

# First Records of Three Collembolan Species from Korea

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## ABSTRACT

We report three collembolan species in Entomobryidae previously unrecorded from Korea: *Homidia socia* Denis and *Homidia nigrocephala* Uchida from aquatic or semiaquatic habitats, and *Entomobrya tokunakai* Yosii from several forests. These species are redescribed.

**Keywords:** Entomobryidae, *Homidia*, *Entomobrya*, hydrophilous, aquatic springtails, Jeonjucheon (stream)

## INTRODUCTION

Entomobryidae is the largest family of springtails, currently with 6 subfamilies of 57 genera and 1677 species worldwide, comprising more than 20% of all described species of Collembola (Hopkin, 1997; Janssens, 2010). The family is characterized by having the fourth abdominal segment much longer than the third, the dorsally crenulate dentes and the short, hooklike mucro.

The first recognizable Korean entomobryid were five species listed by Yosii and Lee (1963): *Sinella umesaoui* Yosii, *Entomobrya striatella* Börner, *E. handschini* Stach, *E. pulcherrima* Yosii, and *Homidia sauteri depicta* Börner. *Entomobrya koreana* Yosii (1965) was established as a new species for Korean specimens previously identified by Yosii and Lee (1963) as *E. handschini*. Many species of this family have been reported subsequently from the Korean Peninsula (Yosii, 1966; Szeptycki, 1973; Lee and Lee, 1981; Mari Mutt, 1983; Lee and Park, 1984, 1992; Kim and Lee, 1995, 2000; Park and Lee, 2000; Park, 2004). As a result the Korean entomobryid fauna comprises 37 species in 7 genera; of these, 13 species in 4 genera from South Korea and 11 species in 3 genera from North Korea previously have been described as new to science.

The purpose of the present paper is to report three new records of Collembola collected during environmental assessment of soil and freshwater in Korea.

## MATERIALS AND METHODS

### Collection and imaging

We selected some different damp sites (floodland, wet meadows, streams, reservoirs, rice fields, banks etc.) for collect-

ing aquatic and semiaquatic Collembola. A fine-meshed hand net, aspirator and small paintbrush were used to pick up hydrophilous Collembola. Some specimens were collected live by aspiration or with Tullgren funnels from leaf litter and moss samples, or were beaten from tree foliage or branches. We also collected specimens from Malaise traps. Specimens were preserved in 95% ethanol and photographed with a 5-megapixel DS-5M digital camera (Nikon, Ganagawa, Japan) mounted on a stereo microscope.

### Morphology

For microscopic study of entire individuals, specimens were cleared in Marc André I fluid (Massoud, 1967), then mounted in Hoyer's medium to prepare permanent slides. Slides were dried and hardened in a 60°C oven for 2-4 days, then ringed with sealant. Specimens were examined with brightfield, differential interference-contrast, or phase-contrast microscopes. Figures of the chaetotaxy were standardized after Szeptycki (1973) and, Chen and Li (1997) to facilitate comparisons of species.

Morphological abbreviations used in this paper are as follows: [Ant. I-IV] antennal segments I-IV, [Th. I-III] thoracic segments I-III, [Abd. I-VI] abdominal segments I-VI. Abbreviations are used instead of administrative provincial divisions in full as follows: [CB] Chungcheongbuk-do, [CN] Chungcheongnam-do, [GB] Gyeongsangbuk-do, [GN] Gyeongsangnam-do, [JN] Jeollanam-do, [JB] Jeollabuk-do,

Voucher specimens examined are deposited in the Insect Collection, Department of Biology Education, Chonbuk National University, Jeonju, and National Institute of Biological Resources (NIBR), Incheon, Republic of Korea.

## SYSTEMATIC ACCOUNTS

Class Collembola Lubbock, 1870  
Order Entomobryomorpha Börner, 1913

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Tel: 82-63-270-2783, Fax: 82-63-270-2781  
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Superfamily Entomobryoidea Womersley, 1934

Family Entomobryidae Schäffer, 1896

Genus *Entomobrya* Rondani, 1861

<sup>1</sup>\**Entomobrya tokunakai* Yosii, 1942 (Figs. 1A, 3)

*Entomobrya tokunakai* Yosii, 1942: 480, fig. 5 (Type locality: "Japan: Honshu"); Yosii, 1955: 389; Uchida, 1957: 44.

**Redescription.** Body length up to 1.9 mm. Ground color pale yellow, with distinct transverse bluish-violet band on Abd. II and Abd. III (Fig. 1A). Brownish color covering the posterior half of Abd. IV and posterior marginal end of Abd. VI. Antennae yellow on Ant. I, becoming dark along the distal parts of Ant. II to IV, or all of Ant. IV dark. Legs, furca and ventral tube pale.

Antennae relatively short, as long as a half of body length or less. Antenna 2.3 times as long as cephalic diagonal; antennal segment ratio as 1.0:1.8:1.8:2.5. Ant. IV with unilobed apical bulb (Fig. 3E). Ant. III organ with two sensory rods. Eyes 8+8, black, eyes G and H very small. Labral setae: 4, 5, 5, 4, prelabral ones feathered; labral margin with 4 papillae (Fig. 3D). Labial basis setae as M, R, E, L<sub>1</sub> and L<sub>2</sub> present, all setae ciliate.

