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Hypogastrura arnei (Collembola, Hypogastruridae), a remarkable new species from the Appalachians (USA)

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Abstract: *Hypogastrura arnei* sp. nov. is described from the USA. This species has a unique combination of morphological characters: an oval and slightly flattened body, a coarse tegumental granulation, a plurichaetotic dorsal chaetotaxy, antennal segment IV with 4-6 lateral sensilla and 1 dorsal cylindrical sensillum, a moderately modified furca and minute anal spines without papilla. The new species is closely related to *H. iwamurai* Yosii, 1960, *H. reticulata* Börner, 1909 and several members of the *nivicola* (= *socialis*), *packardi* (= *sahlbergi*) and *crassaegranulata* groups sensu Christiansen & Bellinger (1980), Babenko *et al.* (1994) and Skarżyński (2009).

Keywords: Springtails - taxonomy - North America - Nearctic.

INTRODUCTION

Hypogastrura Bourlet, 1839, comprising 170 species (Bellinger *et al.,* 2019), is the largest collembolan genus within the family Hypogastruridae. Although the genus is considered cosmopolitan, the vast majority of species lives in the temperate climatic zone of the northern hemisphere. At present, about one hundred species are known in the Palaearctic (Babenko *et al.*, 1994; Thibaud *et al.*, 2004; Babenko & Fjellberg, 2006; Skarżyński, 2006a, b, 2009, 2010, 2011; Fanciulli & Dallai, 2008; Jiang & Chen, 2008; Skarżyński & Kaprus, 2009; Jiang & Yin, 2010, 2012; Skarżyński & Babenko, 2009; Jia *et al.*, 2011; Jiang *et al.,* 2011; Dányi, 2013, Kahrarian *et al.*, 2013; Skarżyński *et al.*, 2017), and only about forty in the Nearctic (Christiansen & Bellinger, 1998; Babenko & Fjellberg, 2006; Skarżyński, 2007; Bernard, 2015). Undoubtedly our knowledge of Nearctic *Hypogastrura* is insufficient and the number of recorded species is underestimated. In the *Hypogastrura* material from the Appalachians (USA), which I obtained from Dr Arne Fjellberg, I found a species new to science. Its description is given below.

MATERIAL AND METHODS

Specimens stored in alcohol were cleared in Nesbitt's fluid (chloral hydrate, concentrated hydrochloric acid, distilled water), slide-mounted in a mixed medium of distilled water, arabic gum, glycerol and chloral hydrate, and studied using a Nikon Eclipse E600 phase contrast microscope. Figures were drawn using a camera lucida. Terminology in the description follows that given in Fjellberg (1984, 1999) and Thibaud *et al.* (2004).

TAXONOMIC PART

Hypogastrura arnei sp. nov.

Figs 1-8

Type material: Male holotype, previously in alcohol, now mounted on permanent slide; USA, Tennessee, Sevier County, Great Smoky Mountains National Park, Clingman's Dome (WGS84 35.56212, -83.50425; 1980 m a.s.l.), moss, fir litter, sample number 07.197; 07.06.2007; leg. A. Fjellberg. – Paratypes: 10 females, 10 males, same data as for holotype. Holotype and 13 paratypes deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C., USA; 5 paratypes in the University of Tennessee Entomology Museum, Knoxville, Tennessee, USA; 2 paratypes in the Muséum d'histoire naturelle de Genève, Switzerland.

Other material: Male on slide; USA, North Carolina, Yancey County, Blue Ridge Parkway, Balsam Gap Overlook (WGS84 35.74837, -82.33337; 1650 m a.s.l.), red spruce litter, sample number 07.167; 04.06.2007;

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leg. A. Fjellberg (deposited in the University of Tennessee Entomology Museum, Knoxville, Tennessee).

Comparative material examined: *Hypogastrura iwamurai* Yosii, 1960: female, previously in alcohol, now mounted on permanent slide, 16 specimens in alcohol; Japan, Hyonosen; 28.08.1938; leg. Yosii. – *Hypogastrura reticulata* Börner, 1909: female, previously in alcohol, now mounted on permanent slide, about 50 specimens in alcohol; Japan, Daimonji, Kyoto; 20.12.1953; leg. R. Yosii. All specimens deposited in the Muséum d'histoire naturelle de Genève, Switzerland.

Etymology: This species is dedicated to Dr Arne Fjellberg, an excellent specialist in Collembola.

