

Taxonomy on Freshwater Canthocamptid Harpacticoids (Copepoda) from South Korea I. Genus *Canthocamptus*

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ABSTRACT

A taxonomic study on the freshwater harpacticoids of the genus *Canthocamptus* has been accomplished as one of the serial researches on the family Canthocamptidae in South Korea. As a result of it, a total of seven species of the genus are listed, two of which are new to Korean fauna: *C. kitaurensis* Kikuchi and *C. macrosetifer* Ishida. Additional materials of five species belonging to *Canthocamptus mirabilis* species group are recorded. A key to the seven species of the genus *Canthocamptus* known from Korea is prepared.

Key words: Taxonomy, *Canthocamptus*, Canthocamptidae, Harpacticoida, freshwater Copepoda, Korea

INTRODUCTION

Five species belonging to *Canthocamptus mirabilis* species group have been known mostly from the various mountain water bodies in South Korea with great abundance and frequent occurrences, showing rather allopatric or parapatric distribution (Chang and Ishida, 2001): *C. morimotoi* Miura, 1969, *C. incurvisetosus* Chang and Ishida, 2001, *C. odaensis* Chang and Ishida, 2001, *C. semicirculus* Kikuchi, 1994 and *C. coreensis* Chang, 2002. Four of them except *C. semicirculus* are tentatively endemic to Korea.

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As for the non-*mirabilis* group of the genus, Chung and Yoo (1983) once mentioned *C. staphylinus* Jurine, 1820 in their collection list from Yeongsan Lake. Later, in the same place, Yoo and Lim (1989) reported *C. carinatus* Shen and Sung, 1973. However, these two species were supposedly misidentified, and should be corrected as *C. kitaurensis*, which will be treated in this paper.

As the first one of the serial studies on the family Canthocamptidae in South Korea, this paper deals with the taxonomic accounts of the genus *Canthocamptus* including two species of non-*mirabilis* group newly reported from Korea.

MATERIAL AND METHODS

Collections were made with a dipnet of no. 10 mesh aperture. All the specimens were dissected, drawn, and measured in lactophenol on H-S slide (Shirayama *et al.*, 1993), a recent variation of Cobb slide. Mounted specimens were observed under a differential interference contrast microscope with Nomarski optics. Figures were prepared with the aid of a camera lucida.

Abbreviations are used in the text and figure legend: enp 1-3 or exp 1-3, the first to third endopodal or exopodal segment of each leg; L/W, length to width ratio.

TAXONOMIC ACCOUNTS

Family Canthocamptidae Sars, 1906 딱정장수노벌레과

Subfamily Canthocamptinae Chappuis, 1929 딱정장수노벌레아과

Genus *Canthocamptus* Westwood, 1836 딱정장수노벌레속

1. *Canthocamptus kitaurensis* Kikuchi, 1999 안가시딱정장수노벌레 (신칭) (Figs. 1, 2)

Canthocamptus kitaurensis Kikuchi, in Ishida and Kikuchi, 1999, p. 343, figs. 3-4; Ishida and Kikuchi, 2000, p. 14, fig. 7.

Material examined. One ♂, Sacheon (swamp), Gangreung, 23 Mar 1987, C. Y. Chang; 2♀♀, Han R. (Paldang), 14 Apr 1990, C. Y. Chang; 1♂, Han R. (Yangsuri), 11 Oct 1999, C. Y. Chang, J. M. Lee and H. S. Ahn; 1♀, Wangsukcheon Stream, Seoul, 12 Nov 1986, C. Y. Chang; 3♀♀, Han R. (Seoul), 10 Oct 1987, C. Y. Chang; 1♀, 1♂, Daecheong Lake (Hoinam), 22 Jun 2001, C. Y. Chang and J. M. Lee; 1♀, 1♂, Daecheong Lake (Naetap), 15 Sep 2001, C. Y. Chang and J. M. Lee; 1♀, 1♂, Daecheong Lake (Naetap, Munui), 27 May 2002, J. M. Lee; 11♀♀, 2♂♂, Wangpicheon Stream, Uljin, 9 Jan 2003, C. Y. Chang and J. M. Lee; 1♀, Gonggeom Res., Sangju, 19 Apr 1986, S. M. Yoon; 5♀♀, 2♂♂, temporary pool in Deagu Univ., Gyeongsan, 23 Mar 2002, C. Y. Chang and J. M. Jeon; 1♂, Baekseok Res., Jeonju, 3 May 1988, C. Y. Chang; 1♀, Mt. Hwawang (swamp), Changnyeong, 21 Jan 1991, J. H. Choi; 1♂, Jeongyangji Swamp, Hapcheon, 19 Feb 2002, C. Y. Chang and J. M. Lee; 1♂, Jinnal-neup Swamp, 11 May 2002, J. M. Lee, E. H. Kwon and J. M. Jeon; 1♀, Hyeongsan R., 11 Oct 1999, C. Y. Chang and J. M. Lee; 6♀♀, 1♂, Yeongji Res., Gyeongju, 4 Apr 1999, C. Y. Chang and J. M. Lee; 4♀♀, Gyeongju (streamlet), 4 Apr 1999, C. Y. Chang and J. M. Lee; 1♀, 1♂,