Head and thoracic tergites with numerous clavate collar setae forming a mane, general chaetotaxy as in Fig. 3A, B. Unguis with two or three inner teeth. Unguiculus lanceolate and untoothed. Clavate tenent hair developed (Fig. 3I). Trochanteral organ well developed, composed of approximately 16 stiff setae (Fig. 3H).

Anterior face of ventral tube with 6+6 macrosetae (Fig. 3C). Tenaculum quadridentate, with one seta (Fig. 3F). Furcal segments ratio manubrium: dens+mucro=1.0:1.4. Mucro bidentate, with a basal spine, anteapical tooth similar than apical one (Fig. 3G).

**Material examined.** [CB] Namcheon valley (N37° 2'26.23" E128° 30'48.5"), Sobaeksan (Mt.), Namcheon-ri, Danyang-gun, Youngchun-myeon: 3 individuals, 28 Jul. 2006-13 Aug. 2006, collected from Malaise traps (J.W. LEE); [GB] Unmunsan (Mt.) (N35° 38'9" E128° 59'18"), Unmun-myeon, Cheongdo-gun: 35 individuals, 26 Apr. 2008-10 May 2008; 13 individuals, 6 Jun. 2008-1 Jul. 2008; 1 individual, 16 Jun. 2009-25 Jul. 2009, collected from Malaise traps (J.W. LEE); [GN] Ppaejae (N35° 51'51" E127° 49'47"), Goje-myeon, Geochang-gun: 5 individuals, 12 Mar. 2010, in needle litter in a pine forest (S.G. Kang and M.H. Imm); [JN] Piagol (N35° 15'00" E127° 35'22"), Jirisan (Mt.), Naedong-ri, Toji-myeon, Gurye-gun: 2 individuals, 5 Mar. 2010, in litter of a deciduous forest dominated by *Quercus* (S.G. Kang and M.H. Imm).

**Biology.** This species climbs vegetation and most specimens

were found in Malaise traps. Some specimens were collected from pine litter.

**Remarks.** This species were recorded from Japan by Yosii (1942, 1955) and Uchida (1957). The Korean specimens were found to be in general agreement in most characters with those in the original description, although the description and figures of those given by Yosii (1942) are insufficient. However, the length of antennae in the Korean specimens is shorter than that of the Japanese specimens as depicted in Yosii's original figure.

This species strongly resembles *Entomobrya ephippiaterra* Salmon, 1941 from New Zealand by sharing the peculiar transverse band on Abd. II and Abd. III. However, the band of *E. ephippiterra* occurs on posterior half of Abd. II and all of Abd. III to halfway down the lateral region. The blue-black pigment of *E. tokunakai* almost completely covers Abd. II and Abd. III.

**Distributions.** Japan, Korea (new record).

Genus *Homidia* Börner, 1906

<sup>2</sup>\**Homidia nigrocephala* Uchida, 1943 (Figs. 2, 4)

*Homidia nigrocephala* Uchida, 1943: 7, Pl. IV, F-I (Type locality: "Taiwan: Baikei; Mt. Taihei"); Uchida, 1957: 45.

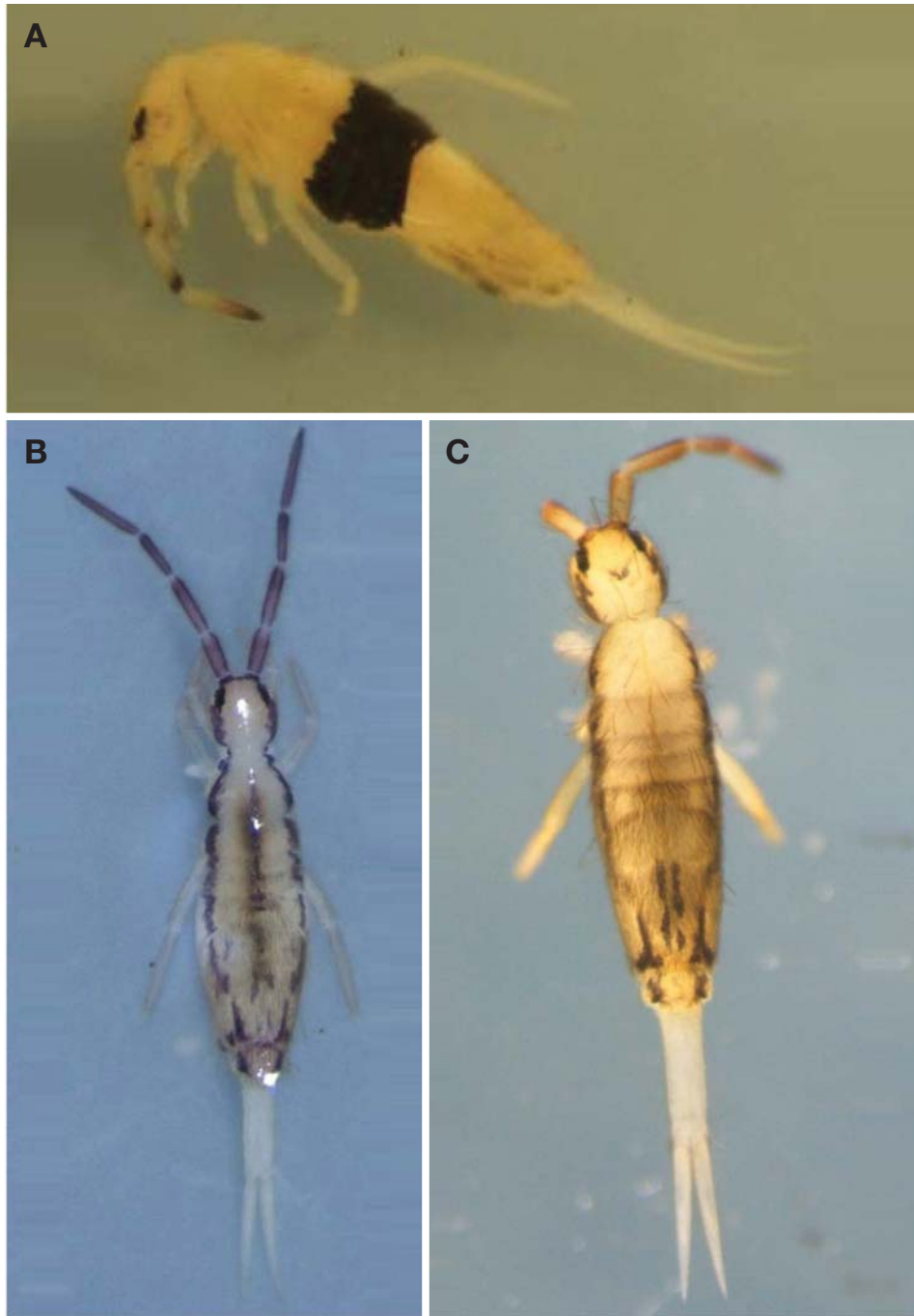
*Homidia nigrocephala* f. *obscura*: Yosii, 1955: 389-390, fig. 6.

