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TWO NEW SPECIES OF CERATOPHYSELLA (COLLEMBOLA: HYPOGASTRURIDAE) FROM KOREA

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ABSTRACT

Two new species of the genus Ceratophysella from Korea, Ceratophysella biclavata n. sp. and Ceratophysella platyna n. sp. are described and illustrated. Ceratophysella biclavata differs from the closely related species Ceratophysella sigillata (Uzel 1891) by the shape of antennal bulb on antennal segment IV, the number of clavate tenent hairs and the number of granules between p, upon abdominal segment V. Ceratophysella platyna resembles Ceratophysella denticulata (Bagnall 1941) and Ceratophysella communis (Folsom 1898), but distinctly differs from the latter by the shape of tenent hairs. A key to the identification of the Korean species of Ceratophysella is included. In addition, the known species Hypogastrura gracilis (Folsom 1899) is described and recorded for the first time from Korea.

Key Words: Hypogastrura, Poduromorpha, Arthropleona, springtail, Apterygota, South Korea

The family Hypogastruridae is common, widespread, and has cosmopolitan distribution containing approximately 659 world species in about 40 genera. The genus Ceratophysella also with worldwide distribution is one of the largest genera in the family, with more than 108 known species (Bellinger et al. 2006). Their habits were noted by Hopkin (2002), who stated that they often form enormous swarms on roads, glaciers, snow, and on the surfaces of puddles. Individuals in the swarms all leap together in the same direction using the orientation of the sun to navigate. They have small expandable sticky sacs on their antennae that help them adhere to the substrate when they land after a jump to stabilize them (Hopkin 2002).


The purpose of this paper is to describe 2 new species and to provide an identification key to the species of Ceratophysella from Korea. Lee & Kim (1995) described C. dolsana as a new species, but there is no description of the genus in their work. Most authors regarded dolsana as belonging in the genus Hypogastrura (Bellinger et al. 2006; Thibaud et al. 2004). However, we include it in the key of Ceratophysella, primarily on the basis of long p, setae on thoracic segments II-III and on the shape of macro in holotype and paratypes. 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; seta a and b: seta a and b among the 7 dorsal sensory setae of Ant. IV; a1, a2, . . . : setae 1, 2 . . . of the anterior row counted from the “middle line”; m1, m2, . . . : setae 1, 2 . . . of the middle row, counted from the “middle line”; p1, p2, . . . : setae 1, 2 . . . of the posterior row, counted from the “middle line”.

MATERIALS AND METHODS

Material was collected from 3 localities in Korea. Either an aspirator for direct collection or a Tallgren apparatus for extracting specimens was used. Collembola were fixed in 90% ethanol. Marc André I and II solutions were used to clear and

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Ceratophyrella biclavata,
new species

Description (Fig. 1). Body length 1,110-1,400 µm (1,200 µm long in holotype). Color dark brown or blackish brown on whole body except inter-segmental portions and the ventral side. Body cylindrical, being narrower abruptly at Abd.V (Fig. 1A). Head length 220 µm in holotype. Antenna shorter than head, 0.9 in ratio to head; ratio of length of antennal segments I:II:III:IV is 5:5:6:4. Ant. IV with a simple apical bulb and a closely associated small papilla, a socket seta and some weak setae (Fig. 1B), with and 7 dorsal sensory setae of which seta a and b thickened. Eversible sac between Ant. III and Ant. IV distinctly developed. Ant. III organ with 2 short sensory and 2 guard sensilla (Fig. 1D). Mandible with 4 apical teeth (Fig. 1F). Eyes 8 + 8, eye patch with 3 setae. Postantennal organ (PAO) consists of 4 peripheral tubercles, about 1.2-1.5 times as long as the diameter of the nearest ocelli, with anterior lobes distinctly larger than posterior and with a small accessory tubercle (Fig. 1C). Tenent hairs 2, 2, 2 with distal end weakly clavate. Unguis elongate, with an inner tooth and a pair of lateral teeth. Unguiculus setaceous and with and broad, rounded apex; lacking ventral file, but with 11-13 relatively long straight setae and seven clear blunt setae (Figs. 2B, E). Eversible sac between Ant. III and IV distinctly differentiated. Left mandible with 5 apical teeth and right with 4 apical teeth (Figs. 2D, H). Postantennal organ with 4 peripheral tubercles, a small accessory tubercle, anterior lobes strikingly larger than posterior and about 1.5 times as long as nearest ocelli. Eye patch with 8 ocelli on each side (Fig. 2C). Unguis slender, slightly curving distally, with 1 inner tooth on internal lamella. Unguiculus pointed and with a basal lamella tapering into a filament, almost ½ as longer internal lamella of unguis. Tenent hairs 1, 1, 1 almost as long as outer unguis and truncate to feebly clavate (Fig. 2G). Ventral tube with 3 + 3 setae. Tenaculum with 4 + 4 barbs. Dens about twice as long as mucro, with 7 posterior setae, without basally enlarged angled setae (Fig. 2F). Mucro 0.8-0.9 times as long as anal spines. Body setae all smooth and slender.

