

A NEW CAVE-DWELLING SPECIES OF *DEUTERAPHORURA* ABSOLON, 1901 (COLLEMBOLA: ONYCHIURIDAE) FROM KOREA

Javier I. Arbea¹ & Kyung-Hwa Park²

¹ c/ Ría de Solía 3, ch. 39, 39610 El Astillero (Cantabria), España — jarbeapo@gmail.com

² Department of Biology Education, Institute of Fusion Science and Institute of Science Education, Chonbuk National University, Jeonju, 561-756, Korea — pkhsyst@jbnu.ac.kr

Abstract: A new cave-dwelling species of the genus *Deuteraphorura* Absolon, 1901 is described from Korea. *Deuteraphorura koreana* sp. nov. is characterized by its peculiar distribution of dorsal (32/133/33332) and ventral (3/011/2212) pseudocelli, which makes it possible to separate it from other congeneric species.

Key words: Collembola, Onychiuridae, taxonomy, chaetotaxy, *Deuteraphorura koreana* sp. nov., Korea.

Una especie cavernícola nueva de *Deuteraphorura* Absolon, 1901 (Collembola: Onychiuridae) de Corea

Resumen: Se describe una especie cavernícola nueva del género *Deuteraphorura* Absolon, 1901 de Corea. *Deuteraphorura koreana* sp. nov. se caracteriza por la peculiar distribución de pseudocelos dorsales (32/133/33332) y ventrales (3/011/2212), que permiten distinguirla de otras especies del mismo género.

Palabras clave: Collembola, Onychiuridae, taxonomía, chaetotaxia, *Deuteraphorura koreana* sp. nov., Corea.

Taxonomy/ Taxonomía: *Deuteraphorura koreana* sp. nov.

Introduction

The genus *Deuteraphorura* Absolon, 1901 includes 80 species in the world (Jordana *et al.*, 2012; Bellinger *et al.*, 1996–2015; Weiner & Fiera, 2014). The genus is characterized by the shape of the postantennal organ with numerous compound vesicles, antennal III sense organ with five papillae and two ribbed sensory clubs, the presence of the chaeta d_0 on head and chaeta p_0 on abdominal tergum IV, the absence of anal spines, the tibiotarsus with nine chaetae in the distal whorl and 2+2 chaetae in one row on the furcal area (Weiner, 1996; Pomorski, 1998).

The Korean fauna of *Deuteraphorura* consists of one described species, *Deuteraphorura gangjinensis* (Lee & Kim, 1995), which was found in soil and seem to be endemic from Korean springtail fauna. Nine years earlier, Lee & Park (1986) described several cave specimens from the mid-eastern part of the Korean Peninsula, and identified them as *Onychiurus* (*Deuteraphorura*) *izuruensis* (Yosii, 1956) from Japan. But the Japanese species is in fact a member of the genus *Orthonychiurus* according to the redescription of Yoshii (1995, 1996). The revision of the Korean specimens tells us that they belong to the genus *Deuteraphorura* rather than *Orthonychiurus*, and represent a new species that is described below.

Materials and Methods

In the description of the new species we used the nomenclature of morphological features as proposed by Weiner (1996), Pomorski (1998) and Jordana *et al.* (1997, 2012). Labial papillae type is named after Fjellberg (1999). Pseudocellar formulae are the number of pseudocelli by half-tergite (dorsally) or half-sternite (ventrally) as follows: head anterior, head posterior/ Th I, Th II, Th III/Abd I, Abd II, Abd III, Abd IV, Abd

V. Formula of tibiotarsal chaetotaxy: total number of chaetae (number of chaetae in the distal whorl –A+T–, number of chaetae in the proximal whorl B, number of basal chaetae).

ABBREVIATIONS: Th—thoracic segment, Abd—abdominal segment, Ant—antennal segment, AIIIIO—sensory organ of antennal segment III, PAO—postantennal sense organ, pso—pseudocellus, psp—pseudopore, psx—parapseudocellus, VT—ventral tube, ma, mm, mp—manubrial rows a, m and p.

MATERIAL DEPOSIT: ICJU—Insect Collection, Department of Biology Education, Jeonbuk National University, Korea.

Species description

***Deuteraphorura koreana* sp. nov.**

= *Onychiurus* (*Deuteraphorura*) *izuruensis*: Lee & Park, 1986 not *Orthonychiurus izuruensis* (Yosii, 1956) *sensu* Yoshii 1995, 1996.