**Redescription.** Body up to 2.2 mm. Color pattern quite variable (Fig. 2). Ground colour in life yellow but easily recognized by the totally black head. Dark posterior bands on Th. III and all abdominal segments. Distinct dark anterior broad transversal band on Abd. IV. Head with distinct V-shaped dorsal mark in specimens with lightly or moderately pigmented. In dark individuals, almost whole body except inter-segments covered by black-violet pigment. Antennae yellow on Ant. I, dark bluish-violet on Ant. II-IV. Legs yellow to dark purple; coxa and trochanter dark purple, femur and tibiotarsus yellow to dark; in dark specimens, femur of hind leg dark. Ventral tube dark. Manubrium of furca pale in specimens with lightly or moderately pigmented, dark purple in heavily pigmented individuals; dens and mucro pale.

Antennae length half of body length or less. Antenna 2.4-2.9 times as long as cephalic diagonal; antennal segments I-IV ratio as 1.0:1.4:1.2:2.1. Apical organ of Ant. IV bilobed (Fig. 4G). Ant. III organ with two sensory rods. Eyes 8+8, black, eyes G and H very small. Labral setae 4, 5, 5, 4, prelabral setae smooth; labral margin without papillae (Fig. 4E). Labial basis with setae as M<sub>1</sub>, M<sub>2</sub>, R, e, l<sub>1</sub> and L<sub>2</sub>; seta M<sub>1</sub> longer than M<sub>2</sub>; seta e and l<sub>1</sub> smooth, and others ciliate.