Diagnosis: Body oval and slightly flattened. Tegumental granulation coarse. Chaetotaxy plurichaetotic. Antennal segment IV with 4-6 lateral sensilla and 1 dorsal cylindrical sensillum. Postantennal organ equal to or slightly smaller than neighboring ocelli. Labrum with distinct apical papillae. Tibiotarsi with one clavate tenent hair. Empodial lamellae broad. Ventral tube with 4 + 4 setae. Retinaculum with 4 + 4 teeth. Dens with 7 setae and fine, uniform granulation including some slightly larger granules in distal part. Mucro with low lamellae and small subapical tooth. Anal spines minute, papilla absent.

Description: Body length 1.1-1.6 mm. Body oval (Fig. 1) and slightly flattened, abdominal segment VI short and rounded at tip. Color in alcohol uniformly dark blue-grey, eye-patches black. Tegumental granulation coarse and uniform, 3-5 granules between setae p_1 on abdominal tergum V (Fig. 3).

Chaetotaxy of head typical of the genus, with complete set of v-setae. Setae slightly different in lengths (especially on last abdominal segments) and curved. Body sensilla (s) about two times longer than microsetae, fine and smooth. Thoracic tergum I with 3 + 3 setae. Dorsal chaetotaxy of thoracic terga II-III and abdominal terga III-VI as in Figs 2-3: setae m_2, m_3 m_4, m_6 and $m_{6'}$ present. Between thoracic tergum II and end of body (especially on abdominal terga IV and V) additional setae present (plurichaetosis). Subcoxae I, II, III with 1, 4, 4 setae, respectively. Microsensillum on thoracic tergum II present.

Antennal segment IV with simple apical vesicle (av), subapical organite (or), microsensillum (ms), 4-6 lateral sensilla and 1 dorsal cylindrical curved, blunt sensillum (Fig. 6) and 5-7 short pointed setae in ventral field. Antennal segment III organ with two long (outer) and two short (inner) sensilla (Fig. 6). Microsensillum on antennal segment III present. Antennal segment I with 8 setae (seta p' present).

Ocelli: 8 + 8. Postantennal organ equal to or slightly smaller than neighboring ocelli, with four lobes, the anterior pair slightly larger than posterior one. Large accessory boss present (Fig. 7). Labrum with six apical papillae (four large and two small marginal ones). Labral setae 5, 5, 4, prelabrals 4. Maxillary head of *H. tullbergi* type (Fjellberg, 1984: fig. 6). Labial palp as shown in Fjellberg (1999: fig. 6). Outer maxillary lobe with two sublobal hairs.

Tibiotarsi I, II, III with 19, 19, 18 setae, respectively. Apical seta A_1 clavate and slightly longer than inner edge of claw. Claws with inner tooth. Empodial appendage with broad basal lamella and apical filament reaching slightly beyond inner tooth of unguis (Fig. 5).

