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Redescription of *Attheyella coiffaiti* CHAPPUIS and *A. coreana* MIURA (Crustacea : Copepoda : Harpacticoida) from Japan

Teruo ISHIDA

Abstract

Attheyella coiffaiti and *A. coreana*, the types of both of which were collected from subterranean waters, are redescribed from specimens from surface waters. Deviation between the types and surface water specimens is briefly discussed.

Key words: taxonomy, Copepoda, Harpacticoida, redescription

1. Introduction

Attheyella coiffaiti was described from subterranean water in Akiyoshi-Do, Yamaguchi Prefecture, western Honshu, Japan (CHAPPUIS, 1958). The species is distributed through mountain waters of western Honshu (ISHIDA, 1989) (Fig. 1). *A. coreana* was described from cave waters in Korea (MIURA, 1969). The species is distributed in South Primorye, Korea, and Tsushima and Kyushu, Japan (Fig. 1) (KIM and CHANG, 1989; ISHIDA, 1990; ISHIDA and ITO, 1991; CHANG, 1993).

Both species are close to *A. idahoensis* (MARSH), *A. yesoensis* ISHIDA, *A. gladkovi sibirica* BORUTSKII, and *A. nakaii* (BREHM). To improve taxonomic understanding of this species group, and diagnosis of the specimens of the surface water populations, the species are redescribed herein. Deviation between subterranean and surface water specimens is briefly discussed.

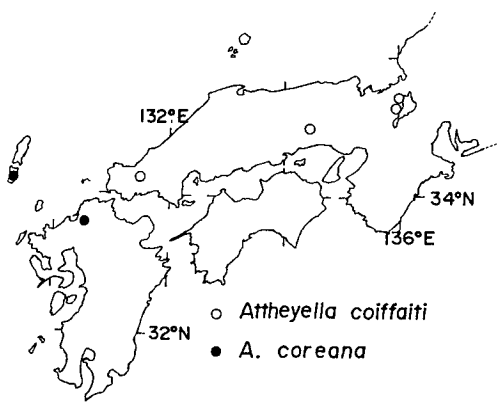

Fig. 1 Map showing the occurrence of *Attheyella coiffaiti* CHAPPUIS and *A. coreana* MIURA from Japan.

2. Material and methods

The material examined was the specimens in my collection, recorded by ISHIDA (1989, 1990), and new specimens of *A. coiffaiti* collected from Sahadani and Ado Streams, on the west coast of Lake Biwa, in 1994. For the description and drawing, material was chosen from dissected or habitus specimens mounted in gum-chloral medium. Some specimens of each species were deposited in the collection of the U.S. National Museum of Natural History, Smithsonian Institution (USNM).

3. Description

3-1. *Attheyella coiffaiti* CHAPPUIS, 1958

(Figs. 2,3)

Attheyella coiffaiti CHAPPUIS, 1958: 71-76, figs. 1-14.

Attheyella coiffaiti, ISHIDA, 1989: 10-11, plate 6.

Material examined: 5 ♀♀ and 1 ♂, dissected on 6 slides, and 1 ♀ and 1 ♂, habitus on 1 slide, from a small stream in Mikazuki, Hyogo Prefecture, 10 January 1987; 1 ♀ and 1 ♂, dissected on 2 slides, and 1 ♀ and 1 ♂, habitus on 2 slides, from Sahadani Stream, Imazu, Shiga Prefecture, 23 May 1988, and 7 March 1994; 12 ♀♀ and 6 ♂♂, in 70% ethanol

(USNM 264017), 2 ♀♀, dissected on 2 slides, and 1 ♀, habitus on 1 slide, from Ado Stream, Shiga Prefecture, 5 September 1994.

Female: Range and mean of lengths of 15 specimens excluding caudal setae 0.74–0.90 mm and 0.83 mm. All somites (Fig. 2a), except anal one, coarsely serrate distally. Genital segment divided partially at middle, with heavy sclerotization produced dorso-laterally into stout spinous processes like those of urosomites. Genital, 3rd and 4th urosomal somites with row of spinules on posterior ventrolateral margin. Anal somite with rows of spinules on each lateral and ventral border above caudal ramus

Fig. 2 *Attheyella coiffaiti* CHAPPUIS, female from Ado Stream: a, habitus, lateral; b, anal somite and caudal ramus; c, distal part of caudal ramus, ventral; d, antenna; e, mandible; f, leg 1 and coupler; g, leg 2 and coupler; h, leg 3 and coupler; i, leg 4 and coupler. Scales= 100μm.