Head and thoracic tergites with numerous clavate collar

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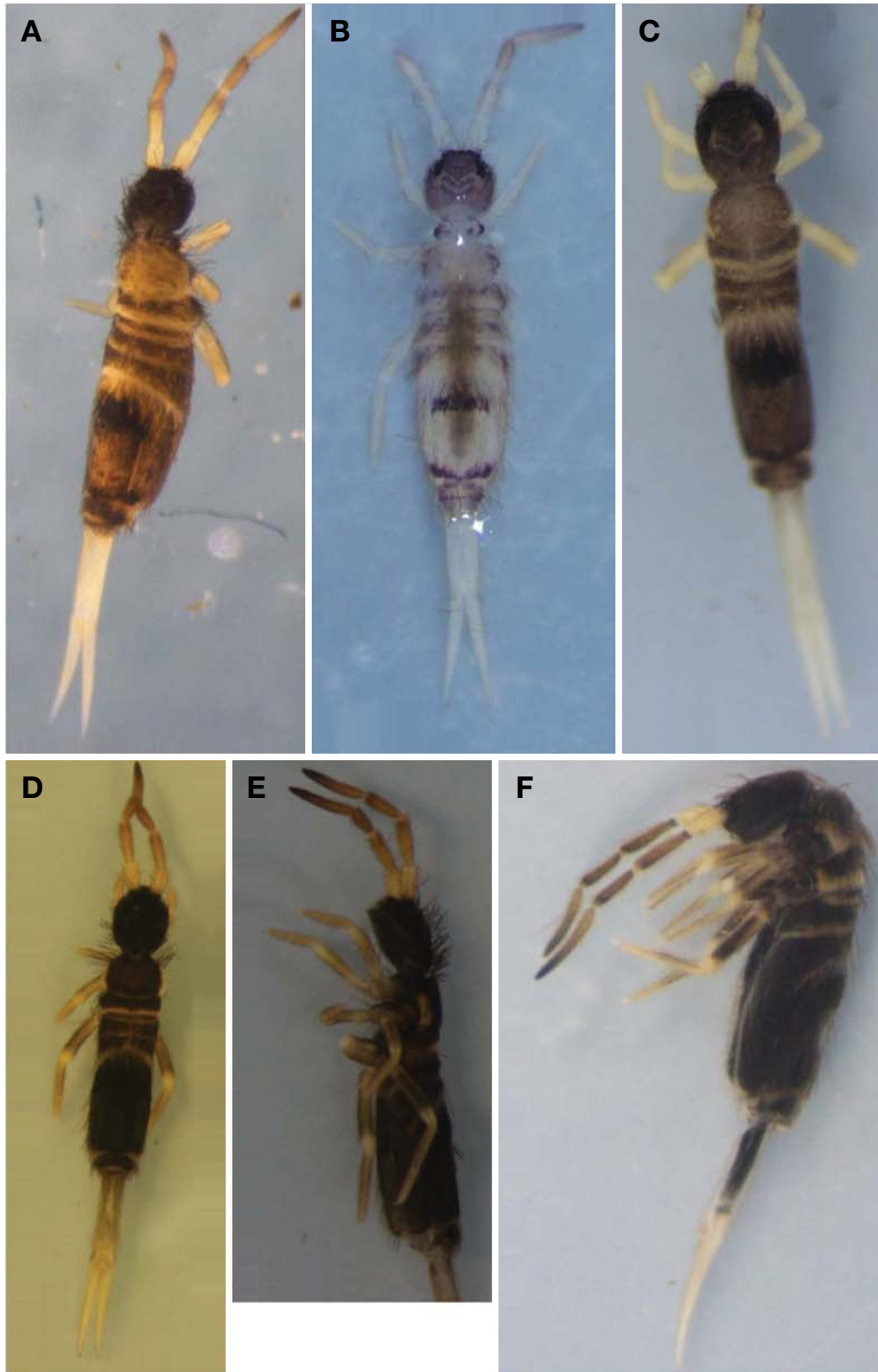


**Fig. 1.** Color patterns. A, *Entomobrya tokunakai* Yosii; B, C, *Homidia socia* Denis.

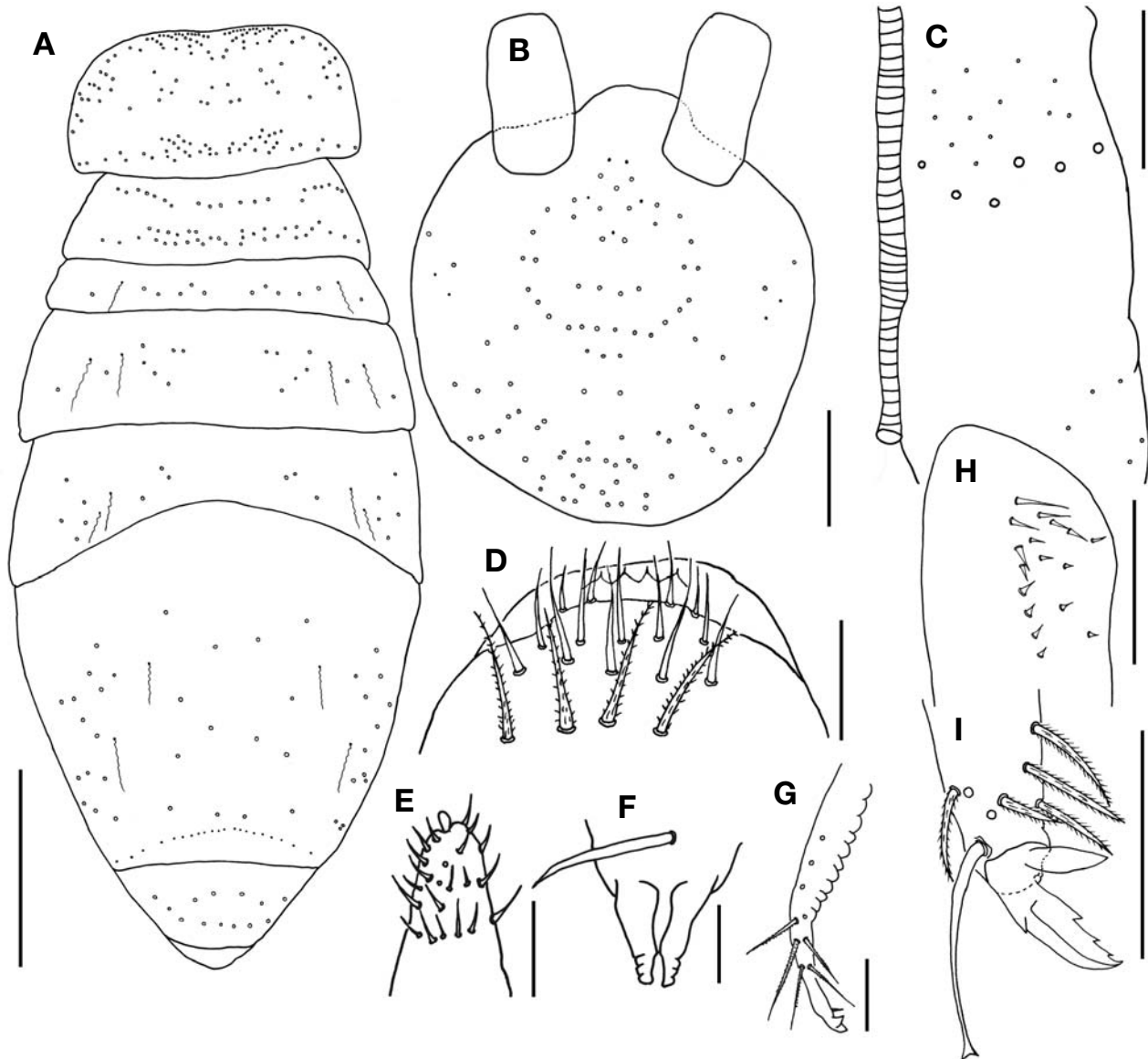
setae forming a mane, general chaetotaxy as in Fig. 4A, B; dorsal region of head with 3 antennal (A), 3 ocellar (O) and 5 sutural (S) macrochaetae; posterior part of Abd. IV with 9-14 macrochaetae, number of setae sometimes different on each side. Unguis with two inner teeth. Unguiculus lanceolate and untoothed. Clavate tenent hair well developed (Fig.