Fig. 1–8, Tables I–III.

TYPE LOCALITY: Sanhodong-gul cave, latitude: 37°26'52.08"; longitude: 128°45'21.97", Yeoryang-ri, Bug-myeon, Jeongseon-gun, Gang-weon-do Province, mid-eastern part of the Korean Peninsula.

TYPE MATERIAL: Holotype: female on slide, 5.IV.1984. Paratypes: one male and two females on slide. Deposited in ICJU (collection no. 84-7-2).

DESCRIPTION: Body: Holotype (female) length 1.8 mm, paratypes: male length 1.5 mm; females length 1.8–2.1 mm. Shape of body typical for the genus: cylindrical without anal spines (Fig 1). Color in alcohol, white. Granulation more or less uniform, distinct.

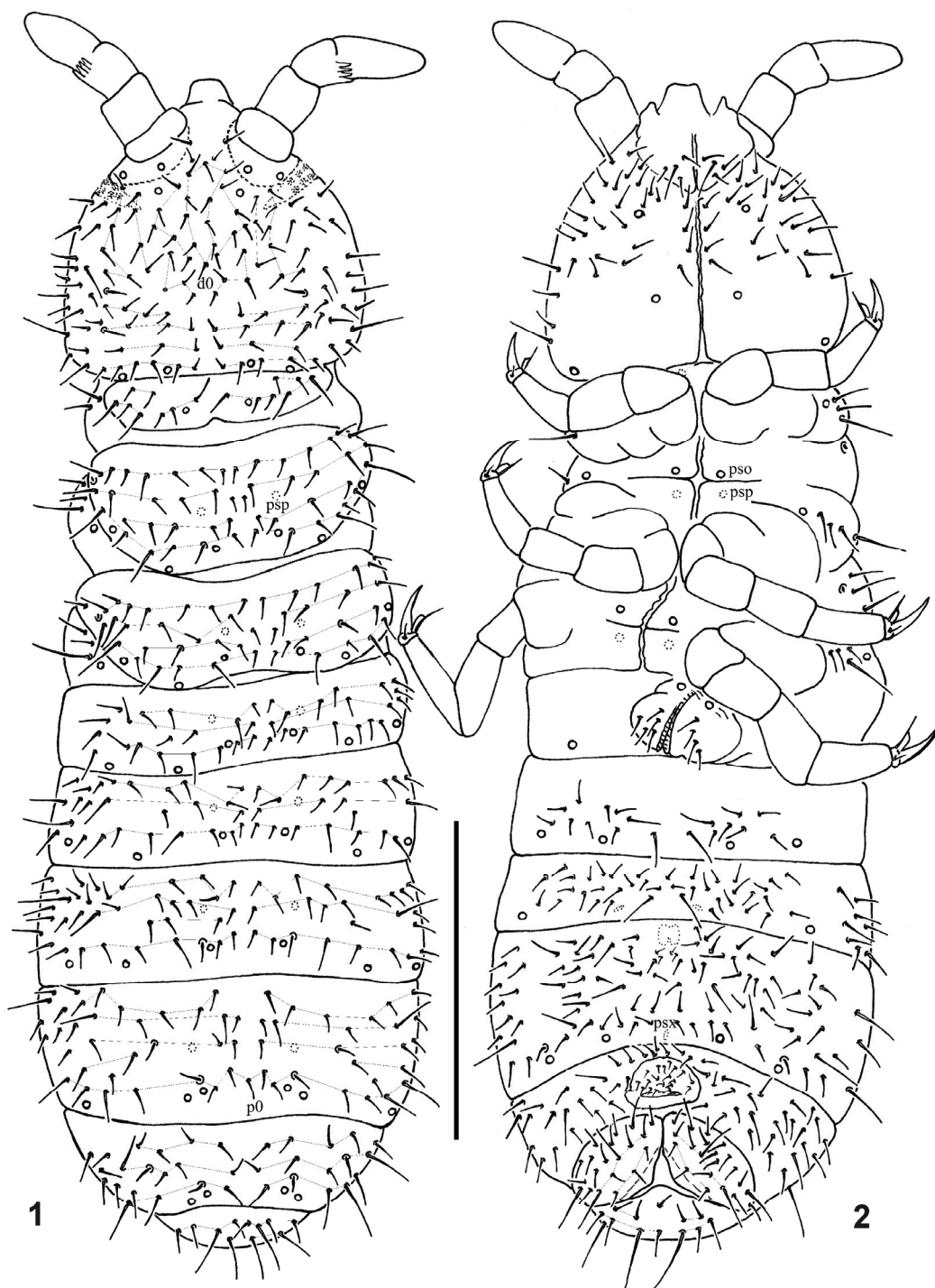


Fig. 1-2. *Deuteraphorura koreana* sp. nov. 1. Habitus and dorsal chaetotaxy; 2. Ventral chaetotaxy. Scale bar: 0.2 mm.

