

New genus and species of Seirini (Collembola, Entomobryidae) from Caatinga Biome, Northeastern Brazil

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ABSTRACT

A new genus and a new species of Seirini (Entomobryidae) are described. The new genus, *Tyrannoseira* n. gen., is represented by three Brazilian *Seira*-like species with a peculiar type of sexual dimorphism: the first pair of legs of adult males bears several spine-like setae in distinct positions, the femur is enlarged and the tibiotarsus is slender. The combination of these morphological features produces clasping structures used during male-male interactions. The new genus is known only from Caatinga, a unique semi-arid biome exclusively present in Brazil. A new species, *Tyrannoseira sex* n. sp., is also described from São João do Cariri, Paraíba State. *Seira raptora* and *S. bicolorcornuta*, described from Caatinga, are also included in the newly described genus. An identification key for the three species of the new genus is also given. Sexual dimorphism and aspects of the systematics of *Seira* are discussed.

KEY WORDS

Collembola,
Entomobryomorpha,
Entomobryidae,
Seirinae,
Seirini,
taxonomy,
Tyrannoseira n. gen.,
new genus,
new species,
new combinations.

RÉSUMÉ

Un nouveau genre et une nouvelle espèce de Seirini (Collembola, Entomobryidae) du biome de Caatinga, nord-est du Brésil.

Un nouveau genre et une nouvelle espèce de Seirini (Entomobryidae) sont décrits. Le nouveau genre, *Tyrannoseira* n. gen., est représenté par trois espèces brésiliennes proches du genre *Seira* avec un type particulier de dimorphisme sexuel : la première paire de pattes des mâles adultes porte plusieurs épines et des soies en positions distinctes, le fémur est élargi et le tibiotarse est mince. La combinaison de ces caractéristiques morphologiques produit des structures qui sont utilisées pendant les confrontations entre les mâles. Le nouveau genre est connu seulement de la caatinga, un biome semi-aride unique existant exclusivement au Brésil. Une nouvelle espèce, *Tyrannoseira sex* n. sp., est également décrite de São João do Cariri, état de Paraíba. *Seira raptora* et *S. bicolorcornuta*, décrites de la caatinga, sont aussi incluses dans le nouveau genre. Une clé d'identification pour les trois espèces du nouveau genre est également donnée. Le dimorphisme sexuel et la systématique de *Seira* sont discutés.

MOTS CLÉS

Collembola,
Entomobryomorpha,
Entomobryidae,
Seirinae,
Seirini,
taxonomie,
Tyrannoseira n. gen.,
genre nouveau,
espèce nouvelle,
combinaisons nouvelles.

INTRODUCTION

Entomobryidae Schött, 1891 is the most diverse family of Collembola with approximately 1700 described species (Bellinger *et al.* 1996-2010; Soto-Adames 2008). The typical entomobryid has long appendages as most species are epiedaphic and the body is covered by scales or small multiciliated microsetae and some macrochaetae. Entomobryidae also have the fourth abdominal segment at least twice as long as the third at the mid-line, there are abdominal botriothricha complexes that include microsetae and fan-shaped scales, crenulate dens and short mucro with one or two well developed teeth (Christiansen & Bellinger 1980, 1998; Soto-Adames *et al.* 2008).

Entomobryidae is separated in two subfamilies: Orchesellinae Börner, 1906 and Entomobryinae Schött, 1891. Within Entomobryinae, there are four recognized tribes: Entomobryini Schött, 1891, Lepidocyrtini Wahlgren, 1906, Willowsini Yoshii & Suhardjono, 1989 and Seirini Yosii, 1961 (Soto-Adames *et al.* 2008). In some classifications, Seirini and Willowsini appear as subfamilies of Entomobryidae (Bellinger *et al.* 1996-2010).

The Seirini (or Seirinae) comprises eight valid genera: *Acanthocyrtus* Handschin, 1925; *Epimetrum*

Schött, 1925; *Lepidocyrtoides* Schött, 1917; *Lepidosinella* Handschin, 1920; *Lepidosira* Schött, 1925; *Seira* Lubbock, 1870; *Sinelloides* Bonet, 1942 and *Vietsira* Yoshii, 1994 (Soto-Adames *et al.* 2008). The most striking morphological characteristic of Seirini is the presence of coarse ribs or denticles covering the scales, which are sometimes pointed (Soto-Adames *et al.* 2008). Approximately 70% of the species of Seirini are *Seira* species (more than 180 species) (Bellinger *et al.* 1996-2010).