4H). Trochanteral organ composed of more than 20 stiff setae. Anterior face of ventral tube with 3+3 macrosetae; proximal (Pr) and external-distal (Ed) macrochaetae oblique to median furrow (Fig. 4D). Tenaculum quadridentate, with one seta.

Furcal segments ratio manubrium: dens+mucro=1.0: 1.4.



**Fig. 2.** Color patterns of *Homidia nigrocephla* Uchida. A, Specimen from Eonseokgyo, Jeonjucheon (stream) (7 May 2006); B, Specimen from Seungamgyo, Jeonjucheon (stream) (16 Apr. 2006); C, Specimen from Eonseokgyo, Jeonjucheon (stream) (16 Apr. 2006); D-F, Specimen from Eonseokgyo, Jeonjucheon (stream) (30 Apr. 2010).



**Fig. 3.** *Entomobrya tokunakai* Yosii. A, thoracic and abdominal chaetotaxy; B, head dorsal chaetotaxy; C, anterior face of ventral tube, right side; D, prelabral and labral setae and papillae; E, antennal segment (Ant.) IV apical bulb; F, tenaculum; G, mucro; H, trochanteral organ; I, hind claw. Scale bars: A=300  $\mu$ m, B=100  $\mu$ m, C, H, I=50  $\mu$ m, D-G=25  $\mu$ m.

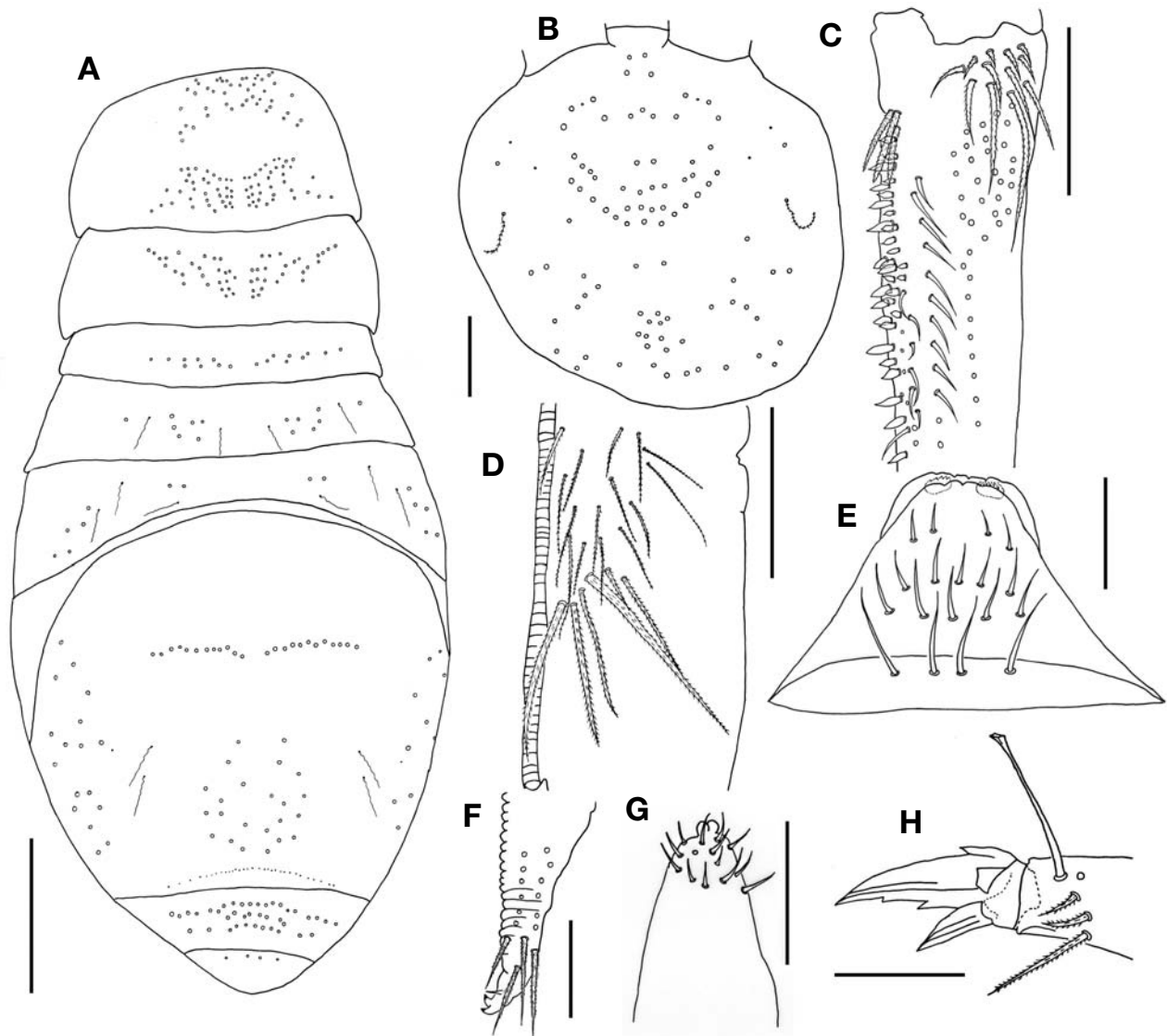
Dens along the edge up to its half length with an irregular double row of 19-30 spines (Fig. 4C). Mucro bidentate with a basal spine, antepical tooth similar than apical one (Fig. 4F). *Material examined.* [JB] around Eonseokgyo (N35° 47'28.4" E127° 11'44.4"), Jeonjucheon (stream), Jeonju-si: 5 individuals, 9 Apr. 2006; 15 individuals, 16 Apr. 2006; 8 individuals, 7 May 2006; 1 individual, 30 Jun. 2006; 45 individuals, 30 Apr. 2010; around Seungamgyo (N35° 48'21.4" E127° 9'54.2"), Jeonjucheon (stream), Jeonju-si: 18 individuals, 7 May 2006; 4 individuals, 30 Jun. 2006; around Dagagy,