Antennae shorter than head. Antennal base well marked. Ant I with 8 chaetae, Ant II with 14 chaetae. AIIIO with 5 guard chaetae, 5 papillae, 2 smooth sensory rods, 2 curved and ribbed sensory clubs, ventro-lateral microsensillum present (Fig. 6). Ant IV with subapical organite, and latero-external microsensillum, ca. 0.25 length from the base; with some blunt macrochaetae and about 20 thin mesochaetae like sensilla, not well distinguishable from ordinary chaetae (Fig 5).

Head: PAO with 16 compound vesicles disposed in two parallel rows. Labral formula of chaetae: 4/142. Maxillary outer lobe with simple palp, basal chaeta and with 2 sublobal hairs (Fig 4). Submentum with 4 + 4 chaetae, baso-

lateral field (mentum) with 5 chaetae. Labial palp of AB type, with six proximal chaetae; labial papillae A, B, C, D, E with 1, 4, 0, 3, 3 guard chaetae respectively (Fig 3).

Pseudocellar formula dorsally: 32/133/33332; ventrally: 3/011/2212. Pso arranged as in Fig 1-2. Subcoxae 1 of I-III legs with 2,2,2 pso. Parapseudocellar formula ventrally on Abd. I-VI sterna: 0011^m00 (^m—single posterior psx on Abd IV). Subcoxae 1 of I-III legs without psx. Pseudopores formula dorsally on Th I-Abd IV: 011/1111, ventrally: 111/0000.

Chaetotaxy: Distribution of dorsal chaetae as in Figure 1 and Tables I-III, well differentiated into macrochaetae and mesochaetae; asymmetries are common. Sensory chaetae s



Fig. 3-8. *Deuteraphorura koreana* sp. nov. 3. Labium; 4. Maxillary palp; 5. Ant III-IV dorsal chaetotaxy; 6. Antennal sensory organ (AIIIO); 7. Furcal rudiment; 8. Tibiotarsal chaetotaxy and claw of leg III. Scale bar: 0.1 mm.

Table I. *Deuteraphorura koreana* sp. nov. Head chaetotaxy. Abbreviations: m, mesochaeta; s, sensilla; z, chaeta z; “–” denotes: absence of chaeta.

Chaeta number/serie	0	1	2	3	4	5	6
d	m	m	m	m	m	–	–
sd	–	m	m	m	m	M	–
sd'	–	m	m	–	m	M	–
v	–	m	m	m	m	–	–
ca	–	–	–	–	–	–	s
cm	–	–	m	m	m	M	–
cb	–	m	–	m	–	M	s
cp	–	m	–	m	–	M	–
p	–	m	m	m	z	M	m

Table II. *Deuteraphorura koreana* sp. nov. Dorsal thoracic chaetotaxy. Abbreviations: m, mesochaeta; ms, microsensilla; “–” denotes: absence of chaeta; “()” denotes: chaeta present or absent.

Chaeta number/serie	1	2	3	4	5	6	7
Th I							
m	–	–	–	M	m	–	–
p	M	–	m	M	M	m	M
Th II–III							
a	m	m	m	M	m	m	M
m	–	M	m	M	–	M	M+ms
ca	m	–	–	–	–	–	–
cp	–	m	m	M	(m)	m	–
p	m	–	M	M	M	m	M

not especially distinct. Head with chaeta d_0 . Th I with 7-8 +7-8 chaetae. Th II and III with lateral microsensilla. Chaeta p_0 present on Abd IV and VI.

Ventral chaetotaxy as in Fig. 2. Th Sterna I–III without chaetae. VT with 5(4)+5(4) chaetae, and without chaetae at base. Furcal area with 2+2 chaeta in one row, three manubrial rows ma, mm and mp, a-row with 2+2 chaetae –

lateral ones displaced on the level of dental microchaetae–, m-row with 2+2, p-row with 2+2 chaetae –external ones as macrochaetae– (Fig. 7). Male ventral organ absent in the only specimen known. Anal valves with numerous acuminate chaetae; each lateral valve with chaetae a_0 , $2a_1$, b_0 , $2b_1$, $2b_2$; upper valve with chaetae a_0 , $2b_1$, $2b_2$.