In Brazil, the tribe Seirini is represented only by *Lepidosira* (two species) and *Seira* (25 species) (Abrantes *et al.* 2010; Bellini *et al.* 2010). Even though *Seira* is the largest genus of Collembola in the country, little is known about the true diversity of the Brazilian collembolan fauna. Most of the territory has not been well sampled and most biomes, like Pantanal (flood plains in the Central West Region), Cerrado (Brazilian Savanna), Pampa (grasslands in the South Region) and Caatinga (semi-arid landscapes in the Northeastern Region), were almost entirely neglected (Abrantes *et al.* 2010). As an example, only 10 species are, so far, known from Caatinga, seven of which are endemic (Bellini & Zeppelini 2009a).

Herein we describe a new genus of Seirini from Caatinga, *Tyrannoseira* n. gen., to group *Seira*-like spe-

cies with a peculiar sexual dimorphism in Collembola. This condition plus the chaetotaxic features point out to a monophyletic lineage of Seirini. Furthermore, a new species from São João do Cariri, Paraíba State is described belonging to the new genus.

MATERIAL AND METHODS

The specimens were mounted into glass slides following the methodology described by Christiansen & Bellinger (1980). The specimens were observed and their morphology was drawn using a BX-41 Olympus optical microscope bearing a drawing tube. The chaetotaxy schemes follow the system of Christiansen & Bellinger (2000) modified from Jacquemart (1974). The type material of *Tyrannoseira* *sex* n. sp. (holotype and six paratypes) is deposited at the Museu Nacional, Universidade Federal do Rio de Janeiro (CM/MNRJ/UFRJ) and two paratypes (one male and one female) are deposited in the collection of the Muséum national d'Histoire naturelle, Paris (MNHN).

SYSTEMATICS

Family ENTOMOBRYIDAE Schött, 1891
Subfamily ENTOMOBRYINAE Schött, 1891
Tribe Seirini Yosii, 1961

Genus *Tyrannoseira* n. gen.

DIAGNOSIS. — Entomobryid habitus, with body covered by yellowish to brownish apically rounded scales. Eyes 8 + 8. Head chaetotaxy with M2 micro- or mesochaetae, S0-S3 always as macrochaetae, resulting in a cephalic region 4 with a total of 7 macrochaetae (Figs 1; 6). Femora of the first pair of legs on males variably enlarged, bearing a variable number of short and strong spines, concentrated on a ventral projection of the femora (Figs 2; 4F). First pair of tibiotarsi curved on males, bearing a single row of long spine-like setae (Figs 2; 4G). Ungues with four inner teeth, two of them unpaired and two paired at the med-line of the structure. Unguiculi acuminate with weakly serrated edges. Tenent-hairs strong and capitate with slightly serrated edges. Absence of macrochaetae on the first abdominal segment of adults (Figs 1; 6). Dens crenulate, mucro falcate, without dental or mucronal spines (Fig. 4J).

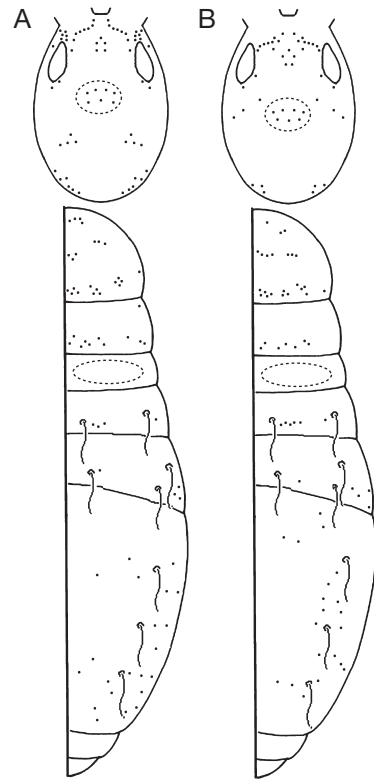


FIG. 1. — Dorsal macrochaetae distribution of: **A**, *Tyrannoseira raptora* (Zeppelini & Bellini, 2006) n. comb.; **B**, *T. bicolorcornuta* (Bellini, Pais & Zeppelini, 2009) n. comb.

TYPE SPECIES. — *Seira raptora* Zeppelini & Bellini, 2006.

OTHER SPECIES OF THE GENUS. — *Tyrannoseira bicolorcornuta* (Bellini, Pais & Zeppelini, 2009) n. comb., described as *Seira bicolorcornuta*; *T. sex* n. sp.

ETYMOLOGY. — From the Greek *tyrannos*: ruler, usurper. *Seira* refers to the clear relationship with the type genus of Seirini.