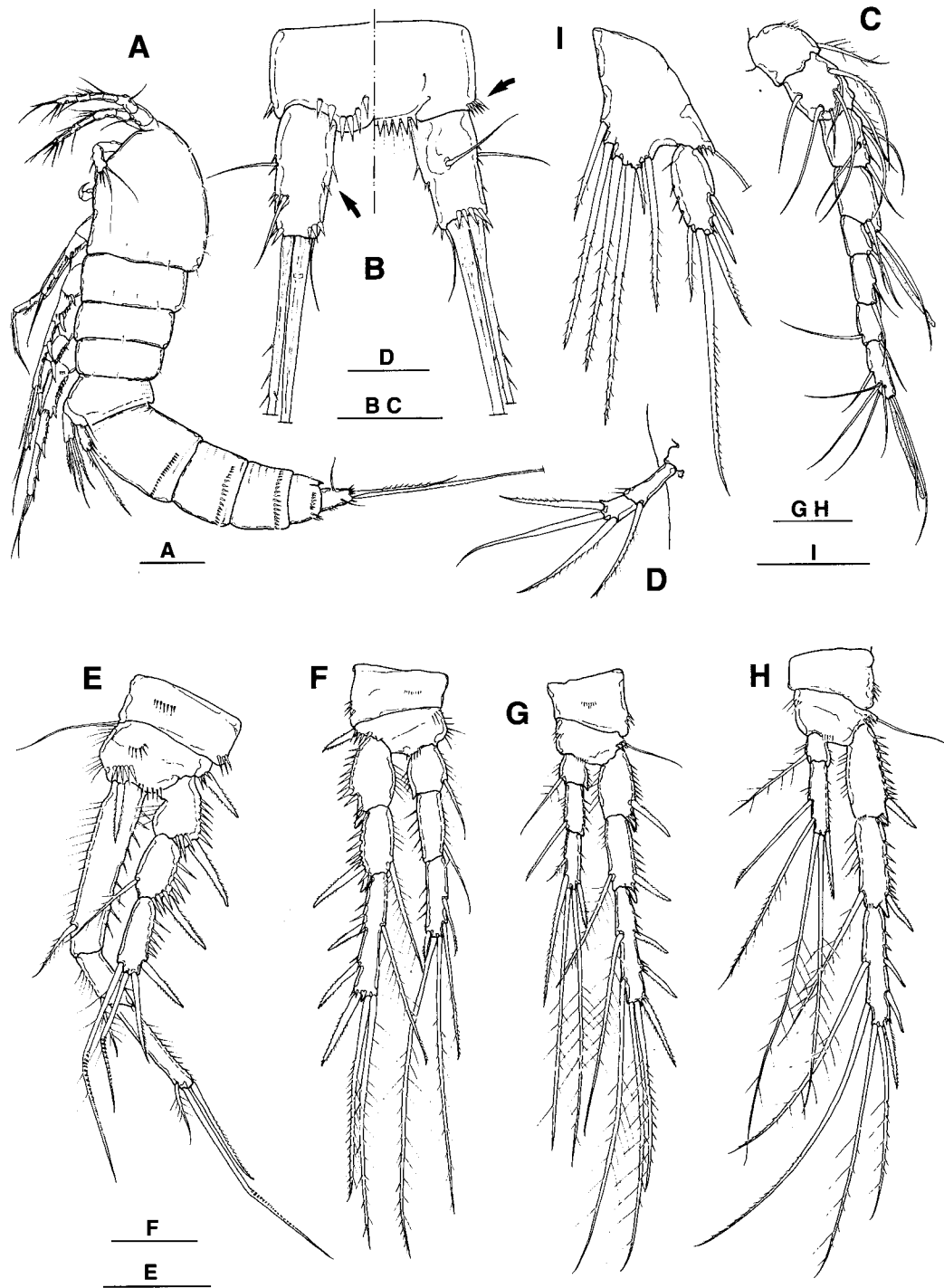


Fig. 1. *Canthocamptus kitaurensis* Kikuchi, female. A, habitus (lateral); B, anal somite and caudal rami (left: ventral, and right: dorsal); C, antennule; D, exopod of antenna; E-I, legs 1-5. Scale bars = 0.1 