 as macrochaetae, a4i as macro or microchaeta, a2p and a5ip as microchaetae; medial series 'm' with 15+15 to 16+16 setae; m1ia, m1i, m2i2, m2i, m1, m2 (present or absent), m4i, m4p and m4 as macrochaetae, m1i3, m1i2, m4ip, m5a, m5 and m5p as microchaetae and one extranumerary microchaeta of uncertain homology (?) between m1ia and m1i2; posterior series 'p' with 20+20 setae; "PmA" group (see Soto-Adames 2008) with six macrochaetae (p1, p1p, p1i2p, p1i, p1ip and p1i2) and one extranumerary microchaeta (?); "PmB" group with three macrochaetae (p2, p2a and p2p) and one extranumerary microchaeta (?); "PmC" group with five macrochaetae (p3, p3p, p2e, p2ep and p2ep2) and p2ea and p4 as microchaetae. Microchaetae p5 and p6 present; p6e, p6ep, p6ep2 and p6ep3 missing.

Dorsal metathorax chaetotaxy (Fig. 25). Series 'a' with 6+6 setae, a2, a4, a5 and a6 as macrochaetae, a1 and a7 as microchaetae; series 'm' with 10+10 setae, m1i and m6 as macrochaetae, m6p as mesochaeta, m1, m4, m5, m6p2, m7 and one extranumerary (?) as microchaetae and m7e as

microsensillum; series 'p' with 10+10 setae, p1i, p1, p2, p2a, p3 and p6 as macrochaetae, p2ia as macro or microchaeta and p2ea, p4 and p5 as microchaetae.

Dorsal abdominal segment I chaetotaxy (Fig. 26). Series 'a' with 8+8 setae, a1 as macrochaeta, a1a, a1e, a2, a3, a5 and a6 as microchaetae and a6e as microsensillum; series 'm' with 6+6 setae, m2, m3 and m4i as macrochaetae and m4, m5 and m6 as microchaetae; series 'p' with 2+2 microchaetae (p5 and p6).

Dorsal abdominal segment II chaetotaxy (Fig. 27). Series 'a' with 7+7 setae, a2 as macrochaeta, a3, as, a6 and a7 as microchaetae, a2p as fan-shaped microchaeta and a5 as bothriotricum with six surrounding fan-shaped microchaetae; series 'm' with 8+8 setae, m3, m3e and m5 as macrochaetae, m3ei as macro or microchaeta, m3ea, m6 and m7 as microchaetae and m2 as bothriotricum with four surrounding fan-shaped microchaetae; series 'p' with 3+3 setae, p6 as mesochaeta and p5 and p7 as microchaeta. Microchaeta se present near p6 and seta el missing.

Dorsal abdominal segment III chaetotaxy (Fig. 28). Series 'a' with 8+8 setae, am6 and a7 as macrochaetae, as and a3 as microchaetae, a1, a2 and a6 as fan-shaped microchaetae and a5 as bothriotricum; series 'm' with 6+6 setae, m3 as macrochaeta, m7 as microchaeta, m4 and m3ea fan-shaped microchaetae and m2 and m5 as bothriotrica; series 'p' with 7+7 setae, pm6, p6, p7i and p7 as macrochaetae, p7e as mesochaeta, p5 as microchaeta and p3 as fan-shaped microchaetae. Microchaeta se present between pm6 and p6 and accessory microchaeta d2 present near p5. Eight fan-shaped microchaetae (c3, emp, em and five unnamed) present between bothriotrica a5 and m5 as two unnamed fan-shaped microchaetae surrounding bothriotricum m2. Seta el present as mesochaeta.

Dorsal abdominal segment IV chaetotaxy (Fig. 29). Series 'A' with 7+7 setae, A3a, A3, A4 and A5 as macrochaetae and A1, A2 and A6 as microchaetae; Ae7 present as macrochaeta; series 'B' with 6+6 setae, B3, B4, B5 and B6 as macrochaetae and B1 and B2 as microchaetae; series 'C' with 4+4 setae, C1 and C4 as macrochaeta, C2 and C3 as microchaetae; C1p absent; series 'T' with 8+8 setae, T7 as mesochaeta, T1, T3, T5 and T6 as microchaetae, T2 and T4 as bothriotrica with T1p, s and m as fan-shaped microchaetae near T2 and Pe, T4a and Pi near T4; series 'D' with 6+6 setae, D3p as mesochaeta, D1p, D2a and D2 as microchaetae, D1 as fan-shaped microchaeta and D3 as bothriotricum; series 'E' with 7+7 setae, E2, E2p, E3, E4 and E4p as macrochaetae, E4p2 as macro or microchaeta and E1 as microchaeta; Ee10 macrochaeta present or absent; series 'F' with 4+4 to 6+6 macrochaetae (F1, F1p, F2, F2p, F3 and F3p), F2p and F3p present or absent; series 'Fe' with 5+5 macrochetae (Fe2, Fe3, Fe4, Fe5 and Fe6). Eight extranumerary microchaetae present between the series 'A' to 'E' and microchaeta ps near T7. Posterior margin of abdominal segment IV with 7+7 unnamed mesochaetae.