Table III. *Deuteraphorura koreana* sp. nov. Dorsal abdominal chaetotaxy. Abbreviations: m, mesochaeta; M, macrochaeta; s, sensilla; “–” denotes: absence of chaeta; “()” denotes: chaeta present or absent.

Chaeta number/serie	0	1	2	3	4	5	6	7
Abd I-II								
a		m	M	(m)	(m)	(m)	M	M
m		m	–	–	M	(m)	–	M
ca		–	–	–	–	m	–	–
p		m	m	S	M	m	M	M
Abd III								
a		m	m	m	M	–	M	M
m		m	–	m	M	m	(m)	M
ca		–	–	–	–	–	–	–
p		m	m	s	M	m	M	M
Abd IV								
a		m	m	m	–	m	M	M
m		m	M	–	M	–	–	M
ca		m	(m)	–	M	–	M	–
cm		–	–	–	M	–	M	–
cp		–	–	–	–	m	–	–
p	m	m	m	s	M	M	M	M
Abd V								
a		m	–	m	M	m	–	
m		m	–	m	M	s	M	
p		M	–	s	–	M	M	
Abd VI								
a		m	M	m	M			
m		M	–	–	M			
p	m	M	m	m	–			

Legs: Subcoxae 1 of I, II and III legs with 3-4, 4-5, 4-5 chaetae; tibiotarsi with 18(9 + 7 + 2), 18(9 + 8 + 1), 17(9 + 7 + 1) chaetae respectively. Chaeta M present in row B. Claw always without denticle. Empodial appendage setaceous, shorter than claw (3/4 of inner edge of the claw), with broad inner basal lamella (Fig. 8).

ETYMOLOGY: The name refers to Korea, the country of the type locality.

DISCUSSION. The new species belonging to the *Deuteraphorura*-group of species with 1+1 pso on Th I, forms part of species with 2+2 pso on the posterior part of head and 3+3 pso on Th II-III (Jordana *et al.*, 2012). Main differences between *D. koreana* sp. nov. and these species are summarized in Table IV. The new species differs from other ones by different formula of the dorsal pso. It is most similar to *D. angelieri* (Izarra, 1968) and *D. jana* (Christiansen & Bellinger, 1980) by a similar formula of the dorsal pso; they differ by the different formula of the ventral pso (Table IV). The new species has the same formula of ventral pso (3/011/2212) as *D. dunaria* (Gisin, 1956), *D. imperfecta* (Denis, 1938) and *D. insubrararia* (Gisin, 1952), but they differ by the different formula of dorsal pso. *D. koreana* sp. nov. is similar to the Korean species *D. gangjinensis* (Lee & Kim, 1995) by the formula of the dorsal pso on Abd I-V; they differ by the different formula of the dorsal pso on Th I-III and ventral pso (Table IV).

Table IV. Main diagnostic characters of Korean species of *Deuteraphorura* and related species to *D. koreana* sp. nov.

