

A REDESCRIPTION OF *CERATOPHYSELLA LUCIFUGA* (PACKARD) (COLLEMBOLA, HYPOGASTRURIDAE) FROM NORTH AMERICAN CAVES

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Abstract: The problematic species *Ceratophysella lucifuga* (Packard) is redescribed based on topotypes from Wyandotte Cave and specimens from two other caves of the south-central Indiana karst area. This species is characterized by lack of body pigmentation, slightly reduced ocelli, absence of an eversible sac between antennal segments III–IV, presence of long lateral sensilla in antennal III-organ, postantennal organ with somewhat subdivided posterior lobes, well developed furca and the absence of setae a'_2 on abdominal tergum V. *C. lucifuga* is similar to other cavernicolous species of the ceratophysellan lineage grouped in genera *Ceratophysella* Börner and *Typhlogastrura* Bonet, especially *C. proserpinae* (Yosii) and *C. troglodites* (Yosii) from Japan, *C. pecki* Christiansen and Bellinger from USA and *C. kapoviensis* Babenko from Russia.

INTRODUCTION

In spite of long-term studies, our knowledge of the Nearctic *Ceratophysella* Börner, 1932 is still far from the expected state. The total number of species recorded from the USA and Canada is only 26 (Christiansen and Bellinger, 1998; Skarżyński, 2006), while 66 have been reported from the Palaearctic region (Thibaud et al., 2004; Skarżyński, 2005; Skarżyński and Smolis, 2006). Moreover, the taxonomic status of some Nearctic species remains unclear. Additional faunistic and taxonomic studies are needed to estimate the real biodiversity of North American springtails. In material obtained from Dr. Kenneth Christiansen, several specimens were present of the problematic species *Ceratophysella lucifuga* (Packard, 1888) from the type locality, Wyandotte Cave in southern Indiana. A redescription of this species is presented below.

SPECIES REDESCRIPTION

Ceratophysella lucifuga (Packard, 1888) (Fig. 1 A–K)

Lipura? lucifuga Packard, 1888: p. 65

Lipura? Achorutes? lucifuga Packard, 1888: 88

Hypogastrura lucifuga: Bonet (1930: 123)

Hypogastrura armata lucifuga: Bonet (1934: 362)

Hypogastrura (Ceratophysella) lucifuga: Christiansen and Bellinger (1980: 161)

MATERIAL EXAMINED

Wyandotte Cave, ca. 5 km NE Leavenworth, Crawford Co., Indiana, from surface of water, four females, one male on slides, August 27, 1928, leg. R. Jeannel (2404); same locality, seven females, four males, four juveniles, June 17, 1934, leg. A. Emerson (384); Ed's Hole, ca. 3.2 km N DePauw, Harrison Co., Indiana, leaf litter on the floor of the entrance, two females, May 29, 1996, leg. J. Lewis

(7976); Little Mouth Cave, ca. 3.2 km S Laconia, Harrison Co., Indiana, one male, November 25, 1992, leg. J. Lewis (7616) (all preserved at the collection of Grinnell College, Iowa).

DESCRIPTION

Body length 0.9–2.2 mm. Body color white, eye patches dark, anal spines yellowish. Granulation rather uniform, 9–14 granules between setae p_1 on abdominal tergum V (Fig. 1B).

Dorsal chaetotaxy of thorax and abdomen as in Figures 1A–1B, chaetotaxy of head typical of the genus. Dorsal setae well differentiated. Macrochaetae long and serrated, usually slightly curved and blunt-tipped on head, thorax and first abdominal segments and distinctly curved and pointed on last abdominal segments. Body sensilla (s) fine and smooth. Thoracic tergum II with p_2 shifted forward, a_3 longer than a_2 , m_3 absent and m_6 present. Setae a'_2 on abdominal terga I–III usually present, on abdominal tergum V always absent. Abdominal tergum IV with p_1 and p_2 microchaetae and macrochaetae respectively, setae p_3 present. The three axial setae (a_1 , m_1 , p_1) on abdominal tergum IV diverging. Subcoxae I, II, III with 1, 3, 3 setae, respectively. Microsensillum (ms) on thoracic tergum II present.