mm (A), 0.05 mm (B, C, E-I) and 0.02 mm (D).

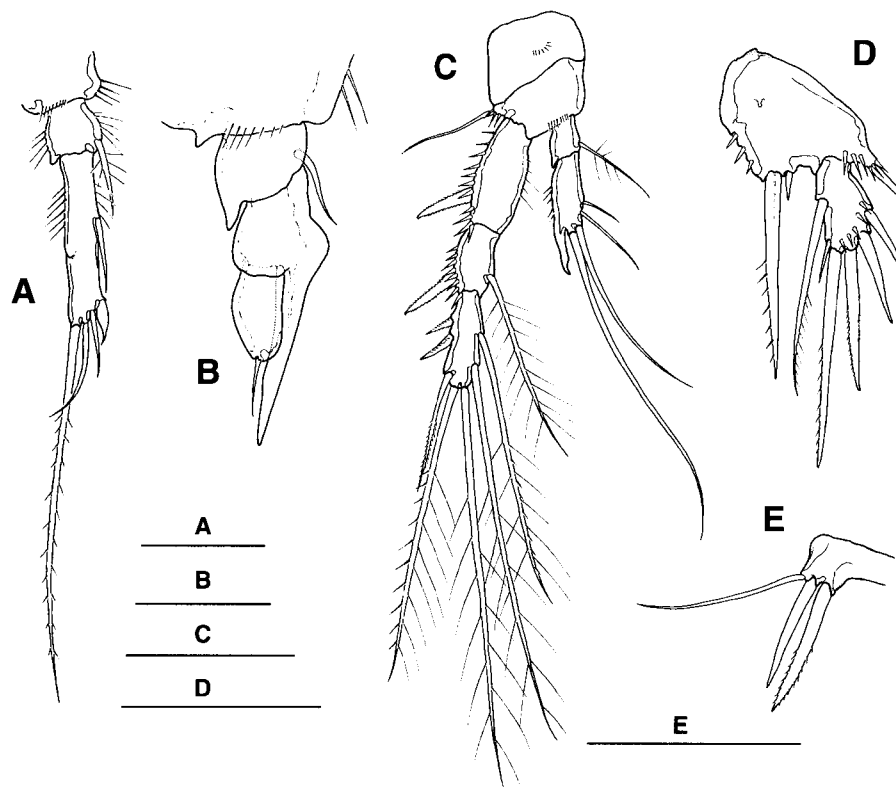


Fig. 2. *Canthocamptus kitaurensis* Kikuchi, male. A, leg 2 endopod; B, leg 3 endopod; C, leg 4; D, leg 5; E, leg 6. Scale bars = 0.05 mm (A, C-E) and 0.03 mm (B).

