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Reassessment of the taxonomic position of *Hypogastrura monticola* Stach, 1946 (Collembola: Hypogastruridae)

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Abstract

New data on the morphology of *Hypogastrura monticola* Stach, 1946, are provided based on extensive material from the Alps, the Pyrenees, the Sudetes and the Carpathians. The taxonomic position of this species within the genus is discussed. A *monticola* group consisting of *H. monticola*, *H. papillata* Gisin, 1949, *H. hispanica* (Steiner, 1955), *H. dasiensis* Selga, 1966, *H. subpapillata* Babenko, 1994 and *H. hatiparae* Babenko, 1994, is proposed. A key to *Hypogastrura* species groups is given.

Keywords: springtails, *H. monticola* group

1. Introduction

The genus *Hypogastrura* Bourlet, 1839, consists of 162 species (Bellinger et al. 2009) and is one of the largest within the Collembola. Yosii (1960), Christiansen & Bellinger (1980), Babenko et al. (1994) and Thibaud et al. (2004) distinguished some groups of morphologically similar and probably related species within this genus:*H. crassaegranulata*, *H. christianseni*, *H. manubrialis*, *H. nivicola*, *H. packardi*, *H. reticulata*, *H. sahlbergii*, *H. socialis*, *H. trybomi* and *H. viatica*. However, numerous species do not belong to any of these groups, for example *Hypogastrura monticola* Stach, 1946. According to Babenko et al. (1994) it is a morphologically distinct species occupying an isolated position within the *Hypogastrura*. *H. monticola* is a species living in European mountains: the Alps, the Pyrenees, the Sudetes and the Carpathians. It inhabits mosses growing on rocks in cold and humid places in the subalpine and alpine zones mainly. Where habitat conditions are close to optimal, it can live at lower altitudes, for example in shaded river valleys and deep rocky ravines. Stach's original and subsequent descriptions of *H. monticola* are quite accurate, but lack information on the chaetotaxy and the mouthpart structure (Stach 1946, 1949). Babenko (Babenko et al. 1994) re-described the species based on the Polish specimens from Stach's collection (Tatra Mts, Zawrat) and supplied the missing data. A comparison of all these data sets shows that Stach and Babenko differed in their assessment of the sensillary chaetotaxy of antennal segment IV. According to the former, *H. monticola* has only slightly thickened, long 2 lateral and 2 dorsal sensilla (Stach 1946: Plate I, Fig. 1), while the latter drew them as distinctly thick (Babenko et al. 1994: Fig. 36.2). A review of extensive material allows me to improve our knowledge of the morphology of *H. monticola* and establish its relationships within the genus.

2. Material examined

Stach's collection: 9 syntypes, Alps, Karinthia, High Tauern, Grossglockner, 1937, leg. Franz; 57 specimens, Tatra Mts, Zawrat, spring, on snow, leg. J. Małachowski; 2 specimens, Tatra Mts, at the base of Giewont Mt., neighbourhood of a snow field, 12 July 1933, leg. J. Stach, (all specimens on slides, formerly in alcoholi vials labelled as '*H. montana* Stach', deposited at the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków).

Fig. 1 Chaetotaxy of antennal segments III–IV of *Hypogastrura monticola*. Abbreviations: *: cylindrical sensilla on antennal segment IV; AOIII: antennal III–organ; av: apical vesicle; ms: microsensillum, or: subapical organite.

Other material: 4 specimens, Austria, Lower Tauern, northern slope of Kleine Wildstelle, 2500 m a. s. l., moist moss on rocks near snow field, 02 August 1948, JaT193, leg. E. Butschek (deposited at the Museum of Natural History, Geneva); 3 specimens, Switzerland, Alps, Murtaröl, near Ofenpass, 2250 m a. s. l., cluster of mosses and plants at the base of shaded calcareous rocks, 16 July 1942, He46 (Gisin's collection deposited at the Museum of Natural History, Geneva); 11 specimens, France, Hautes-Pyrénées, Gavarnie, 21 August 1993, near lower glacier of Gabiétous, 65–155 (deposited at the Museum of Natural History, Paris); 6 specimens, Poland, Tatra Mts, Wołoszyn, 1100 m a. s. l., mosses on rocks in spruce forest, 07 September 1999, leg. A. Smolis; 1 specimen, Poland, Tatra Mts, northern slopes of Gładkie Upłaziańskie, 1600 m a. s. l., litter in dwarf mountain pine shrubs, 01 June 2001, leg. D. Skarżyński; 2 specimens, Poland, Tatra Mts, Gąsienicowa Valley, 1900 m a. s. l., mosses on rocks near snow field in alpine zone, 18 August 2004, leg. D. Skarżyński; 1 specimen, Poland, Babia Góra Massif (Carpathians), 1100 m a. s. l., mosses on rocks in spruce forest, 06 September 1999, leg. A. Smolis; 1 specimen, Poland, Pieniny Mts (Carpathians), neighbourhood of village Jaworki, 600 m a. s. l., mosses on shaded moist calcareous rocks, 08 April 2005, leg. D. Skarżyński; 7 specimens, Poland, Karkonosze Mts (Sudetes), glacial cirque Kocioł Małego Stawu, 1200 m a. s. l., mosses on rocks in dwarf mountain pine shrubs, 28 May 2001, leg. D. Skarżyński; 1 specimen, Karkonosze Mts, debris on gravel bed of Kamienna river near Szklarska Poręba, 550 m a. s. l., 15 October 2001, leg. D. Skarżyński (deposited at the Department of Biodiversity and Evolutionary Taxonomy, Wrocław University, Poland).