Type Materials

Holotype: Female, Temple Jeongamsa, Gacheon-ri Dongmyeong-myeon Chilgok-gun, Gyeongsangbuk-do Province, collected from litter soil layer of the forest near stream. 24-X-2004, collection no. 204-21. Paratypes: 2 males and 3 females, same data as holotype.

Etymology. The specific name is derived from the number and shape of tenent hairs in each leg.

Remarks. The present species is very similar to C. sigillata (Uzel 1891), and redescribed by Babenko et al. (1994), in chaetotaxy of thorax and abdomen, in shape of mucro and basal lamella of unguiculus and in shape of seta on dens. However, they can be separated easily by differences in the shape of antennal bulb on Ant. IV, the number of tenent hairs on each leg and in the number of granules between p, upon Abd.V. Number of granules between p, of Abd. V is 20-25 in C. sigillata and 11-13 in the present new species. Also, the present species differs from C. sigillata by the strongly developed eversible sac (weakly developed in C. sigillata) and the absence of hook-like sensilla upon fourth antennal segment (Table 1).

Ceratophyrella platyna,
new species

Description (Fig. 2). Body length 1,200-1,400 µm (1,200 µm long in holotype). Body dark brown with blue pigment scattered over dorsum of segments in the form of irregular transverse bands (Fig. 2A). Head length 270 µm in holotype. Antenna shorter than head, 0.8 length of head; ratio of length of antennal segments I:II:III:IV is 3:4:5:6. Fourth antennal segment with a simple apical bulb and a closely associated protective papilla, giving a bilobed appearance to the antennal apex; lacking ventral file, but with 11-13 relatively long straight setae and seven clear blunt setae (Figs. 2B, E). Eversible sac between Ant. III and IV distinctly differentiated. Left mandible with 5 apical teeth and right with 4 apical teeth (Figs. 2D, H). Postantennal organ with 4 peripheral tubercles, a small accessory tubercle, anterior lobes strikingly larger than posterior and about 1.5 times as long as nearest ocelli. Eye patch with 8 ocelli on each side (Fig. 2C). Unguis slender, slightly curving distally, with 1 inner tooth on internal lamella. Unguiculus pointed and with a basal lamella tapering into a filament, almost ½ as longer internal lamella of unguis. Tenent hairs 1, 1, 1 almost as long as outer unguis and truncate to feebly clavate (Fig. 2G). Ventral tube with 3 + 3 setae. Tenaculum with 4 + 4 barbs. Dens about twice as long as mucro, with 7 posterior setae, without basally enlarged angled setae (Fig. 2F). Mucro 1.5 times as long as mucro. Mucro 0.8-0.9 times as long as anal spines. Body setae all smooth and slender.
moderately granular. Granular stripe on Abd. V arranged regularly, 9-12 granules lying between the p1 setae on Abd. V (Fig. 2I). Fovea lying between the p1. Anal spines slender, on unusually large contiguous papillae. On Abd. VI, a nearly as long as anal spine including anal papilla (Fig. 2J).

Chaetotaxy. Area verticalis confluent with area occipitalis and with 2 + 2 setae. Th. I with 3

+3 setae in a row. Th. II and III with 3 rows of setae, m₁ and m₃ absent, p₁ a macroseta and p₂, the sensory seta. Abd. I-III with 2 rows of setae, without m-seta, with a₁', p₁, a macroseta and p₂ the sensory seta. Abd. IV with 3 rows of setae, a₁ slightly laterally dislocated, a₂, m₁ and m₃ absent, p₃ longer than p₁ and p₂, the sensory seta. Abd. V with 2 rows of setae, without a₂', p₁ longer than p₃, a₃ lack and p₄, the sensory seta (Fig. 2K).

Type Materials

Holotype: Male, 700 m a.s.l., Mt. Moacksan, Gui-myeon, Waju-gun, Jeollabuk-do Province, collected from the leaf litter under snow, 14 Feb 2004, collection no. 204-01-1. Paratypes: 2 males and 2 females, same data as holotype.