Mangyeong R., 6 Nov 2000, C. Y. Chang and J. M. Lee; 1 ♀, Daeam Dam, Ulju, 30 Jan 1987, M. K. Shin; 5 ♀ ♀, Sacheonji Res., Jindo Is., 1 Nov 1994, C. Y. Chang; 1 ♀, 1 ♂, Ssanggyesa Temple (reservoir), Jindo Is., 1 Nov 1994, C. Y. Chang; 1 ♀, 1 ♂, Mt. Dharma (reservoir), Haenam, 10 Feb 2003, C. Y. Chang and J. M. Lee; 1 ♀, 2 ♂ ♂, Gangjin (pond), 9 Feb 2003, C. Y. Chang and J. M. Lee; 1 ♀, Sudong-cheon Stream, Gangjin, 9 Feb 2003; 2 ♀ ♀, 2 ♂ ♂, Geumildo Is., 9 Feb 2003, C. Y. Chang and J. M. Lee.

Diagnosis. Body cylindrical, 0.78-0.90 mm long in females and 0.58-0.69 mm in males, excluding rostrum and caudal setae; usually tinged pale gray in alcohol or formalin; anal somite (Fig. 1B) without triangular posterolateral protrusion; anal operculum convex with 8-10 spinules along posterior margin; several long hairs situated on each side of anus; caudal rami (Fig. 1B) of both sexes cylindrical, oblong (L/W about 2.0-2.2) and a little divergent, with several spinules along medioventral face, with a prominent longitudinal ridge at anteromedial side of dorsal surface, ending with a dorsal seta; lateroterminal caudal seta normal, sparsely ornamented with secondary setules; antennule (Fig. 1C) 8-segmented; exopod of antenna (Fig. 1D) 2-segmented, distal segment bearing 3 setae; leg 1 enp 1 (Fig. 1E) slightly shorter than exopod; female legs 2-4 (Figs. 1F-H) with typical pattern of *Canthocamptus*; female leg 5 (Fig. 1I) exopod furnished with 3-4

spinules along a little expanded medial margin, bearing 5 apical setae, L/W about 1.4-1.6; baseoendopod bearing 6 spiniform setae, lateral second of which very short and usually not exceeding half of exopod; male leg 2 enp 2 (Fig. 2A) bearing 1 medial, 2 distomedial, and 2 apical setae with spinule row along proximal half of lateral margin, one of distomedial seta swollen proximally; male leg 3 enp 2 (Fig. 2B) armed with stout tapering process (apophysis); enp 3 with 1 slender distal seta; male leg 4 (Fig. 2C) enp 2 with 2 slender distomedial setae, 2 long apical setae and 1 curved protrusion; male leg 5 (Fig. 2D) baseoendopod with 2 spiniform setae, lateral one of which strikingly diminished; leg 5 exopod rather oval, L/W about 1.4, with 6 spines or setae in total including 1 long medial seta and 1 minute distomedial seta; leg 6 (Fig. 2E) represented by a small plate bearing 2 inner spines and 1 slender setae.

Remarks. Yoo and Lim (1989) reported *Canthocamptus carinatus* Shen and Sung, 1973 from Yeongsan Lake. According to Ishida and Kikuchi (1999), *C. carinatus* described from Songhuajiang River, Manchuria is closely similar to *C. iaponicus* Brehm, 1927, which is widely distributed in Honshu and Hokkaido, Japan. The most important morphological difference between them is known to be the relative length of leg 1 enp 1 to exopod (a little shorter in *C. iaponicus* while nearly same in length in *C. carinatus*). Nevertheless, the difference is rather subtle, and can be changed depending on the individual variations or the preparation condition. Therefore, *C. carinatus* might be regarded as the junior synonym of *C. iaponicus* (Ishida, *pers. comm.*).

However, after re-examining the *Canthocamptus* species, gathered from 120 or more localities in South Korea since the year 1986, *C. iaponicus* has not been found, while *C. kitaurensis* turns out to be widely distributed, and occur frequently from the various habitats in Korea. In consideration of the zoogeographical distribution, the identity of *C. iaponicus* and *C. carinatus* is not so much probable.

In the morphological aspect, *C. carinatus* seems to be much similar to *C. kitaurensis* rather than to *C. iaponicus*. The former two species share the relatively shorter caudal rami (more or less than 2 times in *C. kitaurensis* and *C. carinatus* while about 2.7 in *C. iaponicus*), the similar setal size arrangement of leg 5 baseoendopod in both sexes, and the elongated leg 2 enp 2 in male. The Korean specimens of *C. kitaurensis* are discernible from the Shen and Sung's figures of *C. carinatus* only by the setule array on the medioventral face of caudal rami. As for the Yoo and Lim's '*C. carinatus*' (see Yoo and Lim, 1989, figs. 1-7), which especially showed the much shorter leg 1 enp 1, the caudal rami with medioventral setules and the setal ornamentation of female leg 5, it also should be regarded as *C. kitaurensis*.