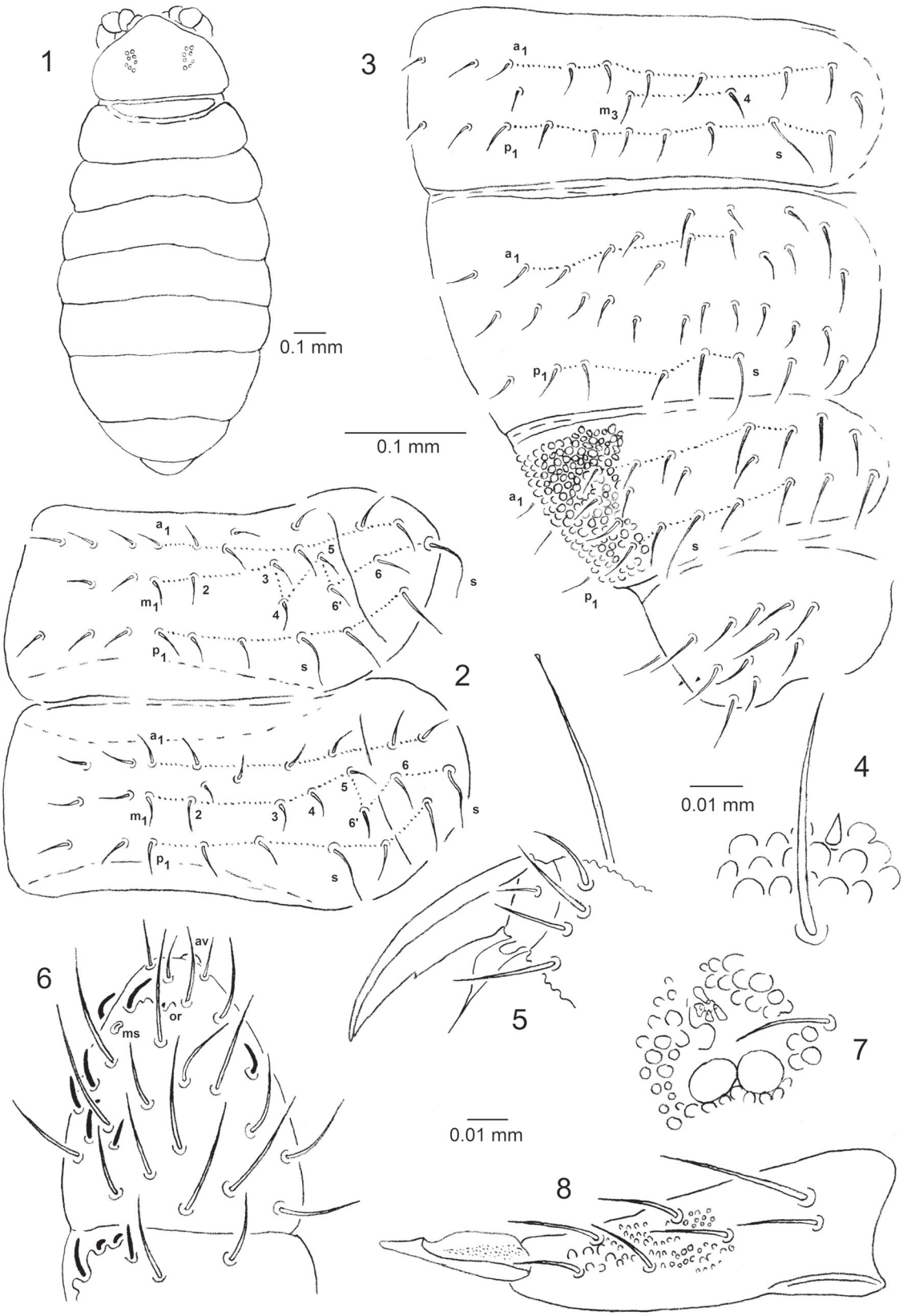
Ventral tube with four setae on each side. Retinaculum with 4 + 4 teeth.

Furca well developed (ratio dens + mucro/inner edge of claw III = 2.7-2.9). Dorsal side of dens with 7 setae and with fine, uniform granulation and some slightly larger but not tooth-like granules in distal part. Apical swelling absent. Mucro with low lateral lamellae (outer one higher than inner one) fusing below apex and forming small subapical tooth. Ratio dens/mucro = 2.2-2.4 (Fig. 8).

Anal spines narrowly conical, minute (equal to or slightly longer than neighboring granuli, ratio anal spine/inner edge of claw III = 0.1-0.15), papilla absent (Fig. 4).

Remarks: *Hypogastrura arnei* sp. nov. is remarkable for its oval and slightly flattened body, coarse tegumental granulation, plurichaetotic chaetotaxy, antennal segment IV with 4-6 lateral sensilla and 1 dorsal cylindrical, blunt sensillum, moderately modified furca and minute anal spines without papilla. The unusual body shape of the new species deserves special attention. Among known species only *H. iwamurai* Yosii, 1960 seems to be similar in this respect. According to Yosii (1960) the body of that species is „somewhat dorsoventrally flattened as in *Ceratrimeria*". The examination of some specimens of *H. iwamurai* showed that the body of this species is oval and slightly flattened, but its abdominal segment VI is long and tapering posteriorly, while it is short and rounded at the tip in *H. arnei* sp. nov. Moreover, these two species differ considerably in body size (1.1-1.6 mm in *H. arnei* sp. nov. versus "up to 2.5 mm" in *H. iwamurai*), in tegumental granulation (3-5 granules between setae p_1 on abdominal tergum V in *H. arnei* sp. nov. versus 12 in *H. iwamurai*) and in size and shape of the anal spines (narrow-conical, minute, without papilla in *H. arnei* sp. nov. versus short, thick, slightly curved, raised on high papillae in *H. iwamurai*).