3. Results and discussion

A review of the available specimens from Stach's collection and other collections showed that they fit the original description and the re-description with one remarkable exception. There are consistently 2 lateral and 3 dorsal slightly thickened sensilla on antennal segment IV (Fig. 1). Distinctly inflated sensilla, probably as a result of long-lasting conservation are visible only in specimens analysed by Babenko (Babenko et al. 1994) from Zawrat (Tatra Mts), whereas the sensilla of other individuals from the same mountains have normal shape and size.

Stach (1946, 1949) compared *H. monticola* with *H. sahlbergi* (Reuter, 1895) and *H. strenua* (Brown, 1923) (now a synonym of *H. sahlbergi*); Babenko (Babenko et al. 1994) regarded its position as isolated, whereas Thibaud et al. (2004) included this species (probably erroneously) in the *crassaegranulata* group.

The present data shed new light on the taxonomic position of *H. monticola*. This species is related to *H. papillata* Gisin, 1949 (Alps, Serra da Lousa Mountains, Pyrénées, Dinaric Mountains), *H. hispanica* (Steiner, 1955) (Sierra de Guadarrama), *H. dasiensis* Selga, 1966 (Pyrénées), *H. subpapillata* Babenko, 1994 (Sayan Mountains) and *H. hatiparae* Babenko, 1994 (Caucasus) (Babenko et al. 1994, Jordana et al. 1997). They constitute a group (the *monticola* group) defined as follows: thin or slightly thickened and long antennal segment IV sensilla arranged in two groups: 3 dorsal and 2–3 lateral, postantennal organ 1.5–2 times larger than the adjacent ocelli, labrum with papillae, basal empodial lamella broad, no more than 1, 1, 1 clavate tenent hairs, quadridentate retinaculum, dens with 7 setae and without tooth-like granules and ventro-apical swelling, mucro without distinct subapical tooth, setae

m_6 on thoracic terga II–III present, m-setae on abdominal tergum V present, usually 4 + 4 setae on the ventral tubus. The above-mentioned species differ in the characteristics summarised in Tab. 1. *H. elevata* Cassagnau, 1959, can also be considered a potential member of the *monticola* group, as the author (Cassagnau 1959) compared this species with *H. monticola* and *H. hispanica* (based on weakly differentiated sensilla on antennal segment IV and postantennal organ larger than neighbouring ocelli). However, to solve this problem a modern redescription of *H. elevata* is necessary.

The *monticola* group fits into the group system proposed by Christiansen & Bellinger (1980) (see key). The system, based on analysis of a large number of various morphological features, is commonly accepted (Babenko et al. 1994, Thibaud et al. 2004), unlike Yosii's (1960) provisional system, which mainly relies on a small number of chaetotactic characters (Tab. 2). Although the classification used by Christiansen & Bellinger (1980), Babenko et al. (1994) and Thibaud et al. (2004) seems to be a not fully substantiated phylogenetic hypothesis, it has high practical value. It facilitates taxonomic studies on this speciose genus. The system is open, numerous weakly recognised species and species with exceptional characteristics remain unclassified.

Tab. 1 Morphological differences between members of the *monticola* group. Data after: *H. papillata* – Gisin (1949), Babenko et al. (1994), Jordana et al. (1997); *H. hispanica* – Steiner (1955), Jordana et al. (1997); *H. dasiensis* – Selga (1966), Jordana et al. (1997); *H. subpapillata* – Babenko et al. (1994) and Babenko (in litt.); *H. hatipare* – Babenko et al. (1994).

Character	*H. monticola*	*H. papillata*	*H. hispanica*	*H. dasiensis*	*H. subpapillata*	*H. hatiparae*
Body granulation	fine	coarse	fine	coarse	coarse	coarse
Antennal segment IV sensilla	5	6	5	5	6	6
Tibiotarsal tenent hair	pointed	clavate or pointed	clavate	clavate	clavate or pointed	clavate
Granulation of distal part of dens	fine	moderate	fine	fine or coarse	coarse	fine
Ratio dens/mucro	4–5:1	3:1	3:1	3–4:1	3:1	3:1
Setae on ventral tubus	4	4	5	4	4	4
Anal spines	as long as papillae	2 x shorter than (basally joined) papillae	as long as papillae	as long as papillae	slightly smaller than papillae	minute on very low papillae

Tab. 2 Characteristics of *Hypogastrura* species groups (after Yosii 1960).

