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

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Source: Florida Entomologist, 89(4) : 489-496
Published By: Florida Entomological Society
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 p1 seta on thoracic segments II-III and on the shape of mucro in holotype and paratypes. Morphological abbreviations used in this paper are as follows: Ant. 1-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, ..., a6 : of the anterior row counted from the “middle line”; m1, ..., m6 : setae 1, 2 ..., of the middle row, counted from the “middle line”; p1, ..., p6 : 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 Tullgren apparatus for extracting specimens was used. Collembola were fixed in 90% ethanol. Marc André I and II solutions were used to clear and
prepare specimen slides (Massoud 1967). KOH solution (10%) was used for rapid de-coloration. To prepare permanent slides, glycerine was placed along the cover glass edge to prevent the slide medium from drying. All type specimens are deposited in the Insect Collection of Biology Education Department, Chonbuk National University, Jeonju, Korea.

*Ceratophysella 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), and with 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 broad, rounded patch with 8 ocelli on each side (Fig. 2C). Unguis about 1.5 times as long as nearest ocelli. Eye prior lobes strikingly larger than posterior and with a small sensory setae (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 broad, rounded patch with 8 ocelli on each side (Fig. 2C). Unguis about 1.5 times as long as nearest ocelli. Eye

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 micro 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).

*Ceratophysella 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 macro, with 7 posterior setae, without basally enlarged angled setae (Fig. 2P). Outer unguis 1.5 times as long as macro. Macro 0.8-0.9 times as long as anal spines. Body setae all smooth and slender. Integument
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 m₂ absent, p₁ a macroseta and p₃ the sensory seta. Abd. I-III with 2 rows of setae, without m-seta, with a₁, p₁, a macroseta and p₃ the sensory seta. Abd. IV with 3 rows of setae, a₁ slightly laterally dislocated, a₂, m₃ and m₅ absent, p₃ longer than p₁ and p₂ the sensory seta. Abd. V with 2 rows of setae, without a₁, p₁ longer than p₂, a₂ lacking and p₃ the sensory seta (Fig. 2K).

Type Materials

Holotype: Male, 700 m a.s.l., Mt. Moacksan, Gui-myeon, Wanjun-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 p₂ a simple apical bulb and a closely associated small papilla, and m₃ seta and Th. III without m₂, m₃, a₃ setae. Abd. II 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 tubercle, 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, p₃ a little longer than others, sensory seta on Th. II without m₅ seta and Th. III without m₅, m₆, a₃ setae. Abd.
I-III bearing two rows of setae, p2 a macroseta and p5 the sensory seta. Abd. IV with three rows of setae and p2, sensory seta. Abd. V bearing 2 rows of setae, p1 longer than p3, and p5 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 m2 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 p5 on Abd. IV larger than p1 and is represented by *C. denticulata* Bagnall 1941 in Europe. The chaetotaxy of *armata*-group represents Gisin’s B type (1947), which seta p5 on Abd. IV smaller than p1. Chaetal arrangement of *Ceratophysella biclavata* 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 p5 is longer than p1 and p3. Microsetae and macrosetae of the species weakly differentiated, but some setae as p5 on Th. II and III, p1 on Abd. I-IV and p1 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 Hypogasturidae consists of 28 species in 6 genera.

**KEY TO 10 SPECIES OF CERATOPHYSELLA FROM KOREA**

1. Fourth abdominal segment with seta p1 longer than seta p3 .......................................................... 2
—. Fourth abdominal segment with seta p1 shorter than seta p3 .......................................................... 8

2. Fourth abdominal segment with seta p1 and seta p3 short, sensory seta p3 ........................................... 3
—. Fourth abdominal segment with seta p1 short and seta p3 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

**TABLE 2. DIAGNOSTIC CHARACTERS FOR CERATOPHYSELLA 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>acuminata</td>
<td>acuminata</td>
<td>clavate</td>
</tr>
<tr>
<td>The number of granules between p1 upon Abd. V</td>
<td>9-12 grains</td>
<td>20 grains</td>
<td>9-12 grains</td>
</tr>
<tr>
<td>a2' seta on Abd. V present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABD. IV with three rows of setae</td>
<td></td>
<td></td>
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</tbody>
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—. 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. p₀, p, and p₁ 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. F. Second leg. G. Dorsal view of mucro and dens. H. Labrum. I. Dorsal chaetotaxy of body.
p₃, p, and p₅ sensory setae upon Abd. I–III, Abd. IV and Abd. V, respectively. Tenent hairs 2, 2, 2 and apical bulb of fourth antennal segment unilobed. .................. biclavata n. sp.
7. Two spines present in the position of p₁ setae on Abd. V. .................. duplicispinosa
—. Two spines absent in the position of p₁ setae on Abd. V. .................. sinetertiaseta
8. Abd. V with a₁ setae; tenent hair acuminate; 9-12 granules between p₁ upon fifth abdominal segment ........................ denticulata
—. Abd. V without a₁ setae
9. Tenent hair acuminate; 20 granules between p₁ upon fifth abdominal segment .......... communis
—. Tenent hair clavate or truncate; 9-12 granules between p₁ upon fifth abdominal segment ..... platyna n. sp.

ACKNOWLEDGMENTS

We are grateful to Professor B.-H. Lee for reviewing the draft, and adding many helpful comments. Particular thanks due to Professor P. Greenslade of Australian National University for critical review and reading through the manuscript. We express our gratitude to Professor J. H. Shim for assisting with the collection the materials. This research was supported by a grant (No. 052-052-040) from the Core Environmental Technology Development Project for Next Generation funded by the Ministry of Environment of the Korean Government.

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