DISTRIBUTION. — Caatinga biome, Northeastern Brazil. Good's biogeographic zone 27 (Good 1974).

HABITAT. — The three known species of *Tyrannoseira* n. gen. are restricted to Caatinga biome, a semi-arid region exclusively seen in Brazil inside or nearby a sub-region named "Planalto da Borborema". This area is known by a rocky irregular and preeminent relief. The climate of the area is "As" following Koeppen's system, which means an equatorial predominant climate and the precipitation with a clear "dry summer" annual season (Kottek *et al.* 2006).

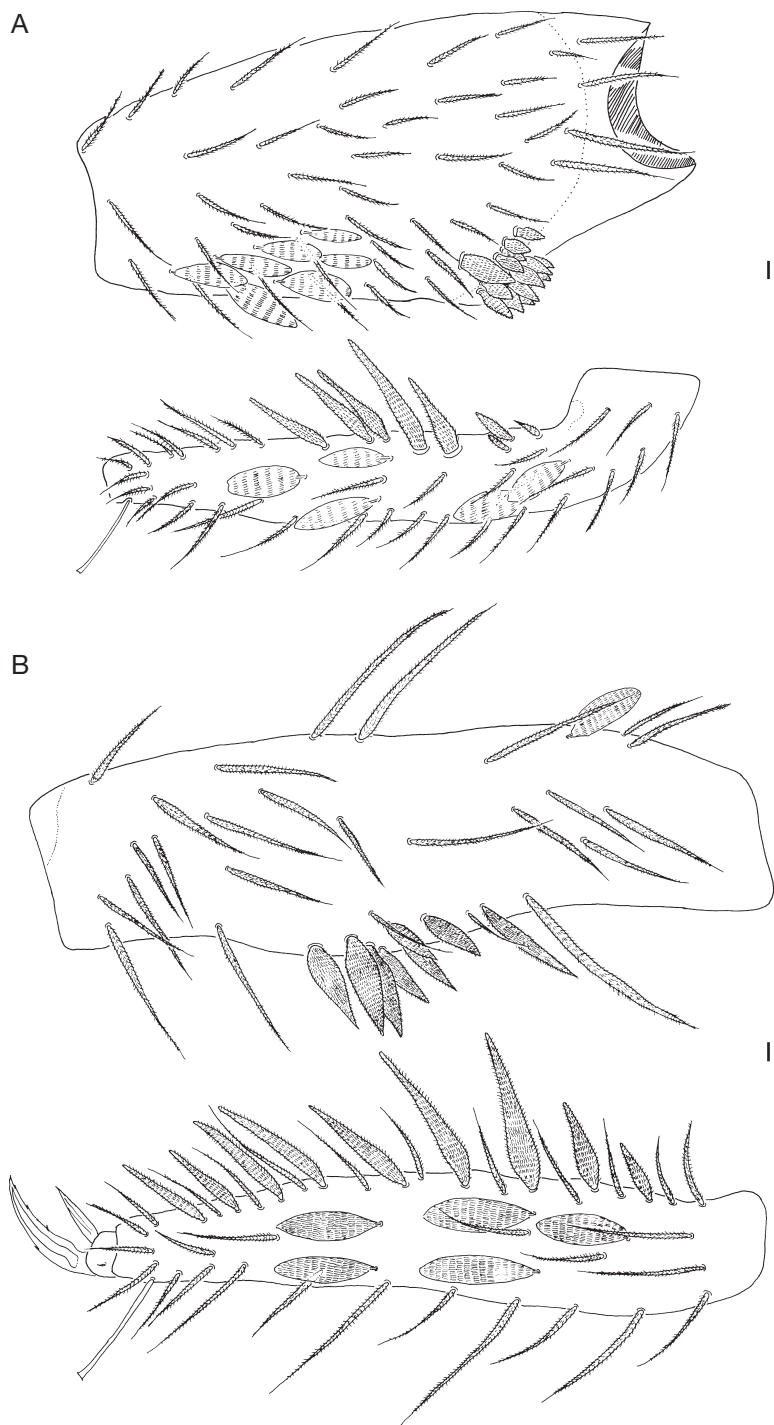


FIG. 2. — Femur and tibia-tarsus of the first pair of legs of males of: **A**, *Tyrannoseira raptora* (Zeppelini & Bellini, 2006) n. comb.; **B**, *T. bicolorcornuta* (Bellini, Pais & Zeppelini, 2009) n. comb. Scale bars: A, B, 10 μ m.