Furthermore, it might be presumed that *C. carinatus* would be insufficiently and inadequately described (especially, omitting the setules on the medioventral face of caudal rami, the minute but very important character) on the basis of the specimens of *C. kitaurensis*. As the type specimens of *C. carinatus* are not remained, and the precise redescription has not been made thereafter, the problem can be clearly solved only after the reexamination of the Chinese specimens.

As for the record of *C. staphylinus* by Chung and Yoo (1983) reported at the same place, the correct name of the species is not certain, because they referred it as '*C. staphylinus*' only in the collection list without any description or illustrations for it. Nowadays, *Canthocamptus staphylinus* group restricted within Europe is differentiated from *C. staphylinoides* group mostly distributed in

the Far East and North America, which includes *C. kitaurensis*, *C. iaponicus*, *C. macrosetifer*, etc. Considering three species of *C. staphylinoides* group above-mentioned often co-occurred in Japan (Ishida and Kikuchi, 1999, 2000), the *Canthocamptus* harpacticoids in Chung and Yoo (1983) would be supposedly *C. kitaurensis* or *C. macrosetifer*.

Korean specimens of *C. kitaurensis* fit well with the original description (Ishida and Kikuchi, 1999), but show two discrepancies: (1) male leg 3 enp 2 armed with a relatively longer apophysis without an apparent barb, and enp 3 with a short distal seta (Fig. 2B) against a short apophysis with a barb at its point and enp 3 without seta in Japanese specimens; (2) anal operculum with 8-10 spinules along posterior margin (Fig. 1B) against 6-8 in the original description. Korean specimens consistently show the swollen subapical seta of male leg 2 enp 2, and usually show the asymmetry in the shape of male leg 5, that is, a relatively short medial seta on the exopod in one side of leg while much longer one in the other side.

The present species occurred frequently from the various freshwaters like lakes, reservoirs, swamps, streams and rivers in South Korea.

Distribution. Japan (Honshu), South Korea.

2. *Canthocamptus macrosetifer* Ishida, 1999 센털딱정장수노벌레 (신칭) (Fig. 3)

Canthocamptus macrosetifer Ishida, in Ishida and Kikuchi, 1999, p. 346, figs. 5-6; Ishida and Kikuchi, 2000, p. 14, fig. 8.

Material examined. Eighty-five ♀♀, 12 ♂♂, 1100 Hill (swamp), Mt. Halla, Jeju Is., 22 Jan 1987, C. Y. Chang; 18 ♀♀, 1 ♂, same locality, 21 Apr 1995, C. Y. Chang; 5 ♀♀ (juv.), same locality, 2 Mar 2000, C. Y. Chang and J. M. Lee; 2 ♀♀, Cheonwangsa Temple (pool), Mt. Halla, 2 Mar 2000, C. Y. Chang; 2 ♀♀, Ongpo (streamlet), Jeju Is., 9 Aug 1987, C. Y. Chang.

Diagnosis. Body (Fig. 3A) cylindrical, 0.76-1.05 mm long in females and 0.65-0.80 mm in males, excluding rostrum and caudal setae; anal somite (Fig. 3B) with triangular posterolateral protrusion; anal operculum convex with 9-10 spinules along posterior margin; caudal rami (Fig. 3B) of both sexes cylindrical, nearly oblong (L/W about 2.1-2.4) and a little divergent, with smooth medioventral face; lateral terminal caudal seta robust and rod-like, ornamented with secondary setules; female antennule, antenna, legs 1-4 with typical segmentation and setal/spine ornamentation of *Canthocamptus*; female leg 5 (Fig. 3D) baseoendopod bearing 6 spiniform setae, lateral second of which minute; exopod with 2-3 setules on proximal part of medial margin, L/W about 1.4-1.6, bearing 5 apical setae; male leg 2 enp 2 (Fig. 3E) bearing 1 medial, 2 distomedial, and 2 apical setae with spinule row along proximal half of lateral margin; male leg 3 enp 2 (Fig. 3F) armed with a barbed process (apophysis); male leg 3 enp 3 with 2 short and slender subdistal setae; male leg 4 enp 2 (Fig. 3G) with 2 long subapical setae and 1 short and blunt protrusion; male leg 5 (Fig. 3H) baseoendopod with 2 spiniform setae, medial one of which about 2 times longer than lateral one; exopod rather oval, L/W about 1.4-1.6, bearing 1 medioproximal seta and 5 spiniform setae; leg 6 (Fig. 3I) represented by an elongate plate bearing 2 spines and 1 slender seta.