Group	Members of the group	Characteristics
nivicola	*H. nivicola* (Fitch, 1846) *H. copiosa* (Folsom, 1916)	Head with 1+1 v-setae, tibiotarsi with 1 tenent hair, sensilla on antennal segment IV rod-like.
christianseni	*H. christianseni* Yosii, 1960 *H. itaya* Kinoshita, 1916	Head with 2+2 v-setae, m–setae on abdominal tergum V present.
reticulata	*H. reticulata* (Börner, 1909)	Head with 2+2 v-setae, m-setae on abdominal tergum V absent, body sensilla on abdominal terga I–IV and V p_4 and p_2 respectively.
manubrialis	*H. manubrialis* (Tullberg, 1869) *H. nemoralis* Yosii, 1960 *H. oregonensis* Yosii, 1960 *H. iwamurae* Yosii, 1960	Head with 2+2 v-setae, m-setae on abdominal tergum V absent, body sensilla on abdominal terga I–IV and V p_5 and p_3 respectively, tibiotarsi with 1 tenent hair.
viatica	*H. viatica* (Tullberg, 1872) *H. gracilis* (Folsom, 1899)	Head with 2+2 v-setae, m-setae on abdominal tergum V absent, body sensilla on abdominal terga I–IV and V p_5 and p_3 respectively, tibiotarsi with more than 1 tenent hair.

Among the features defining the *monticola* group, the arrangement of antennal segment IV sensilla deserves special attention. In *Hypogastrura* the basic pattern is 3 dorsal and 3 lateral sensilla; the *manubrialis* group tends to have a larger number of dorsal sensilla; and the *nivicola* (= *socialis*), *packardi* (= *sahlbergi*) and *crassaegranulata* groups a tendency to show a greater number of lateral ones can be seen (Babenko et al. 1994). The *monticola* group shows quite a different tendency: towards a smaller number of lateral sensilla. Another important character defining the newly distinguished group is the large size of the postantennal organ (1.5–2 times larger than the adjacent ocelli). Members of the *manubralis* group and some representatives of the *trybomi* group share this feature, while the remaining ones have their postantennal organ slightly smaller than the neighbouring ocelli (Christiansen & Bellinger 1980, Babenko et al. 1994).

Among the species of the *monticola* group, three – *H. monticola*, *H. hispanica* and *H. dasiensis* – have so far not been classified within any species group; two others – *H. papillata* and *H. hatiparae* – have been located within the *crassaegranulata* group; and *H. subpapillata* has been placed within the *socialis* group (Babenko et al. 1994). Although *H. papillata* and *H. hatiparae* share coarse body granulation with members of the *crassaegranulata* group, they strongly differ from the latter in having weakly differentiated sensilla on antennal segment IV (versus well differentiated), a smaller number of lateral

sensilla on antennal segment IV (3, versus 3–7), a larger postantennal organ (1.5–2 times larger than the adjacent ocelli, versus slightly smaller than the neighbouring ocelli) and the presence of m-setae on abdominal tergum V (versus absence of m-setae on abdominal tergum V). Re-examination of the types by Babenko (Babenko in litt.) showed that *H. subpapillata* is devoid of the typical features of the *socialis* group: it has a dens without tooth-like granules and a prominent ventroapical swelling and a mucro without a distinct subapical tooth. In consequence this species has been transferred to the newly created *monticola* group as it shares its characteristics.

Key to *Hypogastrura* species groups (after Christiansen & Bellinger 1980, Babenko et al. 1994)

1. More than 1 clavate tenent hair on tibiotarsi, retinaculum tridentate .....…***viatica* group**

– 1 clavate or pointed tenent hair on tibiotarsi, retinaculum quadridentate or rarely tridentate **2**

2. Labrum without distal papillae **3**

– Labrum with 4–6 distal papillae **4**

3. Empodial appendage with narrow basal lamella, setae m_6 on thoracic terga II–III absent . . . . . ***manubrialis* group**

– Empodial appendage with broad basal lamella, setae m_6 on thoracic terga II–III present . . . . . ***trybomi* group**

4. Antennal segment IV with 3 dorsal and 2–3 lateral weakly differentiated sensilla, postantennal organ 1.5–2 times larger than the adjacent ocelli, m-setae on abdominal tergum V present . . . . . ***monticola* group**

– Antennal segment IV with 3 dorsal and 3–14 lateral well differentiated sensilla, postantennal organ slightly smaller than adjacent ocelli, m-setae on abdominal tergum V absent **5**

5. Dens with tooth-like granules in distal part and prominent ventro-apical swelling, mucro with distinct subapical tooth . . . . . ***nivicola* group (Nearctic), *socialis* group (Palaearctic)**

– Dens without tooth-like granules and prominent ventro-apical swelling, mucro without distinct subapical tooth **6**

6. Body granulation fine (more than 6 granules between setae p_1 on abdominal tergum V) . . . . . ***packardi* group (Nearctic), *sahlbergii* group (Palaearctic)**

– Body granulation coarse (3–6 granules between setae p_1 on abdominal tergum V) . . . . . ***crassaegranulata* group**

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