Antennal segment IV with trilobed apical vesicle (av), subapical organite (or), microsensillum (ms), seven cylindrical sensilla, about 15 thin only slightly modified sensilla in the ventral file (Figs 1C–D). Antennal III-organ with two long (20–22 μm , lateral) and two short (internal) curved sensilla. Microsensillum on antennal segment III present. Eversible sac between antennal segments III–IV absent. Antennal segment I with 7 setae. Ocelli 8 + 8 or 8 + 7 (F + G fused) (Figs 1H–K). Arrangement of ocelli labile (Fig. 1I). Diameter of eyes usually reduced to 9–12 μm and incidentally to 5–6 μm (Fig. 1H). Postantennal organ 2–3

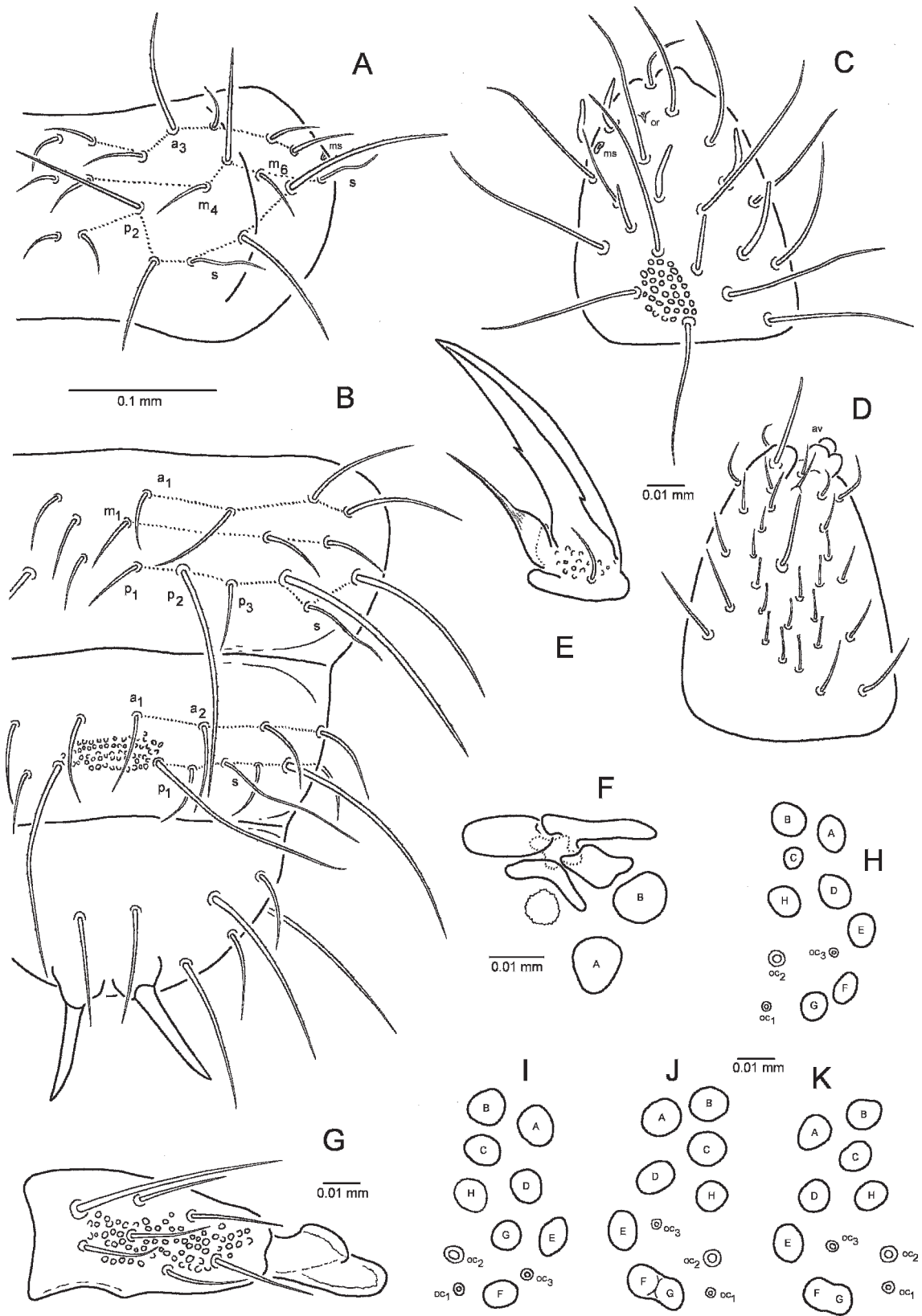


Figure 1. *Ceratophysella lucifuga*: (A) chaetotaxy of thoracic tergum II; (B) chaetotaxy of abdominal terga IV–VI; (C) dorsal side of antennal segment IV; (D) ventral side of antennal segment IV; (E) claw III; (F) postantennal organ and neighbor ocelli; (G) dens and mucro; (H–K) variants of eye arrangement: (H) ocelli A, B, D–G normal, ocellus C minute; (I) ocelli A–F in typical positions, ocellus G dislocated; (J) ocelli A–E normal, ocelli F and G incompletely fused; (K) ocelli A–E normal, ocelli F and G completely fused.