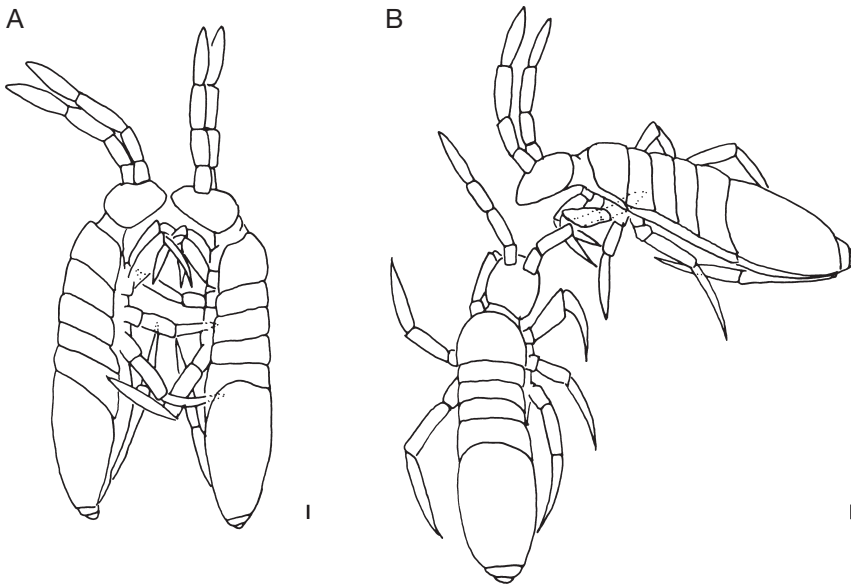


FIG. 3. — Males of *Tyrannoseira raptora* (Zeppelini & Bellini, 2006) n. comb. fighting: **A**, males grabbing each other to strike with legs, antennae and furca; **B**, male grabbing an antenna of another male. Scale bars: A, B, 100 μ m.

REMARKS

Tyrannoseira raptora n. comb. was originally in *Seira* and it fits the current diagnoses of the genus (Zeppelini & Bellini 2006). On the other hand the species, *T. bicolorcornuta* n. comb. and *T. sex* n. sp. are clearly part a of monophyletic lineage inside the genus, as they show a unique type of sexual dimorphism among the Entomobryidae. Other species of *Seira*, like *S. domestica* Nicolet, 1842, *S. mantis* Zeppelini & Bellini, 2006 and *S. uwei* Barra, 2010 also show sexual dimorphic legs (Gisin & Gama 1962; Zeppelini & Bellini 2006; Palacios-Vargas & Castaño Meneses 2009; Barra 2010), but the morphological condition seen in *Tyrannoseira* n. gen. is strikingly different from that of *S. domestica* and related species, suggesting a convergent origin of similar sexual dimorphism in both taxa. The most remarkable difference is seen in male femora, being enlarged with short strong spines emerging from a single spot on the ventral side of each femur in *Tyrannoseira* n. gen. as opposed to normal-shaped femora with large spines in a single row in *S. domestica* group (see Zeppelini & Bellini 2006 and Barra 2010). The tibiotarsi also show

important differences. In *Tyrannoseira* n. gen., the tibiotarsi are clearly curved at the apex and there is only a single row of long spines (Zeppelini & Bellini 2006; Bellini *et al.* 2009). In the *domestica* group, there are several short spines inside three rows at the apex of the tibiotarsi, and the size of spines in the structure is significantly smaller than in *Tyrannoseira* n. gen. (Gisin & Gama 1962; Zeppelini & Bellini 2006; Barra 2010). Despite the size and number of spines, these differences on the legs of both groups also point to a more important feature: many spines, which are originated from setae, are clearly not homologous in *Tyrannoseira* n. gen. and the *domestica* group. To support this theory, there are several important differences on the dorsal chaetotaxy of both groups. There are obvious differences in the distribution of dorsal macrochaetae in all segments, but there is a pattern within each group, especially on the head (7 macrochaetae in *Tyrannoseira* n. gen. and 9 macrochaetae in the *domestica* group on cephalic region 4) and abdominal segment I (no macrochaetae in *Tyrannoseira* n. gen. and 6 + 6 macrochaetae in the *domestica* group). In fact, the constant morphology showed by the *domestica* group

TABLE 1. — General features of species of *Tyrannoseira* n. gen. and *Seira* Lubbock, 1870. Abbreviations: **A-**, minor apical; **M+**, larger medial; +, present; -, absent; ?, not clearly observed.