(Fig. 2a, b). Anal operculum convex, with row of fine denticles on posterior magin. Caudal ramus (Figs. 2a-c) robust, 2 times longer than length of anal somite; sclerotized dorsal keel extending from proximal to distal end and slightly protruding at dorsally directed seta. Lateral surface of ramus with group of 2 setae at about midlength, and seta at posterior fourth, each with 2 or 3 spinules at base. Distal end of ramus with row of spinules medioventrally. Middle and outer caudal setae short, 1.2 and 0.3 times longer than ramus, respectively. Inner caudal seta tiny.

Antennule of 7 articles, articles 4 and 7 with esthetasc. Exopodite of antenna (Fig. 2d) single article with 4 setae. Mandible (Fig. 2e) with biarticulate palp, distal article bearing 3 terminal and 1 subterminal setae.

Swimming leg 1 with exopodite and endopodite of 3 articles, legs 2-4 each with exopodite of 3 articles and endopodite of 2 articles (Figs. 2f-i). Setation formula for major armament as follows:

Leg 1 basis 1-1 exp 0-1; 1-1; 0, 2, 2
enp 1-0; 1-0; 1, 2, 0
Leg 2 basis 0-1 exp 0-1; 1-1; 1, 2, 3
enp 1-0; 0, 2, 0
Leg 3 basis 0-1 exp 0-1; 1-1; 2, 2, 3
enp 1-0; 2, 2, 0
Leg 4 basis 0-1 exp 0-1; 1-1; 2, 2, 3
enp 0-0; 0, 1, 1

Couplers of legs 1, 3 and 4 without ornamentation, that of leg 2 with spinules on each posterolateral margin.

Leg 5 (Fig. 3a) with inner expansion of basipod reaching distal end of exopodite and bearing 6 spiniform setae. Exopodite about 3.5 times longer than broad and bearing 5 spiniform setae.

Male: Range and mean of lengths of 8 specimens 0.55-0.66 mm and 0.60 mm. Body (Fig. 3b) more slender than that of female. Second to 4th urosomites with row of spinules on distal margin ventrally, 2nd-3rd ones continuous, 4th one discontinuous midventrally. Ornamentation of anal somite same as that of female. Caudal ramus tapering posteriorly, 2 times longer than length of anal somite. Middle caudal seta about 3 times longer than length of ramus. Antennule geniculate. Antenna and mandible as in female.

Leg 1 and leg 2 exopodite as in female; leg 2 endopodite (Fig. 3c) article 2 with long inner seta, about 3 times longer than length of article 2. Leg 3 (Fig. 3d) exopodite with smooth enlarged spines and terminal setae; endopodite of 3 articles, article 3 with only one short terminal seta. Leg 4 (Fig. 3e) exopodite as in female, except distal medial seta of article 3 shorter than that of female; endopodite article 2 with one outer subterminal spine and 2 setae. Leg 5 (Fig. 3f), exopodite with 5 spines, subapical innerone longest; basoendopodite reaching to midlength of exopodite, with 2 well developed spines.

Variation within surface water populations: Variation in the shape and numerical characters were not seen in specimens examined.

Remarks: Distribution range of the species seems to be restricted to the western part of Honshu, and the northern limit lies in Shiga Prefecture.

The confirmed habitats are cave waters, seep waters, and trickles to streams. The animals from surface waters are usually coated by detritus, which may be derived from the life in mud. The short terminal setae of caudal rami also suggest the semi-terrestrial or terrestrial life.