Jeonjucheon (stream), Jeonju-si: 1 individual, 9 Apr. 2006; 11 individuals, 16 Apr. 2006; 1 individual, 7 May 2006; 1 individual, 30 Jun. 2006; around Wansangyo (N35° 48'45" E127° 8'24"), Jeonjucheon (stream), Jeonju-si: 2 individuals, 30 Apr. 2010, collected from emergent vegetations (K.H. Park and J.Y. Kim).

*Biology.* Hydrophilous species. This species occurs on emergent stems and leaves.

*Remarks.* The description provided by Uchida (1943) and Yosii (1955) is here augmented with additional characters





**Fig. 4.** *Homidia nigrocephala* Uchida. A, thoracic and abdominal chaetotaxy; B, head dorsal chaetotaxy; C, dental spines, right side; D, anterior face of ventral tube, right side; E, prelabral and labral setae; F, mucro; G, antennal segment (Ant.) IV apical bulb; H, hind claw. Scale bars: A=300  $\mu$ m, B-D=100  $\mu$ m, E-H=50  $\mu$ m.

that provide a more precise diagnosis. The species shows much variation in the body pattern and color. The light form of Korean specimens agrees entirely with the description and figures given by Uchida (1943). The pigmented specimens with dark coloration are very similar to those described by Yosii as *H. nigrocephala* f. *obscura* (Yosii, 1955). We examined numerous specimens and found that this species has a color range of yellow to dark even in the same population (Fig. 2). There appear to be no morphological differences between among color variants, and therefore, *H. nigro-*