Remarks. *Canthocamptus macrosetifer* was collected frequently from the various water bodies in Japan, and from the mountainous waters at Mt. Halla in Korea. This species is much similar to *C. staphylinus* especially in having the triangular protuberance distolaterally of the anal somite, and

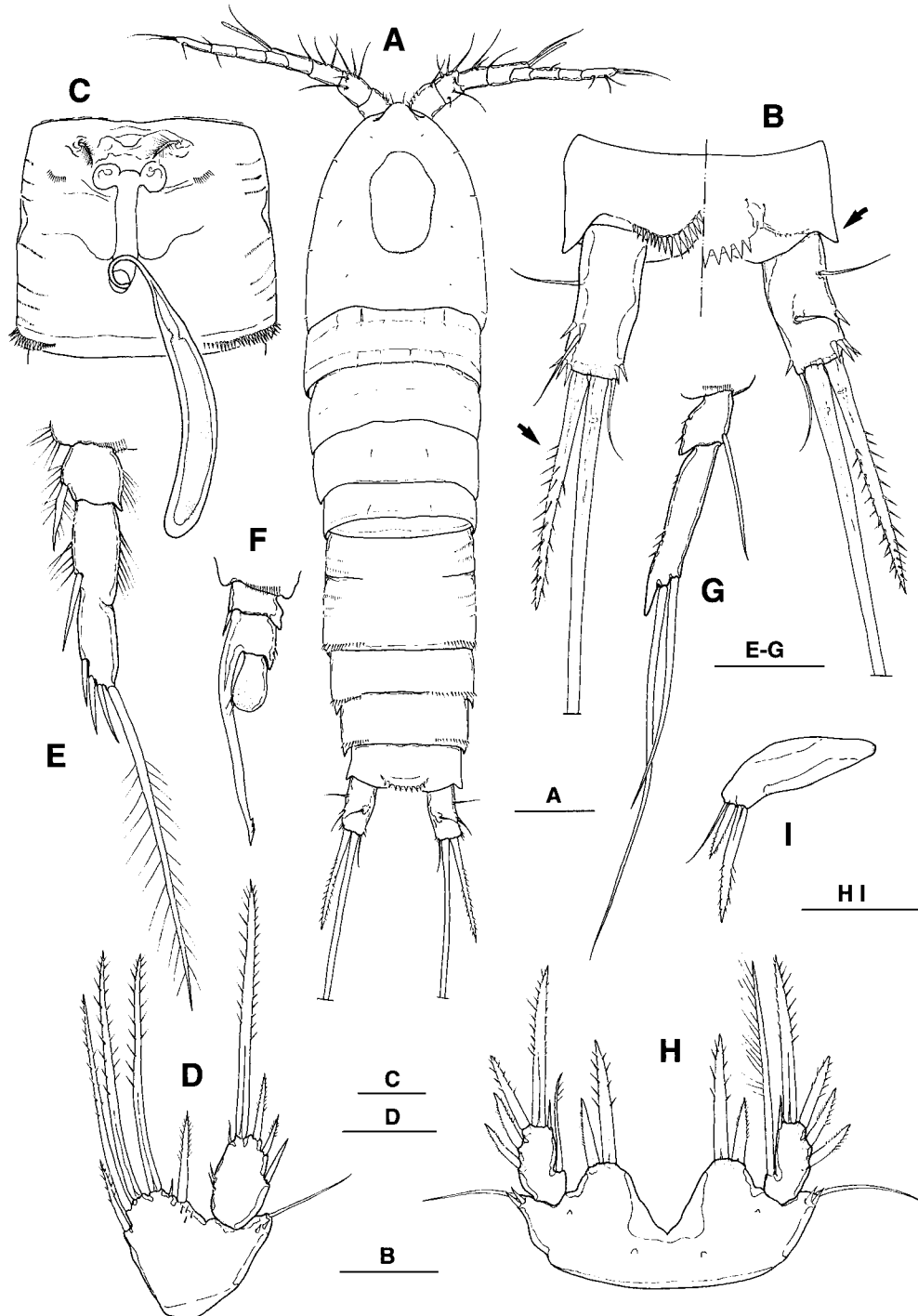


Fig. 3. *Canthocamptus macrosetifer* Ishida. Female: A, habitus (dorsal); B, anal somite and caudal rami (ventral and dorsal); C, genital somite (ventral) and spermatophore; D, leg 5. Male: E-G, endopods of legs 2-4; H, leg 5; I, leg 6. Scale bars = 0.1 mm (A) and 0.05 mm (B-I).

most of the previous reports on *C. staphylinus* in Japan should be corrected as *C. macrosetifer* (Ishida and Kikuchi, 2000). As indicated in the specific name, this species is characteristic in having the "robust and rod-like" lateral terminal caudal seta.

Korean specimens were well coincided with the original description except for the presence of the medial setules on the proximal part of female leg 5 exopod, and the much elongated enp 2 (more than 3 times longer than wide, while about 2.5 times in the original description) in male leg 4 with relatively short protrusion on it. According to the original description (Ishida and Kikuchi, 1999), 'the length of the lateral terminal caudal seta varies among individuals (1.4-3.4 times the length of the caudal ramus)', but Korean specimens showed the even narrower range of 1.8-2.4.