Differences between the cave and surface water specimens exist in the female. Important diagnostic features of the females of the cave populations, in contrast to females of the surface populations are the 2 apical setae on the distal article of the mandibular palp (versus 4 setae in surface ones). Also, legs 2 and 3 endopodite article 2 each bears only one apical spine (versus plus 1 apical seta, and plus 1 apical seta and 2 medial setae, respectively). As shown in the following description of *A. coreana*, and also in *A. nakaii* (ISHIDA, 1994), decrease of ornamentation of swimming leg endopodites is not uncommon. But, as far as I know, the decrease of setae on mandibular palp in a species is the first record in the genus.

3-2. *Attheyella coreana* MIURA, 1969

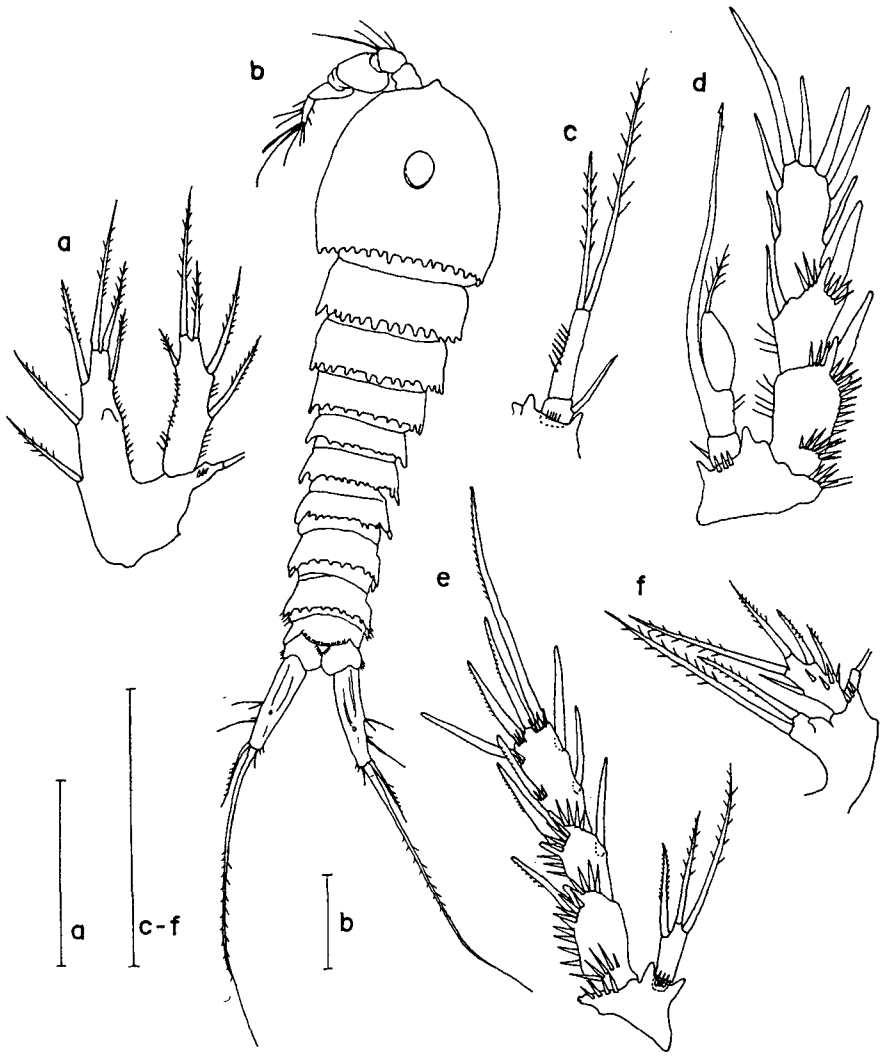

Fig. 3 *Attheyella coiffaiti* CHAPPUIS, female, continued: a, leg 5. Male from Sahadani Stream: b, habitus, dorsal; c, leg 2 endopodite; d, leg 3; e, leg 4; f, leg 5. Scales=100μm.

(Figs. 4-6)

Attheyella coreana MIURA, 1969: 246-250, figs. 16-31.

Attheyella coreana, KIM and CHANG, 1989: 165. (not consulted)

Attheyella coiffaiti, ISHIDA, 1990: 43.

Attheyella coreana, ISHIDA and ITO, 1991: 80; CHANG, 1993: 182-183.