Hypogastrura arnei sp. nov. differs also from all the remaining representatives of the genus in the arrangement of cylindrical sensilla on antennal segment IV. Although the new species shares a tendency towards a greater number of lateral sensilla with members of the *nivicola* (= *socialis*), *packardi* (= *sahlbergi*) and *crassaegranulata* groups sensu Christiansen & Bellinger (1980), Babenko *et al.* (1994) and Skarżyński (2009), the presence of a single dorsal sensillum (versus usually 3) places this species at an isolated position. Nevertheless, *H. arnei* sp. nov. is similar to some species of all these groups. Coarse



Figs 1-8. *Hypogastrura arnei* sp. nov. (1) Habitus, dorsal view. (2) Chaetotaxy of thoracic terga II-III. (3) Chaetotaxy of abdominal terga III-VI. (4) Anal spine. (5) Claw III with empodial appendage. (6) Chaetotaxy of antennal segments III-IV, dorsal view. (7) Postantennal organ and adjacent ocelli. (8) Dens and mucro of furca. Scale lines: 1; 2-3; 4; 5-8 to same scale. Abbreviations: av - apical vesicle; or - subapical organite; ms - microsensillum; a_1 - setae of a-row; m_{1-6} - setae of m-row; p_1 - setae of p-row; s - body sensilla.

body granulation and an only moderately modified furca (tooth-like granules, apical swelling on dens and large subapical tooth on mucro absent) make *H. arnei* sp. nov. similar to several Nearctic and Palearctic species/forms. *Hypogastrura macrotuberculata* Hammer, 1953 from Alaska and Canada (Babenko *et al.*, 2019) also has a coarse tegumental granulation, but mainly on the last abdominal terga. Moreover, that species is characterized by the lack of plurichaetosis, by the presence of 1+1 v-setae (rarely 1+2 or 2+2) on the head and by small but not minute anal spines on clear papillae. *Hypogastrura reticulata* sensu Hammer (1953) nec Börner, 1909, an incompletely described species (chaetotaxy unknown) from the Arctic part of Canada, has a special feature that makes it easily distinguishable, i.e. the presence of reticular structures all over the body segments. In addition, it has a hook-like mucro and small but not minute anal spines on clear papillae, and according to Yosii (1960) 1 + 1 v-setae on the head. Among the Palearctic species similar to *H. arnei* sp. nov. are the following members of the *crassaegranulata* group: *H. chouardi* Cassagnau, 1959 (Pyrenees) and *H. hohi* Babenko in Babenko *et al.* (1994) (Caucasus) and *H. reticulata* Börner, 1909 (Japan). The first two, having more than 4 + 4 setae on the ventral tube and a typical dorsal chaetotaxy (plurichaetosis absent), are easy to distinguish. The third, of which I examined some specimens, is unique due to combination of large body size (2.5 mm) and the presence of reticular structures all over the body segments.

Coarse body granulation and a moderately modified furca are also present in summer forms of cyclomorphic species of the *nivicola* (= *socialis*) group: *H. kelmendica* Peja, 1985 (Albania, Croatia, Poland), *H. lapponica* (Axelson, 1902) (Palaearctic) and *H. simsi* Hart & Waltz, 1995 (USA). Their summer and winter forms clearly differ from *H. arnei* sp. nov. in small but not minute anal spines on distinct papillae, and by the abdominal tergum IV without setae m_1 (present in *H. kelmendica*), by a short mucro, ratio dens/mucro about 4 (in *H. lapponica*) and by the dens projecting beyond the apex of the mucro (in *H. simsi*) (Axelson, 1902; Peja, 1985; Babenko *et al.*, 1994; Hart & Waltz, 1995; Christiansen & Bellinger, 1998; Skarżyński & Smolis, 2003).

Finally, plurichaetotic chaetotaxy relates the new species to some members of the *packardi* (= *sahlbergi*) group: *H. austriaca* Babenko & Thibaud, 1990 (Austria, Burgenland), *H. pomorskii* Skarżyński, 2010 (Tien Shan), *H. tatrica* (Stach, 1949) (N Carpathians) and *H. tchabensis* Babenko in Babenko *et al.* (1994) (foreland of the Caucasus) and the *nivicola* (= *socialis*) group: *H. bokusi* Yosii, 1961. Nevertheless, the first four species are distinct, having a fine tegumental granulation and numerous setae (at least 7 + 7) on the ventral tube (Stach, 1949; Babenko & Thibaud, 1990; Babenko *et al*., 1994; Skarżyński, 2010). *Hypogastrura bokusi* has tooth-like granules on dens and a large subapical tooth on the mucro (Yosii, 1961).

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