Lateral abdominal segment IV chaetotaxy (Fig. 30). Series 'G' with G1 as mesochaeta and series 'H' with 4+4 mesochaetae (H1, H2, H3 and H4).

Ventral abdominal segment IV chaetotaxy (Fig. 31). Series 'I' with 4+4 to 5+5 mesochaetae (I1, I2, I3, I4 and I5), I5 present or absent; series 'J' with 3+3 mesochaetae (J1, J2 and J3); series 'K' with 5+5 mesochaetae (K1, K3, K3p, K4 and K5); series 'Ke' with 12+12 to 14+14 mesochaetae (Ke1, Ke2, Ke2p, Ke3, Ke4, Ke5, Ke6, Ke7, Ke8 and five unnamed), two present or absent.

Dorsal abdominal segment V chaetotaxy (Fig. 32). Series 'a' with 5+5 setae, a5 as macrochaeta, a1, a3, as, a3ae and one extranumerary (?) as microchaetae and a6 absent (atypical); series 'm' with 6+6 setae, m2, m3, m5 and m5e as macrochaetae and m5a as mesochaeta; posteroanterior series 'pa' with 4+4 setae, p5a as mesochaeta and p3a, p4a and p6ai as microchaetae and p6ae absent (atypical); series 'p' with 8+8 setae, p0 absent, p1, p3, p4, p5 and one extranumerary (?) as macrochaetae, ap6 and ap6e as mesochaetae and pp6 as microchaeta; posterior-posterior series 'pp' with 3+3 microchaetae (p1p, p3pi and p3pe). One unnamed microchaeta typically present between series 'm' and 'p'.

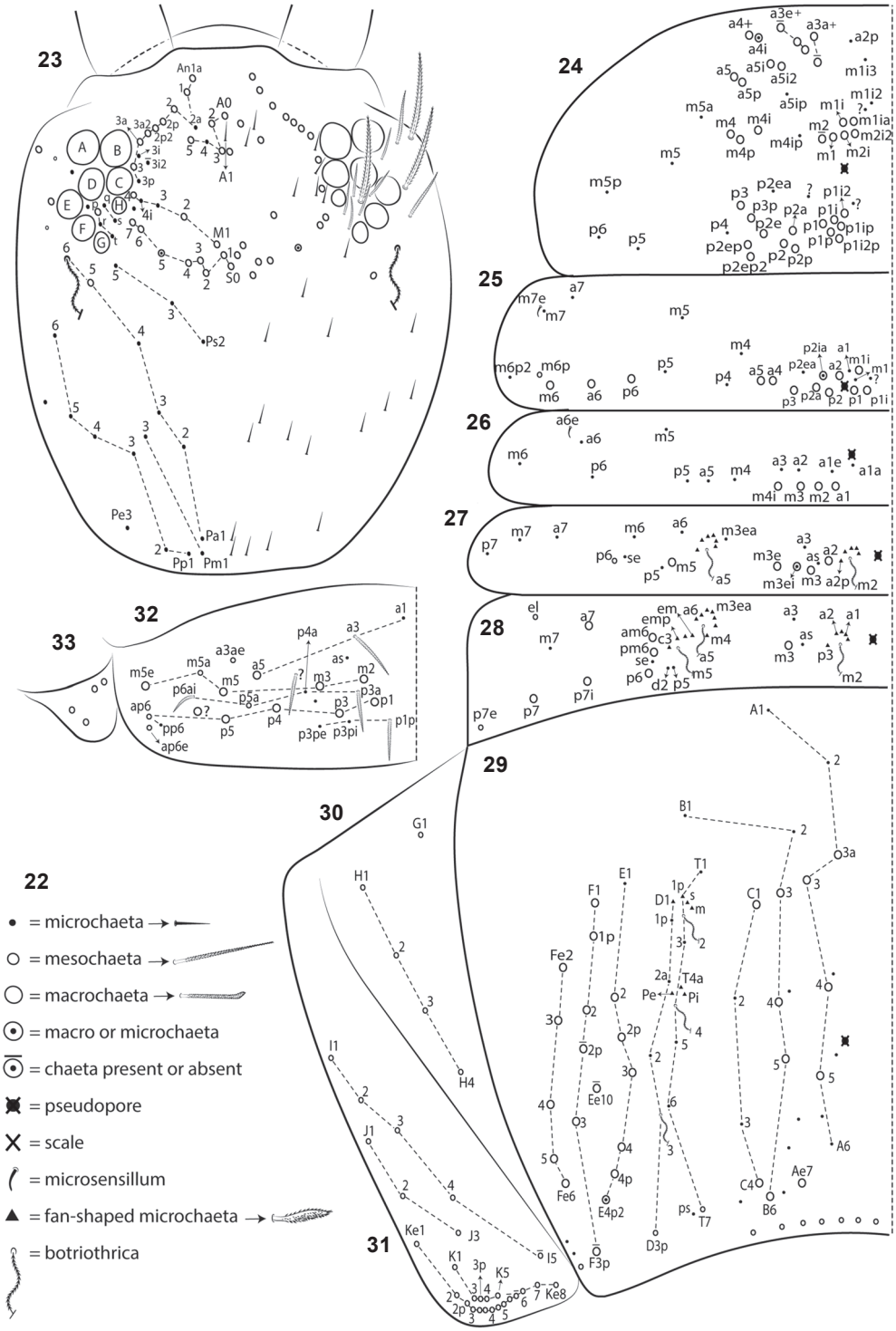
Lateral abdominal segment V chaetotaxy with 4+4 mesochaetae (Fig. 33).