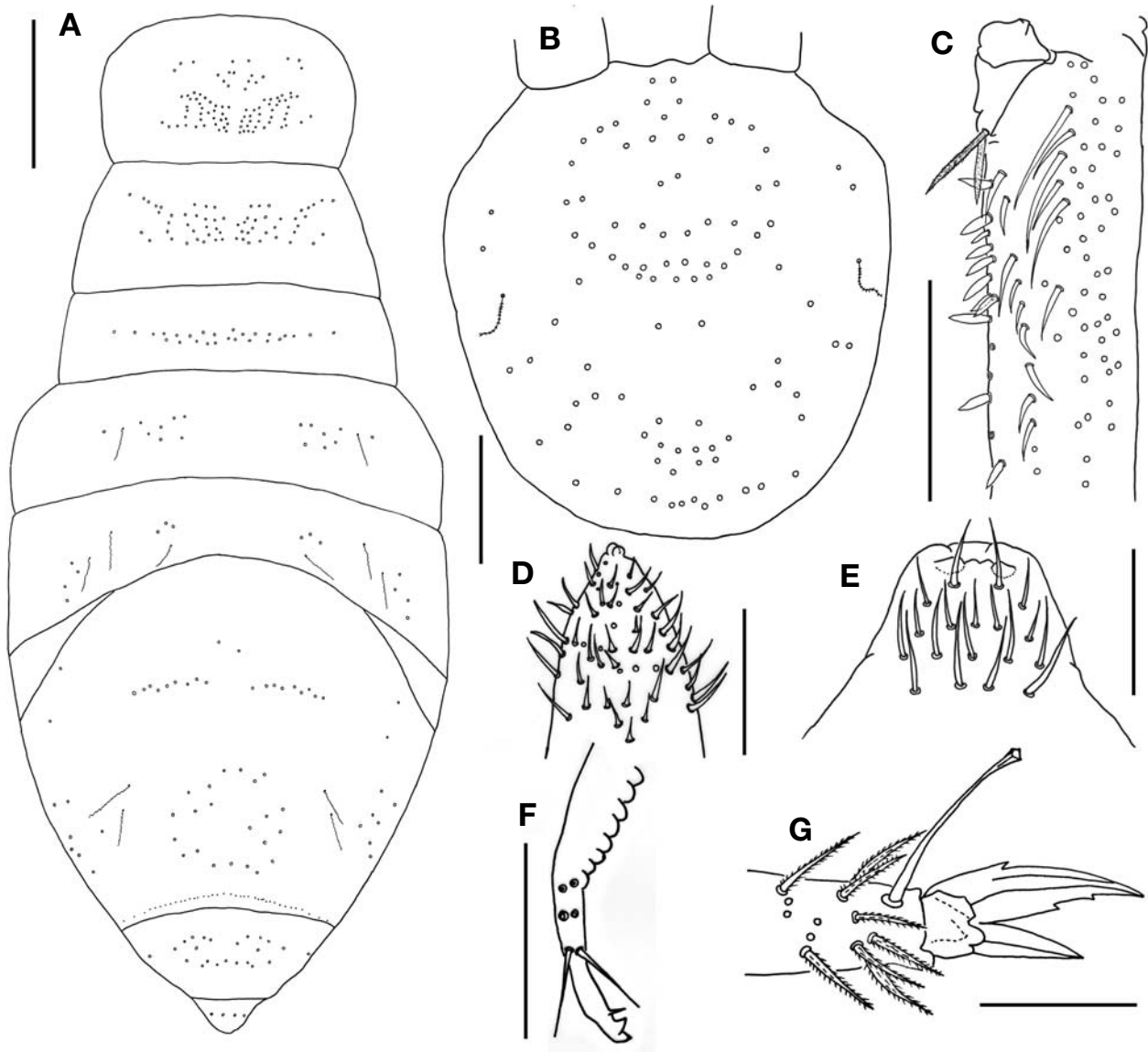
*cephala* f. *obscura* is considered to be a dark variant of *H. nigrocephala* without taxonomic standing.

*Distributions.* Taiwan, Japan, Korea (new record).

<sup>1</sup>\**Homidia socia* Denis, 1929 (Figs. 1B, C, 5)

*Homidia socia* Denis, 1929: 310, figs. 1-4 (Type locality: "South China: Foochow"); Yosii, 1942: 487, fig. 10; Uchida, 1957: 45; Yosii, 1955: 389; Stach, 1964: 19, Pl. 10, fig. 2; Stach, 1965: 359, Pl. 32, figs. 1-6; Christiansen and Bellinger, 1980: 884, fig. 727; Christiansen and Bel-

<sup>1</sup>\*긴줄털보톡토기 (신칭)



**Fig. 5.** *Homidia socia* Denis. A, thoracic and abdominal chaetotaxy; B, head dorsal chaetotaxy; C, dental spines, right side; D, antennal segment (Ant.) IV apical bulb; E, prelabral and labral setae and papillae. F, mucro; G, hind claw. Scale bars: A=300  $\mu$ m, B, C=100  $\mu$ m, D-G=50  $\mu$ m.

linger, 1998: 982, fig. 727.

**Redescription.** Body up to 2.7 mm. Ground colour in life yellow but with distinct black longitudinal stripe along the lateral edge of the head and trunk, and a middorsal stripe on Th. II to Abd. III (Fig. 1B, C). Antennae dark bluish-violet. Legs, furca and ventral tube pale.

Antennae longer than half of body length. Antenna 3.3 times as long as cephalic diagonal; antennal segments I-IV ratio as 1.0:1.4:1.2:1.8. Apical organ of Ant. IV bilobed (Fig. 5D). Ant. III organ with two sensory rods. Eyes 8+8, black, eyes G and H very small. Labral setae 4, 5, 5, 4, pre-

labral setae smooth; labral margin with 4 minute papillae (Fig. 5E). Labial basis with setae as M, R, E, L<sub>1</sub> and L<sub>2</sub>; all setae ciliate.

Head and thoracic tergites with numerous clavate collar setae forming a mane, general chaetotaxy as in Fig. 5A, B; dorsal region of head with 4 antennal (A), 3 ocellar (O) and 5 sutural (S) macrochaetae; middle part of Abd. III with 3+3 macrochaetae. Unguis with two inner teeth. Unguiculus lanceolate and untoothed. Clavate tenent hair developed (Fig. 5G). Trochanteral organ well developed, composed of more than 30 stiff setae. Anterior face of ventral tube with 3+3 macrosetae; proximal (Pr) and external-distal (Ed) macro-

chaetae parallel to median furrow. Tenaculum quadridentate, with one seta.

Furcal segments ratio manubrium: dens+mucro=1.0:1.3. Dental spines up to 17 in adults (Fig. 5C). Mucro bidentate with a basal spine, antepical tooth similar than apical one (Fig. 5F).