Etymology: The specific name, platyna, refers to the shape of body in this species.

Remarks: This species is characterized by the presence of an antennal bulb and the shape of tenent hairs. In many respects this species resembles C. pratorum of C. boletivora-group from North America (Christiansen & Bellinger 1998), but they differ in chaetotaxy. The present species is a member of Gisin’s A type (Gisin 1947) with p₁, seta longer than p₁ seta on Abd. IV (p₁ > p₂ in C. pratorum). The antennal bulb clearly separates C. platyna n. sp. from C. boletivora and C. biloba of C. boletivora-group. Also, the present species is closely related to palaearctic species C. annae described by Babenko (1994), but is distinguished by the darker body colour, the presence of eversible sac and having 7 dorsal sensilla setae on Ant. IV (C. annae has 6). Chaetotaxy of the present species is similar to C. communis (Folsom) from Korea (Lee 1974; Lee & Thibaud 1975) by the presences of the a₁' seta on Abd. I-III, the absence of the a₂' seta on Abd. V, but it is separated from the latter in the shape of tenent hairs and the number of granules between p₁ upon Abd. V. It also has the same number of granules between p₁ upon Abd. V with cosmopolitan C. denticulata (Bagnall 1941) (Yosii 1962; Lee & Kim 2000). However, this new species is distinctly different from C. denticulata and C. communis in the shape of tenent hairs (Table 2).

Hypogastrura gracilis (Folsom, 1899), new record

Diagnosis (Fig. 3). Body length 1,500-1,900 µm (1,700 µm long in holotype). Color grey or blackish brown on whole body except only intersegmental portions and the ventral side. Body laterally swollen at Abd. II and III, being gradually narrower toward posterior end (Fig. 3A). Head length 310 µm in holotype. Antenna longer than head, ratio 1.1 to head length; ratio of length of antennal segments I:II:III:IV is 12:13:18:30. Fourth antennal segment with a distal, slightly trilobed end-bulb and a number of socket setae, with 3 weak setae each on a slightly differentiated, small subapical papillae (Figs. 3C, E). Third antennal segment organ of 2 small rods in a shallow groove accompanied by 2 curved setae. Labrum with 4/5, 5, 4 setae, their distal row very weak. Labral margin with 4 rounded tubercles (Fig. 3H). Postantennal organ of 4 peripheral tubercles, with or without a small accessory tubercule, subequal to nearest ocelli (Figs. 3B, D). Eyes 8 + 8, on black patches. Unguis of all legs subequal, relatively small, dorsally carinate and with 1 inner tooth near the distal end. Unguiculus setaceous and reaching three-quarters of the distance from base to apex of unguis. Basal half with lamella on the inner side apically arcuate. Tenent hairs 2, 3, 3 rather thick and conspicuously swollen at apex. Median tenent hairs larger than others and above the level of others on the second and third legs (Fig. 3F). Ventral tube with 4+4 setae. Tenaculum with 3 + 3 barbs. Dens almost smooth dorsally with 7 setae, about 4 times as long as mucro. Mucro strongly compressed bilaterally and somewhat blade-shaped (Fig. 3G). Mucro 3.7-5.5 (mostly 4) times as long as anal spines. Outer unguis 1.3-1.8 times as long as mucro. Anal spines 0.25 times as long as inner unguis and subequal to anal papillae. All body setae short and fine.

Chaetotaxy. Th. I with 3+3 setae in a row. Th. II and III composed of 3 rows of setae, p₁ a little longer than others, sensory seta on Th. II without m₁ seta and Th. III without m₂, m₃, a₃ setae. Abd.
**TABLE 2. DIAGNOSTIC CHARACTERS FOR CERATO PHYSELLA PLATYNA N. SP.**

<table>
<thead>
<tr>
<th>Species/Character</th>
<th>C. denticulata</th>
<th>C. communis</th>
<th>C. platyna n. sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape of tenent hair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of granules between p1 upon Abd. V a2' seta on Abd. V</td>
<td>acuminate</td>
<td>acuminate</td>
<td>clavate</td>
</tr>
<tr>
<td>present</td>
<td>9-12 grains</td>
<td>20 grains</td>
<td>9-12 grains</td>
</tr>
<tr>
<td>absent</td>
<td>present</td>
<td>absent</td>
<td>absent</td>
</tr>
</tbody>
</table>