Examined material. Holotype male on slide COLLE 037/INPA, Brasil, *Tocantins*, Palmas, Taquaruçu district, "Fazenda Ecológica de Taquaruçu" (10°15'S, 48°08'W), 13-20.v.2013, pitfall-trap, A. S. Lopes coll. Paratypes: 1 male, 18 females and 2 immature on slides COLLE 037A-T/INPA; and 6 specimens in ethanol 92°GL, same data as holotype.

Etymology. The name "*caerucinerea*" refers to the blue to gray color of the new species (from Latin: *caeruleo* and *cinereo*).

Distribution and habitat. The species was so far only found in its type locality at the state of Tocantins, Brazil. Good's biogeographic zone 27 of the Neotropical region, Highlands of Eastern Brazil: North Brazilian (Good 1974). The climate of the area, according to the Köppen-Geiger system, is tropical (Aw) with predominance of the dry season (Kottek *et al*. 2006). This is the first species of *Seira* described from the Cerrado domain, as well as the first record of the genus from the state of Tocantins.

Remarks. The dorsal pattern of chaetotaxy in *Seira caerucinerea* **sp. nov.** resembles *S. insalahi* Jacquemart, 1974 from Algeria, north Africa, and *S. paraibensis* Bellini & Zeppelini, 2009 from northeastern Brazil. The new species differs from the others by its dorsal head chaetotaxy, which presents seta S4 as macro or microchaeta, and by the presence of interocular (p) macrochaeta (absent in *S. insalahi* and *S. paraibensis*) (Figs 21, 23). *Seira caerucinerea* **sp. nov.** also presents a very peculiar dorsal chaetotaxy on mesothorax, with six macrochaetae in "PmA" group (p1, p1i, p1p, p1ip, p1i2 and p1i2p), whereas there are five in *S. paraibensis* and seven in *S. insalahi*; metathorax with three macrochaetae (a6, m6 and p6) in the lateral margin of tergite; abdominal segment I with four macrochaetae (a1, m2, m3 and m4i); and abdominal segment IV with 25 to 29 macrochaetae (E4p2, Ee10, F2p and F3p present



Figures 22-33. *Seira caerucinerea* **sp. nov.**: (22) symbols used in detailed chaetotaxy schemes; (23) dorsal head chaetotaxy; (24) dorsal mesothorax chaetotaxy; (25) dorsal metathorax chaetotaxy; (26) dorsal abdomen I chaetotaxy; (27) dorsal abdomen II chaetotaxy; (28) dorsal abdomen III chaetotaxy; (29) dorsal abdomen IV chaetotaxy; (30) dorsal abdomen V chaetotaxy; (31) lateral abdomen IV chaetotaxy; (32) ventral abdomen IV chaetotaxy; (33) lateral abdomen V chaetotaxy.

or absent); all these features (Figs 21, 23-29) distinguish the new species from *S. paraibensis* and *S. insalahi*.