Species	Lobes on antennal apical bulb	Annulations on 4th antennal segment	Ratio antenna/cephalic diagonal	Number of inner unguinal teeth	Distinctly larger inner unguinal tooth	Number of ventral manubrial subapical setae	Presence of broadened femora in males	Presence of slender tibiotarsi in males	Macrochaetae on abdominal segment I
<i>T. raptora</i> (Zeppelini & Bellini, 2006) n. comb.	1	-	1.923	4	M+, A-	7	+	+	-
<i>T. bicolorcornuta</i> (Bellini, Pais & Zeppelini, 2009) n. comb.	1	-	2.143	4	-	4	+	+	-
<i>T. sex</i> n. sp.	1	-	2.1	4	M+, A-	4	+	+	-
<i>S. domestica</i> Nicolet, 1842	2	+	2.75-3.2	4	M+, A-	4	-	-	+
<i>S. mantis</i> Zeppelini & Bellini, 2006	2	+	3.33	4	M+, A-	6	-	-	+
<i>S. uwei</i> Barra, 2010	?	+-	?	4	M+, A-	4	-	-	+
<i>S. mirianae</i> Arlé & Guimarães, 1981	1-2	-	1.5-2.2	2-3	-	2	-	-	-
<i>S. andensis</i> Jacquemart, 1980	?	-	1.65	3	-	2?	-	-	-

indicates that it is very likely that this set of species also forms a monophyletic lineage inside *Seira*.

Our preliminary studies showed that males of *T. raptora* n. comb. use the first pair of legs, modified into a clasping organ, to grab other males during intrasexual agonistic behavior, when they fight for feeding areas (Fig. 3). This behavior possibly increases access to females, while at the same time it limits the number of reproductive competitors. We expect the same behavior in other members of the new genus.

Our laboratory and field observations showed many important features on the behavior of *T. raptora* n. comb. and *Seira* species that can explain the selection of modified legs in males and the dual origin of this feature in the whole group. First, species of both genera and possibly most Seirini are very active during day time. Aggressive intraspecific behavior was observed in *T. raptora* n. comb., *S. mirianae* Arlé & Guimarães, 1981, *S. mendoncia* Bellini & Zeppelini, 2009, *S. nigrans* Arlé, 1960 and *S. potiguara* Bellini *et al.*, 2010 (Bellini & Zeppelini, unpubl.). The females of *T. raptora* n. comb., which lacks the modified legs, can also fight grabbing each other when they protect feeding areas. We didn't

observe the behavior of males grabbing each other in species other than *T. raptora* n. comb., but the behavior of the females of this last species suggests it is very likely that it occurs in some *Seira* species. In these particular cases, any morphological modification which raises the efficiency in the fights, like the emergence of spines or modifications in the form of the structure to increase the efficiency of grabbing, would be rapidly incorporated into the populations as the males bearing them have higher rates of success during the reproduction process. That would explain the convergent origins of the modified legs in *Tyrannoseira* n. gen. and in the *domestica* group and makes possible the discovery of other groups among the Seirini with minor or major modifications to increase the fitness of the structure.

The combination of head chaetotaxy with mesochaetae M2 as and macrochaetae S0 to S3, and the lack of macrochaetae on abdominal segment I is not exclusive to *Tyrannoseira* n. gen. Two other neotropical *Seira* species, *S. mirianae* and *S. andensis* Jacquemart, 1980 also have the same combination of characters (Christiansen & Bellinger 2000) shown in Table 1. The overall dorsal chaetotaxy of both species is similar to that in *Tyrannoseira* n. gen. spe-