**I-III bearing two rows of setae, p2, a macroseta and p3, the sensory seta. Abd. IV with three rows of setae and p4, sensory seta. Abd. V bearing 2 rows of setae, p1 longer than p2, and p3, the sensory seta (Fig. 31).**


Remarks. This specimen generally correlates with the descriptions by Yosii (1960) from Japan. Some minor differences are observed, however, in the fourth antennal segment setae, in the presence or absence of accessory tubercle, in the position of the median tenent hair on the second and third legs. In addition, the present material is shown to have some local variation as compared to the original description. More extensive collections must be examined to determine whether this is a geographically variable species or a group of several similar species. The present species resembles *H. bulba* Christiansen & Bellinger 1980 of the viatica group in the trilobed antennal bulb. But it differs somewhat from *H. bulba* in the length ratio of macro and dens, the number of tenent hairs on each leg (2, 3, 3 or 3, 3, 3 in *H. bulba*), and relative length of anal spine to anal papilla. Also, this species is similar to *H. tullbergi* (Schäffer 1900), but differs in the absence of spine-like setae on the apex of the third antennal segment.

Distribution. Japan, Korea (new record).

**DISCUSSION**

The species of *Ceratophysella* are characterized by having a well developed unguiculus and a spoon-shaped mucro with a lateral lamella. Posterior arms of postantennal organ are large, and seta m on thoracic segment II is absent. In Japan, about 12 species are recorded (Furuno et al. 2000; Tamura 2001). Three species are known to occur in China (Zhao et al. 1997).

The taxonomic status of the members of genus *Ceratophysella* have been described by several researchers world-wide (Yosii 1960, 1962; Bourgeois & Cassagnau 1972; Bonet et al. 1973; Christiansen & Bellinger 1998; Babenko et al. 1994; Thibaud 2004). According to Yosii (1960, 1962), 3 species-groups are recognized in the genus *Ceratophysella*: communis, armata, and denisana-groups. The communis-group has the chaetotaxy of Gisin’s A type (1947), which seta p1 on Abd. IV larger than p2, and is represented by *C. denticulata* Bagnall 1941 in Europe. The chaetotaxy of armata-group represents Gisin’s B type (1947), which seta p2 on Abd. IV smaller than p1. Chaetal arrangement of *Ceratophysella bicaivata* n. sp. is typical for the armata-group in the chaetotaxy of Abd. IV. *Ceratophysella platyna* n. sp. is clearly different from armata-group in the chaetotaxy of Abd. IV, where seta p3 is longer than p1 and p2. Microsetae and macrosetae of the species weakly differentiated, but some setae as p2 on Th. II and III, p3 on Abd. I-IV and p2 on Abd. V are longer than others, thus indicating the communis-group of chaetotaxy, that is Gisin’s A type. *Ceratophysella platyna* n. sp., commonly forms enormous swarms under leaves covered with snow.

In the present study, 2 new species and 1 newly recorded species are recognized in Korea. As result of this study, the Korean faunal list of Hypogastruridae consists of 28 species in 6 genera.

**KEY TO 10 SPECIES OF CERATO PHYSELLA FROM KOREA**

1. Fourth abdominal segment with seta p1 longer than seta p2 ........................................ 2
   — Fourth abdominal segment with seta p2 shorter than seta p1 ........................................ 8
2. Fourth abdominal segment with seta p1 and seta p2 short, sensory seta p3 ......................... 3
   — Fourth abdominal segment with seta p2 short and seta p long, sensory seta p3 .................. 7
3. Fifth abdominal segment, an integumentary process “languette” present ......................... liguladorsi
   — Fifth abdominal segment, an integumentary process “languette” absent ......................... 4
4. Dens with bladder-like swelling .................................................................................. bengtssonii
—. Dens without bladder-like swelling ................................................................. 5
5. Fourth antennal segment with conspicuous ventral “file”, tenent hair acuminate .................... armata
—. Fourth antennal segment without conspicuous ventral “file”, tenent hair clavate or truncate ........ 6
6. p₆, p₅, and p₄ sensory setae upon Abd. I-III, Abd. IV and Abd. V, respectively. Tenent hairs 1, 1, 1
   and apical bulb of fourth antennal segment trilobed ........................................... dolsana

Fig. 3. Hypogastrura gracilis. A. Habitus. B. Postantennal organ (PAO) and 8 ocelli. C. Dorsal view of antenna
IV segment. D. Various types of postantennal organ (PAO). E. Various types of fourth antennal segment apical bulb.
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