Distribution. Japan (Hokkaido, Honshu, Kyushu), South Korea (Jeju Is.).

3. *Canthocamptus morimotoi* Miura, 1969 소백딱정 장수노벌레 (신칭)

Canthocamptus morimotoi Miura, 1969, p. 40, fig. 5; Chang, 1998, p. 427, figs. 1-5.

Additional materials examined. Two ♀♀, 1 ♂, Heebangsa Temple, Punggi, 13 Nov 1999, C. Y. Chang and J. M. Lee; 3 ♀♀, 1 ♂, Bonjeongsa Temple, Andong, 13 Nov 1999, C. Y. Chang and J. M. Lee; 2 ♀♀, 2 ♂♂, Mt. Seorak, 21 May 1996, S. M. Yoon; 3 ♀♀, 1 ♂, Mt. Seorak, 3 Dec 1998, S. M. Yoon.

Distribution. South Korea (subterranean waters of Sobaek mountains and Mt. Seorak).

4. *Canthocamptus semicirculus* Kikuchi, 1994 반달딱정 장수노벌레

Canthocamptus semicirculus Kikuchi, in Kikuchi and Ishida, 1994, p. 40, fig. 5; Ishida and Kikuchi, 2000, p. 16, fig. 12; Chang, 2002, p. 234, fig. 1.

Additional materials examined. One ♀, Sudong-cheon Stream, Gangjin, 9 Feb 2003, C. Y. Chang and J. M. Lee; 1 ♀, 1 ♂, Mt. Sudeok, 28 Oct 1995, C. Y. Chang; 1 ♂, Daejeon (streamlet), 17 Mar 1986, C. Y. Chang.

Distribution. Japan, Taiwan, South Korea.

5. *Canthocamptus odaeensis* Chang and Ishida, 2001 오대딱정 장수노벌레 (신칭)

Canthocamptus odaeensis Chang and Ishida, 2001, p. 668, figs. 1-4.

Additional materials examined. Four ♀♀, 2 ♂♂, Woljeongsa Temple, Mt. Odae, 28 Jul 1999, J. M. Lee.

Distribution. South Korea (Mt. Odae, Gangreung, Daegwanryeong Hill).

6. *Canthocamptus incurvisetosus* Chang and Ishida, 2001 딱정 장수노벌레 (신칭)

Canthocamptus incurvisetosus Chang and Ishida, 2001, p. 672, figs. 5-6.