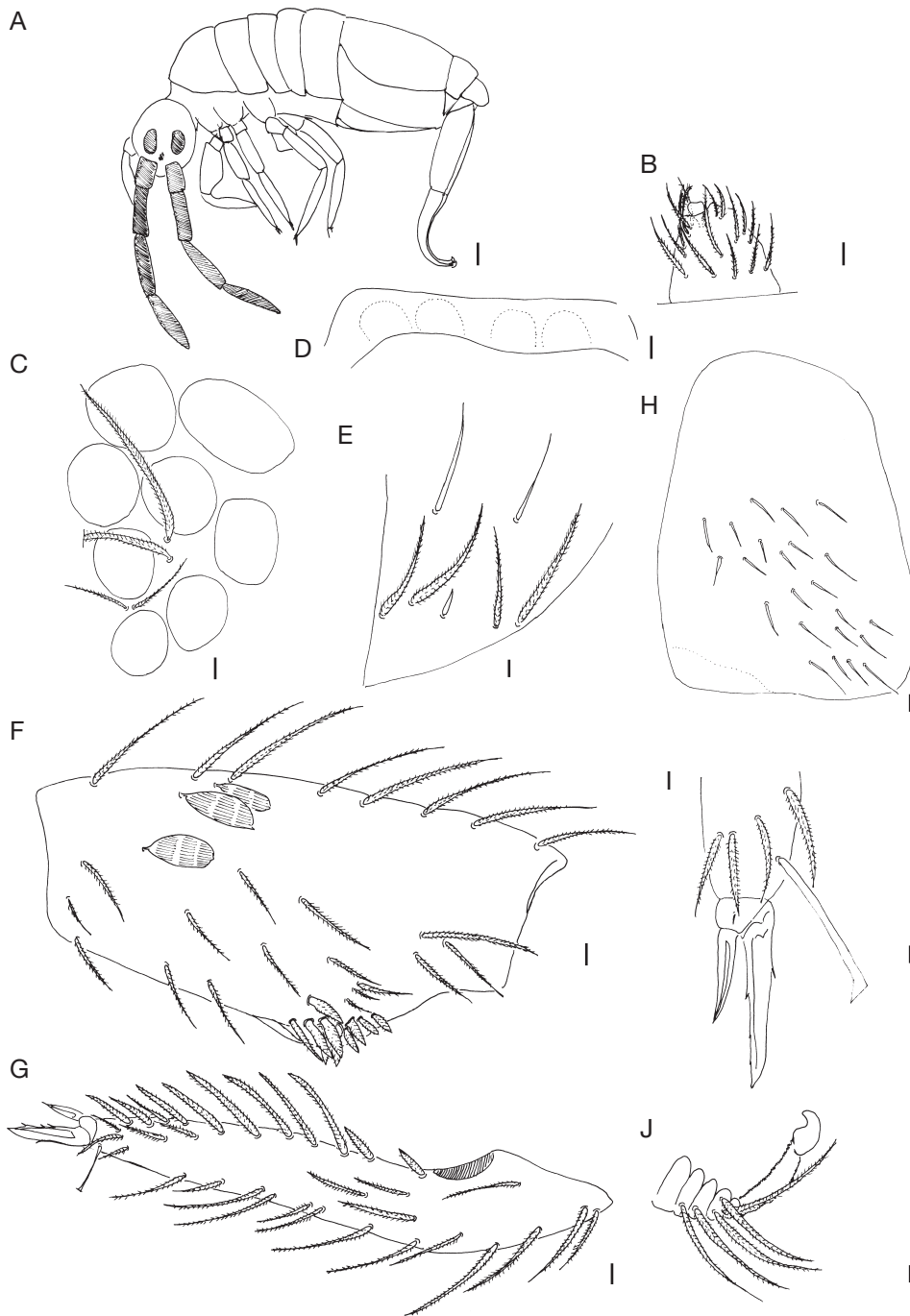


FIG. 4. — *Tyrannoseira sex* n. sp.: **A**, habitus; **B**, apical bulb of the 4th antennal segment; **C**, right eye patch; **D**, labial papillae; **E**, setae of the labial triangle; **F**, anterior femur of males; **G**, anterior tibiotarsus of the males; **H**, trochanteral organ; **I**, second foot complex; **J**, distal dens with mucro. Scale bars: A, 100 μ m; B-J, 10 μ m.