Material examined: 15 ♀♀ and 6 ♂♂, in 70% ethanol (USNM 264016), 10 ♀♀ and 1 ♂, dissected on 11 slides, and 2 ♀♀ and 3 ♂♂, habitus, on 3 slides, from a small pathside flow, Izuhara, Tsushima Island (34°13.5'N 129°17.4'E), 7 March 1989; 11 ♀♀, dissected on 11 slides, from trickles, Sasaguri, Fukuoka Prefecture (33°38.4'N 130°34.6'E), 7 March 1989.

Female: Range and mean of lengths of 15 specimens from Tsushima I. excluding caudal setae 0.69-0.78 mm and 0.73 mm. Body shape similar to that of *A. coiffaiti* except caudal rami. Fourth urosomite with row of spinules on posterior ventrolateral margin, whereas genital and 3rd urosomites with no or few spinules at corresponding location. Anal somite with rows

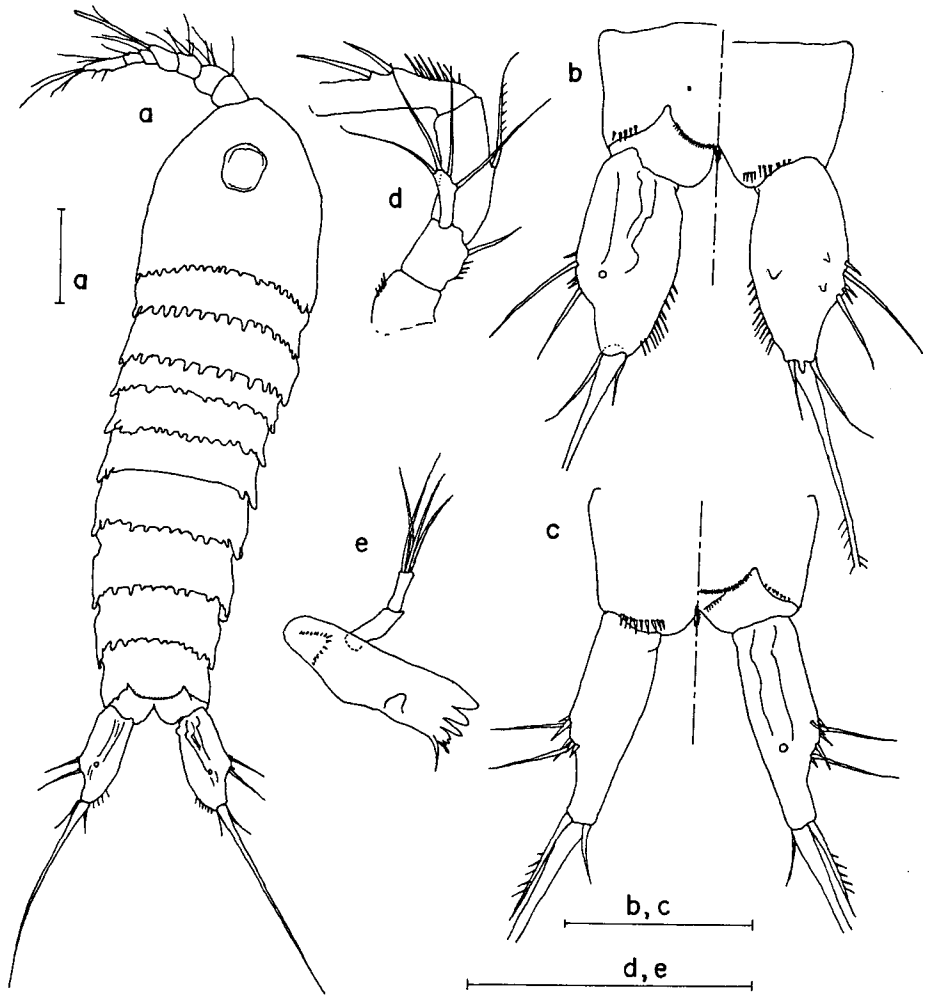

Fig. 4 *Attheyella coreana* MIURA, a, b, and d, e, female from Tsushima Island: a, habitus, dorsal; b, anal somite and caudal ramus; c, anal somite and caudal ramus of a specimen with male type caudal rami from Kyushu; d, antenna; e, mandible. Scales=100μm.