Additional materials examined. One ♂, Mt. Gwanak, 13 Apr 1987, C. Y. Chang; 1 ♀, Mt. Cheongryang, 5 Apr 1995, J. M. Lee; 1 ♀, Gyeongju (ditch), 4 Apr 1999, C. Y. Chang, J. M. Lee and Y. H. Song; 4 ♀♀, Mt. Naesosan, 15 May 1991, C. Y. Chang; 3 ♀♀, 2 ♂♂, Daeheungsa Temple, 8 Feb 2003, C. Y. Chang and J. M. Lee; 1 ♀ (juv.), Mt. Weochul, 7 Feb 1987, C. Y. Chang; 2 ♀♀, 2 ♂♂, Songgwangam Temple, Geogumdo Is., Goheung, 1 Aug 2002, J. M. Lee; 6 ♀♀, 6 ♂♂, Bijindo Is., Tongyeong, 8 Jun 2002, J. M. Lee.

Distribution. South Korea (whole S. Korea, excluding the vicinity of Mt. Odae and Jeju Is.).

7. *Canthocamptus coreensis* Chang, 2002 고려딱정 장수노벌레

Canthocamptus coreensis Chang, 2002, p. 237, figs. 2-4.

Additional materials examined. One ♀, 2 ♂♂, Mt. Jungmi, Yangpyeong, 16 Oct 1999, C. Y. Chang, J. M. Lee and Y. H. Song; 2 ♀♀, Mt. Yumyeong, Yangpyeong, 16 Oct 1999, C. Y. Chang, J. M. Lee and Y. H. Song; 1 ♀, Deogjeokdo Is., 27 Oct 1995, M. O. Song; 3 ♀♀, 2 ♂♂, Mt. Hoimun, Sunchang, 4 Sep 1999, J. M. Lee and H. S. Ahn.

Distribution. South Korea (northwestern part of S. Korea, that is, Geonggi-do Prov., Chungcheong-do Prov., and northern part of Jeonbuk Prov.).

A key to the species of genus *Canthocamptus* from Korea

1. Caudal rami cylindrical or oblong 2
Caudal rami usually oval or inverted-bottle shaped 3 (*mirabilis* group)
2. Lateral terminal seta normal (slender and sparsely haired); distolateral corner of anal somite not protruded; caudal rami with medioventral spinules (Fig. 1B, arrows)
..... *C. kitaurensis* Kikuchi, 2000
Lateral terminal seta stout and rod-like; distolateral corner of anal somite protruded (Fig. 3B, arrows); caudal rami without medioventral spinules *C. macrosetifer* Ishida, 2000
3. Hyaline membrane of anal operculum lacking or, if present, very narrow 4
Hyaline membrane of anal operculum prominent, with obtuse triangle shaped 5
4. Leg 5 exopod with medial setules *C. semicirculus* Kikuchi, 1994
Leg 5 exopod with smooth medial margin *C. coreensis* n. sp.
5. Apical seta of male leg 4 exopod modified, with 4-5 strong secondary spinules; lateroterminal caudal seta usu. incurved with 2-3 setules medially
..... *C. incurvisetosus* Chang and Ishida, 2001
Apical seta of male leg 4 exopod normal, with more than 20 pectinate spinules; lateroterminal caudal seta normal with sharp secondary setules laterally 6
6. Male caudal rami elongate and spindle-shaped, with medial setules
..... *C. odaeensis* Chang and Ishida, 2001
Male caudal rami stumpy and subconical, without medial setules *C. morimotoi* Miura, 1969

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한국 담수산 딱정장수노벌레과 갈고리노벌레류의 분류

I. 딱정장수노벌레 (*Canthocamptus*)속

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요 약

한국 담수산 딱정장수노벌레과 (*Canthocamptidae*)의 요각류에 대한 분류학적 연구의 일환으로, 딱정장수노벌레속의 2한국미기록종 (*C. kitaurensis* Kikuchi, *C. macrosetifer* Ishida)을 보고한다. *mirabilis* 종군에 속하는 한국산 5종의 추가 관찰재료 목록을 덧붙였다. 현재까지 한국에서 기록된 딱정장수노벌레속의 종 검색표를 작성하였다.