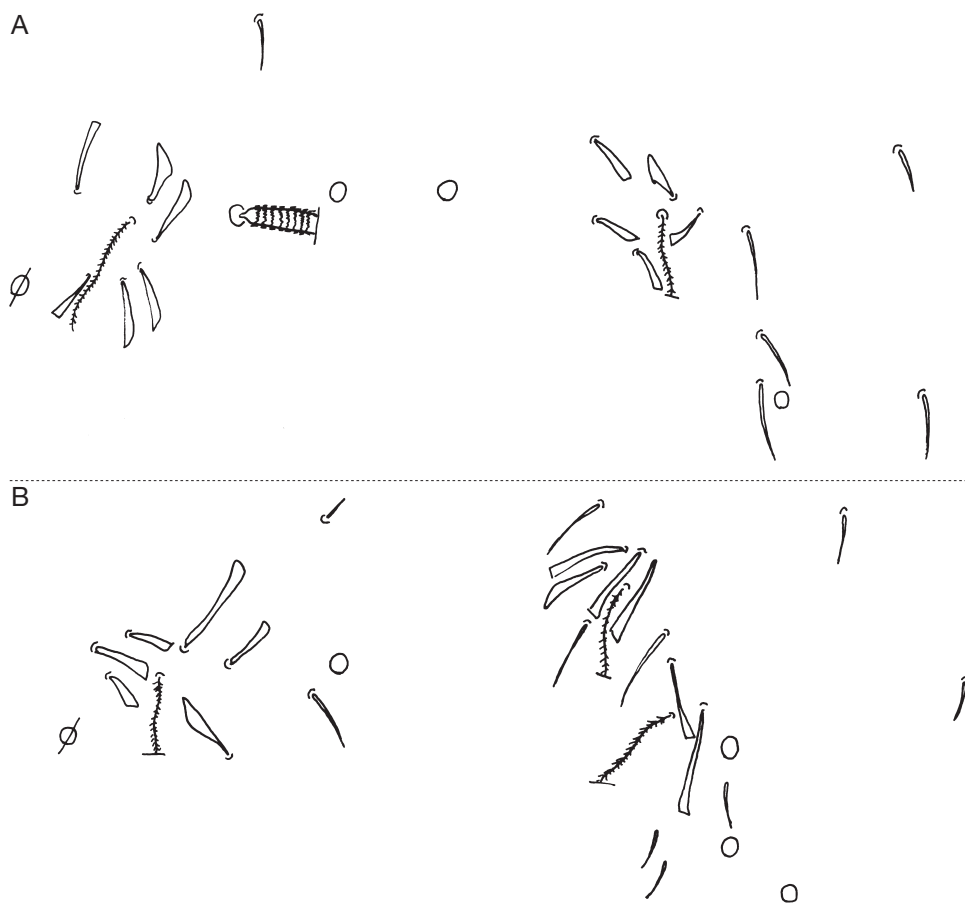


FIG. 5. — *Tyrannoseira sex* n. sp., dorsal chaetotaxy of: **A**, second and **B**, third abdominal segments.

cies. It is very likely that *S. mirianae*, a sympatric species to *T. raptora* n. comb., is closely related to *Tyrannoseira* n. gen. However, only a phylogenetic analysis of *Seira* and *Tyrannoseira* n. gen. could provide support to this hypothesis.

Seira comprises more than 180 described species, many of which are incompletely described. This makes it difficult to produce a rapid and clear comparison among the species. Therefore, a phylogenetic revision and subdivision of the genus into manageable taxonomic groups is urgent. *Seira* is divided into three subgenera (*Afroseira* Yosii, 1959, *Lepidocyrtinus* Börner, 1903 and *Seira* s.s.) (Yosii 1959), but they are not well accepted and rarely used in current taxonomic work (Christiansen &

Bellinger 2000; Barra 2004a, b; Negri *et al.* 2005; Zeppelini & Bellini 2006; Bellini & Zeppelini 2008a, b, 2009b; Soto-Adames *et al.* 2008; Bellini *et al.* 2009, 2010). The most remarkable problem with this subdivision is the large number of species retained in *Seira* s.s. *Afroseira* is represented by only one species, *S. rowani* Yosii, 1959, which lacks the distal pair of botriothricle on the fourth abdominal segment. This particular morphology is probably a pedomorphic character on Seirini, since the first instar of some species (probably all) like *S. dowlingi* Wray, 1959 (Soto-Adames 2008) and *T. raptora* n. comb. lacks these botriothricle. *Lepidocyrtinus* is a group of frequently elongated body species of *Seira* with large blunt setae on the dens, and less than

10 fitting species (Arlé 1959; Yosii 1959; Bellinger *et al.* 1996-2010; Christiansen & Bellinger 2000). In South America, three species of *Lepidocyrtinus* were described by Arlé (1959) as *Ctenocyrtinus*, a genus posteriorly synonymized with *Seira* by Christiansen & Bellinger (2000). While *Afroseira* and probably *Lepidocyrtinus* are monophyletic groups, they are not helpful in making easier the identification of many *Seira* species. The small monophyletic groups represented by *Afroseira*, *Lepidocyrtinus* and *Tyrannoseira* n. gen., leaves a paraphyletic *Seira* s.s. and a phylogenetic analysis of the whole group is needed to shade some light in the relationship in Seirini and test the monophyly of *Seira* s.s.

Tyrannoseira sex n. sp.
(Figs 4-6)

TYPE MATERIAL. — **Brazil.** Paraíba, São João do Cariri, Furna dos Ossos, 15-16.VI.2008, Farias, A.A. Coll, holotype ♂, 6 paratypes (5 ♀♀, 1 ♂) (2175, CM/MNRJ); 2 paratypes (1 ♂, 1 ♀) (EA010032, MNHN).

ETYMOLOGY. — The species was named after its sexual dimorphism.

DISTRIBUTION. — Good's biogeographic zone 27 (Good 1974).