In addition to these characteristics, *S. caerucinerea* **sp. nov.** can be distinguished from *S. paraibensis* by the shape of unguiculi, which is acuminate with serrate edges in the new species and truncate with smooth edges in *S. paraibensis* (see Bellini & Zeppelini 2009). Also, *S. caerucinerea* **sp. nov.** is the only one that presents a smooth seta in metaungues (Figs 15-17). Finally, both species present very distinct color patterns.

DISCUSSION

The chaetotaxic characteristics added in the description of *S. caerucinerea* **sp. nov.** are usually omitted in descriptions of *Seira* species and most other Entomobryoidea (ventral head chaetotaxy, prelabral and labral setae, labial papilla setae, maxillary palp setae, chaetotaxy of subcoxae and collophore, lateral and ventral region of the abdominal segments IV and V). These added characteristics provide new directions and features to compare species in the genus and in higher taxa. It is possible that some of these characters can also provide phylogenetic information, since they are stable within the genus, or even within Seirini. For instance, the prelabral and labral setae formulae described for *S. caerucinerea* **sp. nov.** (Fig. 4) can also be observed in *S. urbana* Nguyen, 2001, *S. desapercebida* Soto-Adames, 2002, *S. dinizi* da Gama, 1888 and *S. taeniata* (Handschin, 1925) (see Yosii 1990: 536). Other examples are the five proximal smooth setae and five (A–E) labial papillae (Fig. 6), which are invariant in *Seira* and among the genera of Entomobryidae (Christiansen & Bellinger 1998, Fjellberg 1999, Xu *et al.* 2013). These features were also similarly described for *S. socotrae* Barra, 2004 and *S. vanharteni* Barra, 2004 (see Barra 2004: 404, 406).

Furthermore, other features vary among *Seira* species or at least among the Entomobryidae genera. The chaetotaxy of collophore can be quite variable in species of *Seira* and other Entomobryidae (Yosii 1990, Barra 2004, 2010). However, species like *S. iricolor* Yosii & Ashraf, 1964, *S. oligoseta* Lee & Park, 1989, and *S. vanharteni* have a somewhat similar pattern to *S. caerucinerea* **sp. nov.** (Fig. 18). The chaetotaxy of the maxillary palp and subcoxae were described for other Entomobryidae genera, such as *Acrocyrtus*, *Lepidocyrtus* and *Pseudosinella* (Mari Mutt 1986, Xu *et al.* 2013) and are more stable, especially the first characteristic (Fig. 7). Nevertheless, small differences can be detected among the few descriptions that provide such information. The stability of this particular morphological characteristic can only be proven by means of a revision of the already described species. The ventral chaetotaxy of the head has rarely been described. Only *S. desapercebida* (see Soto-Adames 2002: 96) and *S. caerucinerea* **sp. nov.** descriptions provide this information among Neotropical *Seira* (Fig. 10). This character varies greatly among Entomobryoidea species, but the comparison between the new species and *S. desapercebida* shows some similar (and possibly stable) groups of setae.

Finally, the lateral and ventral chaetotaxy of the abdominal segments IV and V of *S. caerucinerea* **sp. nov.** are described here for the first time for Entomobryoidea (Figs 30, 31, 33). Even if these features are difficult to visualize, they can provide important elements and bring new insights into species comparisons of *Seira* and other Entomobryoidea. New descriptions and revisions will possibly support this point of view and the viability of comparing these taxonomic features.

ACKNOWLEDGMENTS

We thank Ana S. Lopes, Carmen Dionísio (UFT), and Vanessa Ferreira (UFAM) for providing the specimens. The first author is granted by CAPES and CNPq. The last author is granted by CNPq/Programa de Pesquisa em Biodiversidade – Invertebrados (PPBio)/Pró-reitoria de Pesquisa – Universidade Federal do Rio Grande do Norte (PROPESQ – UFRN).

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Submitted: 19.VI.2014; Accepted: 16.IX.2014.
Editorial responsibility: Gabriel L.F. Mejdalani