Table 1. Morphological differences between *C. lucifuga*, *C. kapoviensis*, *C. pecki*, *C. proserpinae*, and *C. troglodites* (after Yosii, 1956, 1960; Christiansen and Bellinger, 1980; Babenko et al., 1994).

Characters	<i>kapoviensis</i>	<i>lucifuga</i>	<i>pecki</i>	<i>proserpinae</i>	<i>troglodites</i>
Body colour	white with dark spots	white	white with dark spots	white with dark spots	white
Number of ocelli	8 + 8, 8 + 7	8 + 8, 8 + 7(F + G)	8 + 8	8 + 8, 8 + 7(H absent)	8 + 8
Apical vesicle on antennal segment IV	simple	trilobed	simple	simple	simple
Eversible sac between antennal segments III–IV	+	–	–	+	–
Number of lobes in postantennal organ	4–5	4	4	4	4
Number of setae on dens	5–6	7	7	6	7
Estimative ratio: empodial filament/inner edge of claws	0.6	0.6	0.9–1.1	?	0.5
Setae a'_2 on abdominal terga I–III	–	+/–	+	+/–	+
Setae p_3 on abdominal tergum IV	–	+	+	+	+
Setae a'_2 on abdominal tergum V	–	–	+	–	+
Setae p_2 and p_4 on abdominal tergum V	–	+	+	+	+
Body sensilla longer than macrochaetae	–	–	–	+	–

times as long as nearest eyes, with four lobes of which the anterior pair is distinctly larger than the posterior. Posterior lobes often incompletely subdivided. Accessory boss present (Fig. 1F). Labrum with 5, 5, 4 setae and 4 prelabrals. Labium of the *succinea* type (papilla C absent, see Fjellberg, 1999). Head of maxilla of the *denticulata* type (Fjellberg, 1984). Outer lobe with 1 sublobal hair.

Tibiotarsi I, II, III with 19, 19, 18 setae, respectively; clavate setae absent. Claws with inner tooth and two pairs of lateral teeth. Empodial appendage with broad basal lamella and the apical filament reaching slightly beyond inner tooth (Fig. 1E). Ventral tube with 4 + 4 setae. Furca well developed, but with delicate cuticular skeleton (see Skarżyński, 2000, Fig. 10). Dens with seven unmodified setae, about twice as long as mucro. Mucro boat-like, delicate (Fig. 1G). Retinaculum with 4 + 4 teeth. Anal spines thin and slightly curved, situated on high basal papillae (Fig. 1B). Anal spines 1.0–1.3 as long as inner edge of last claw.

REMARKS

C. lucifuga was briefly described by Packard (1888). The redescrptions of Bonet (1934) and Christiansen and Bellinger (1980) increased our knowledge, but the taxonomic status of this species remained unclear. Due to little morphological differentiation, *C. lucifuga* was considered by Christiansen and Bellinger (1980) to be a local variant of the *denticulata* complex. Examination of topotypes revealed new characters and allowed refinement of its systematic position.

The following morphological characters, which may be regarded as cave adaptations, appear most characteristic: lack of body pigmentation, slightly reduced ocelli, absence

of eversible sac between antennal segments III–IV, presence of long lateral sensilla in antennal III-organ and postantennal organ with somewhat subdivided posterior lobes. These regressive and progressive features, the well developed furca and well differentiated chaetotaxy of A type (Thibaud et al., 2004) make *C. lucifuga* similar to other cavernicolous species of the ceratophysellan line among *Ceratophysella* (*denticulata* group) and *Typhlogastrura* Bonet, 1930 (see Thibaud, 1980; Christiansen and Bellinger, 1998; Thibaud et al., 2004; Christiansen and Wang, 2006). Considering the small amount of troglomorphy (Christiansen, 1985), *C. lucifuga* is comparable with weakly pigmented *Ceratophysella proserpinae* (Yosii, 1956) (Japan), *C. kapoviensis* Babenko, 1994 (Russia, Bashkiria), *C. troglodites* (Yosii, 1956) (Japan) and *C. pecki* Christiansen and Bellinger, 1980 (USA). The first two species have slightly reduced eyes and dental chaetotaxy, while the latter two have the full number of dental setae and ocelli (Table 1). One may say that *C. proserpinae* and *C. kapoviensis* have evolved as *Schaefferia* (Absolon, 1900) and *C. lucifuga*, *C. troglodites* and *C. pecki* as *Typhlogastrura*.

C. lucifuga is a species of limited distribution. It is known from three caves that occur in the unglaciated south-central Indiana karst belt. Ed's Hole and Wyandotte Cave are both in the Crawford Upland, while Little Mouth Cave is in the adjacent Mitchell Plain. Little Mouth Cave lies about 35 km SE and Ed's Hole Cave is about 19 km NNE of Wyandotte Cave (Lewis, 1998).

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