*Material examined.* [JB] around Eonseokgyo (N35° 47'28.4" E127° 11'44.4"), Jeonjucheon (stream), Jeonju-si: 26 individuals, 9 Apr. 2006; 16 individuals, 16 Apr. 2006; 30 individuals, 7 May 2006; 58 individuals, 30 Jun. 2006; 70 individuals, 30 Apr. 2010; around Seungamgyo (N35° 48'21.4" E127° 9'54.2"), Jeonjucheon (stream), Jeonju-si: 3 individuals, 9 Apr. 2006; 30 individuals, 7 May 2006; 13 individuals, 30 Jun. 2006; around Hanbyeokgyo (N35° 48'28.6" E127° 9'48.3"), Jeonjucheon (stream), Jeonju-si: 2 individuals, 9 Apr. 2006; 1 individual, 16 Apr. 2006; 10 individuals, 7 May 2006; 1 individual, 30 Jun. 2006; around Dagagyo, Jeonjucheon (stream), Jeonju-si: 4 individuals, 9 Apr. 2006; 3 individuals, 16 Apr. 2006; 5 individuals, 7 May 2006; 2 individuals, 30 Jun. 2006; around Wansangyo (N35° 48'45" E127° 8'24"), Jeonjucheon (stream), Jeonju-si: 25 individuals, 30 Apr. 2010, collected from emergent vegetations (K.H. Park and J.Y. Kim); [JB] Samnyecheon (stream) (N35° 50' 39.9" E127° 6'23"), Samrye-eup, Wanju-gun: 2 individuals, 16 Jun. 2006, on running water and emergent vegetations (K.H. Park and J.Y. Kim); [JB] Hwaamsa (Temple) (N36° 03'30" E127° 16'40"), Gacheon-ri, Gyeongcheon-myeon, Wanju-gun: numerous specimens, 31 Oct. 2009, in debris of rice field (K.H. Park and S.G. Kang); [CN] Sogeun reservoir (N36° 47'58.4" E126° 12'39"), Sogeun-ri, Sowon-myeon, Taean-gun: 2 individuals, 7 Jul. 2007, bank of reservoir, on slime under a tuft of rotting grasses (K.H. Park and J.Y. Kim); [CN] Ggusunamugol Beach (N36° 55'44" E126° 17'45"), Nae-ri, Iwon-myeon, Taean-gun: numerous specimens, 8 Jul. 2007, on water and emergent stems and leaves of temporary pools formed by rain (K.H. Park and J.Y. Kim); [CN] Gonam reservoir (N36° 49'6.90" E126° 25'38.6"), Gonam-ri, Seongyeon-myeon, Seosan-si: numerous specimens, 8 Jul. 2007, on water and emergent stems and leaves of vegetations in lake (K.H. Park and J.Y. Kim); [CN] Ondong reservoir 1 (N36° 56.21'70" E126° 35.4'50"), Janghang-ri, Godaemyeon, Dangjin-gun: numerous specimens, 8 Jul. 2007, in small creek near the reservoir (K.H. Park and J.Y. Kim); [CN], Sunwon reservoir (N36° 48'52.2" E126° 40'10.9"), Wondong-ri, Myeoncheon myeon, Dangjin-gun: numerous specimens, 8 Jul. 2007, on water and emergent stems and leaves of vegetations in rice field near reservoir (K.H. Park and J.Y. Kim).

*Biology.* Hydrophilous species. This species is common and numerous in different damp sites. It is often abundant in riparian zones, around seeps and in moist areas in agricultural

fields.

*Remarks.* In pattern of the body, bilobed apical bulb of Ant. IV, labral papillae furnished with teeth, lancet-like empodial appendage, and chaetotaxy of Abd. III, the Korean specimens seem to be identical with *Homidia socia* Denis, examined closely by Stach (1964, 1965) and Christiansen and Bellinger (1980, 1998). Compared with individuals from China (Stach, 1965), chaetotaxic variations were observed; with the number of macrosetae greater in Korean specimens.

*Distributions.* China, Japan, USA, Taiwan, Korea (new record).

## DISCUSSION

A number of systematic studies of hydrophilous Collembola on seashores and associated with freshwater have been carried out in North America, Japan, and several European countries (Uchida and Tamura, 1966; Yosii, 1971; Scott and Yosii, 1972; Christiansen and Bellinger, 1988; Thibaud and Christian, 1989, 1991; Christiansen and Snider, 2008). The hydrophilous collembolan fauna of Korea has only recently been studied (Lee and Kim, 1994; Thibaud and Lee, 1994; Park and Lee, 1995, 2000; Thibaud and Kim, 1995; Kim and Lee, 2000). The only previous report from Korean freshwater habitats was that of Kim and Lee (2000) listing ten species in nine genera, of which four species were new to science and six were new records for the Korean Peninsula.

Waltz and McCafferty (1979) divided Collembola into three categories based on the relative degree of association and adaptation to the aquatic environment. Primary aquatic associates are those found exclusively in aquatic habitats; secondary aquatic associates are found in and around aquatic habitats, but also inhabit other areas with high humidity and moisture; and tertiary aquatic associates, typical in part of the transitory neuston and inhabiting temporary pools formed by rain while having the least apparent adaptation to aquatic habitats. In this study, *Homidia nigrocephala* from Korea were collected from emergent vegetations in streams with a hand net. In the original description by Uchida (1942) stated that he collected his specimens under dead leaves and humus. This species is considered secondary aquatic associates by Waltz and McCafferty (1979). *Homidia socia* is common and numerous in various damp sites, and often occurs in agricultural fields. This species can be considered a secondary or perhaps tertiary aquatic associate.

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