Species	Dorsal pso	Ventral pso	Distribution	Habitat
<i>gangjinensis</i> (Lee & Kim 1995)	32/022/33332	1/111/0101	South Korea	Soil
<i>koreana</i> sp. nov.	32/133/33332	3/011/2212	South Korea	Cave
<i>angelieri</i> (Izarra 1968)	32/133/33342	3/011/1212	France	Soil
<i>antheuili</i> (Denis 1936)	32/133/33354	2/011/0000	Europe	Soil & cave
<i>banatica</i> (Gruia 1965)	32/133/33354	3/0--/3222	Romania	Cave
<i>bergamaria</i> (Gisin 1956)	32/133/34454	2/000/2212	Italy	Cave
<i>cebennaria</i> (Gisin 1956)	32/133/33354	3/011/3212	Europe	Cave & soil
<i>defensaria</i> (Gisin 1964)	32/133/33354	2/011/1212	Italy	Cave
<i>dunaria</i> (Gisin 1956)	32/133/33354	3/011/2212	Europe	Cave
<i>eduardi</i> (Denis 1937)	32/133/33353	2/000/1212	Italy & France	Soil & cave
<i>gemae</i> (Simón <i>et al.</i> 1994)	32/133/33353	3/011/3212	Spain	Soil
<i>gigoni</i> (Gisin 1962)	32/133/33354	3/011/0111	Europe	Cave
<i>haybachae</i> (Gisin 1962)	32/133/33354	3/011/3222	Austria	Cave
<i>imperfecta</i> (Denis 1938)	32/133/33354	3/011/2212	Europe	Soil & cave
<i>insubrararia</i> (Gisin 1952)	32/133/33353	3/011/2212	Europe	Soil & cave
<i>jana</i> (Christiansen & Bellinger 1980)	32/133/23332-3	2/000/1101-2	USA & New Mexico	Cave?
<i>mangazeya</i> Babenko 2007	32/133/33353	3/011/3212	Russia, Siberia	Soil
<i>opa</i> (Christiansen & Bellinger 1980)	32/133/33343-4	2-3/011/0-1112	USA & New Mexico	Soil & cave
<i>paro</i> (Christiansen & Bellinger 1980)	32/133/3333-42-3	2/000/2111	USA & Canada	Cave & soil
<i>pseudoinsubrararia</i> (Dallai 1970)	32/133/33353	3/011/1212	Italy	Soil
<i>silvaria</i> (Gisin 1952)	32/133/33353	3/011/3222	Europe	Soil & cave
<i>traiani</i> Gruia & Popa 2005	32/133/33343	3/000/0112	Romania	Cave
<i>variabilis</i> (Stach 1954)	32/133/33343	2/---/1112	Europe	Soil
<i>vercoraria</i> (Gisin 1963)	32/133/33354	3/011/3222	Europe	Soil

References

- BELLINGER, P. F., K. A. CHRISTIANSEN & F. JANSSENS 1996-2015. *Checklist of the Collembola of the world*. <http://www.collembola.org>, accessed on 19-I-2015.
- FJELLBERG, A. 1999. Labial palp in Collembola. *Zoologischer Anzeiger*, **237**: 309-330.
- JORDANA, R., J. I. ARBEA, C. SIMON & M. J. LUCIANEZ 1997. *Collembola, Poduromorpha*. In: Ramos, M.A. et al. (eds.). Fauna Iberica, vol. 8. Museo Nacional de Ciencias Naturales. CSIC. Madrid, España. 807 pp.
- JORDANA, R., E. BAQUERO, S. REBOLEIRA & A. SENDRA 2012. Reviews of the genera *Schaefferia* Absolon, 1900, *Deuteroaphorura* Absolon, 1901, *Plutomurus* Yosii, 1956 and the *Anurida* Laboulbene, 1865 species group without eyes, with the description of four new species of cave springtails (Collembola) from Krubera-Voronya cave, Arabika Massif, Abkhazia. *Terrestrial Arthropod Reviews*, **5**: 35-85.
- LEE, B. H. & K. H. PARK 1986. Three New Species of Onychiuridae (Collembola) from a Korean Cave. *The Korean Journal of Systematic Zoology*, **2**(1): 11-20.
- LEE, B.H. & J. T. KIM 1995. Two new species of Collembola (Insecta) from Korea. *Korean Journal of Entomology*, **25**: 135-138.
- POMORSKI, R. J. 1998. Onychiurinae of Poland (Collembola: Onychiuridae). *Genus* supplement, Wrocław, 201 pp.
- WEINER, W. M. 1996. Generic revision of Onychiurinae (Collembola: Onychiuridae) with a cladistic analysis. *Annales de la Société Entomologique de France (N. S.)*, **32**: 163-200.
- WEINER, W. M. & C. FIERA, 2014. New species of *Deuteroaphorura* (Collembola: Onychiuridae) from Romania. *Florida Entomologist*, **97**(1): 247-255
- YOSII, R. 1956. Monographie zur Hohlencollembole Japans. *Contributions from the Biological Laboratory Kyoto University*, **3**: 1-109.
- YOSHII, R. 1995. Identity of some Japanese Collembola. II. *Deuteroaphorura* group of *Onychiurus*. *Annales of the Speleological Institute of Japan (Iwaizumi)*, **13**: 1-12.
- YOSHII, R. 1996. Identity of some Japanese Collembola IV. *Deuteroaphorura* group of *Onychiurus* – continued. *Annales of the Speleological Institute of Japan (Iwaizumi)*, **14**: 1-15