HABITAT. — *Tyrannoseira sex* n. sp. was collected in São João do Cariri municipality, about 200 km from João Pessoa, capital of Paraíba State, northeastern Brazil. The collections were made during the wet season (June 2008) inside an archeological site named "Furna dos Ossos". The climate of the area is "As" following Koeppen's system (Kottek *et al.* 2006) and the flora is hiperxerophytic with areas of typical Caatinga forest.

DESCRIPTION

Total length of the holotype 1.58 mm. Habitus typically entomobryid (Fig. 4A). Color of mounted specimens pale yellow, with light blue pigment covering the antennae and dark blue pigment covering eyepatches and labrum area (Fig. 4A). Yellowish to brownish rounded scales covering head, thorax, abdomen, legs, antennal segments I and II, and basal halves of antennal segments III and IV. Ventral tube without scales. Fourth antennal segment not annulated, with a single apical bulb, without pin setae (Fig. 4B). Eyepatches oval, 8 + 8 lenses, biggest

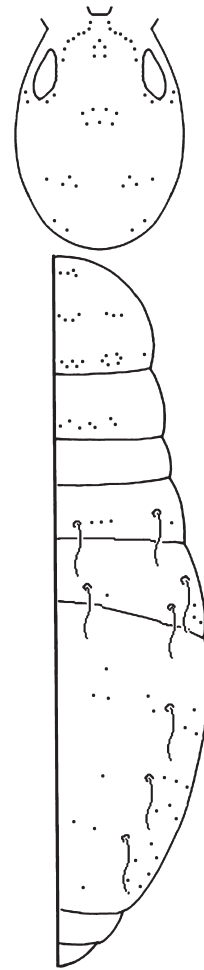


FIG. 6. — Dorsal macrochaetae distribution of *Tyrannoseira sex* n. sp.

lens B and smallest lens G, two interocular feathered mesochaetae and two interocular macrochaetae (Fig. 4C). Pre-labral and labral setae feathered. Labral papillae as show in Figure 4D. Labial triangle seta r reduced M1, M2 and E feathered (Fig. 4E). Femur of the first pair of legs heavily broadened in males, bearing 10 strong spines (Fig. 4F). Male tibiotarsus of first pair of legs apically slender with one row of 10 elongated spine-like setae (Fig. 4G). Trochanteral organ V- shaped with approximately 23 short spine-like setae (Fig. 4H). All unguis with four inner teeth, one pair at the base and two distal

unpaired teeth (Fig. 4I). Unguiculi acuminate, with slightly serrated edges (Figs 4I). Tenent hair capitate, slightly serrated at the edges. Venter of manubrium with 4 + 4 subapical multiciliated setae on a transversal line. No spine-like setae present on manubrium. Mucro typically falcate, without basal spine (Fig. 4J). No macrochaeta on first abdominal segment of adults, dorsal chaetotaxy of second and third abdominal segments as shown in Figure 5. Dorsal macrochaetae distribution on head and body as in Figure 6. Other characters are listed in Table 1.

DISCUSSION

The closest species to *T. sex* n. sp. is *T. raptora* n. comb. Both species share a similar shape of the first pair of legs on males, with heavily broadened femora against the weakly broadened femora seen

in *T. bicolorcornuta* n. comb. *Tyrannoseira sex* n. sp. and *T. raptora* n. comb. also share a similar overall dorsal chaetotaxy, especially on cephalic regions 2, 4 and anterior 6, mesothorax and abdominal segments I, II and III (Figs 1; 6). The distribution of macrochaetae on the metathorax and the labial triangle chaetotaxy of *T. sex* n. sp. is similar to those of *T. bicolorcornuta* n. comb. However, *T. sex* n. sp. can be clearly distinguished from both species by lacking body dark pigment, by the presence of broadened femora with only 10 spines, against 14 or more in *T. raptora* n. comb., by the presence of only 2 + 2 macrochaetae on head's posterior region 6 and by the pattern of macrochaetae on meso- and metathorax and abdominal segment IV (Fig. 6). Other characteristics of *Tyrannoseira* n. gen. species are compared in Table 1 and in the following key.

KEY TO THE CURRENT SPECIES OF *TYRANNOSEIRA* N. GEN.

1. Fixed adult specimens with dark pigment covering the body 2
- Fixed adult specimens pale white or pale yellow, body pigment restrict to eyespots
..... *T. sex* n. sp.
2. First pair of femora on males strongly enlarged, with approximately 14 spines coming out of a same point (Fig. 2A) *T. raptora* n. comb.
- First pair of femora on males weakly enlarged, with approximately 8 spines coming out of a same point (Fig. 2B) *T. bicolorcornuta* n. comb.

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