of spinules on each dorsolateral and ventral border above caudal ramus (Fig. 4b, c). Anal operculum convex, with row of fine denticles on posterior margin. Caudal ramus (Fig. 4b, c) of normal female suboval, 2 times longer than broad, of male type cylindrical, 3 times longer than broad, with dorsal keel extending around dorsally directed seta; lateral surface of ramus with two lateral setae, each with 2 spinules at base; medial surface with row of spinules on posterior half; distal end with small tonguelike protrusion ventrally. Middle caudal seta about 2 times longer than length of ramus. Outer caudal seta 1/2, and inner one 1/4 length of ramus. Shapes of caudal rami and terminal setae of female with male type caudal rami (Fig. 4c) similar to those of male; middle terminal seta about 2.5 times length of ramus.

Antennule of 7 articles, article 4 and 7 with esthetasc. Exopodite of antenna (Fig. 4d) single article with 4 setae. Mandible (Fig. 4e) with biarticulate palp, distal article with 3 setae apically, 1 seta slightly subapically.

Legs 1-5 (Fig. 5) similar to those of *A. coiffaiti*, except leg 2 endopodite. Specimens from Tsushima Island with 1 medial seta on leg 2

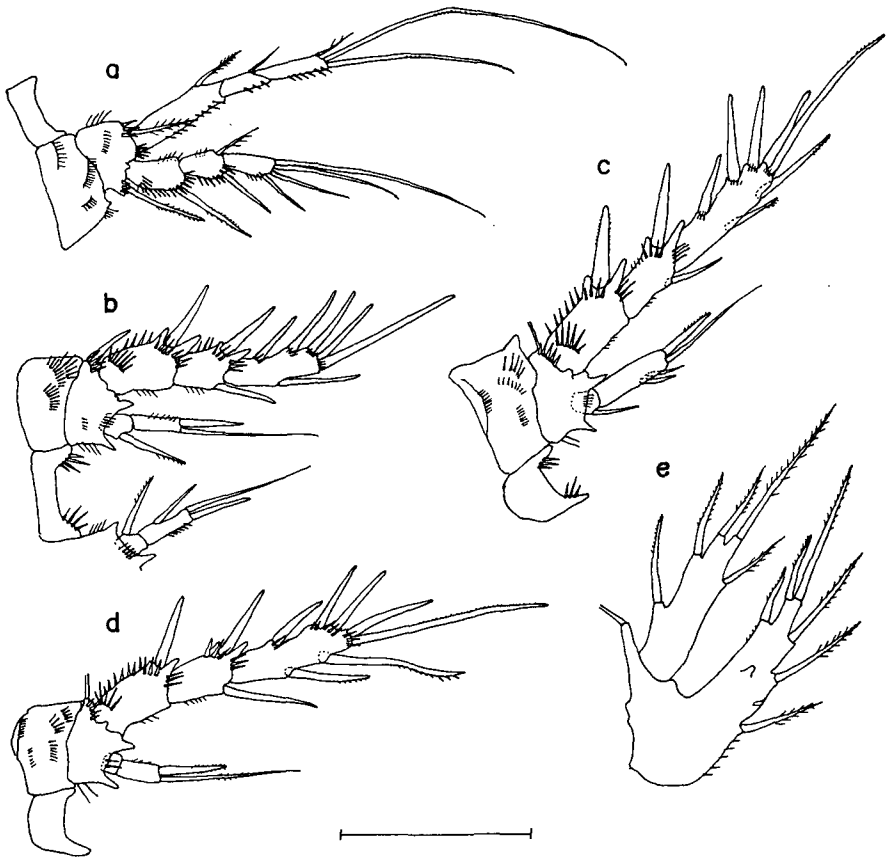

Fig. 5 *Attheyella coreana* MIURA, female from Tsushima Island: a, leg 1 and coupler; b, leg 2 and coupler; c, leg 3 and coupler; d, leg 4 and coupler; e, leg 5. Scale=100μm.

endopodite article 2. Couplers of legs 1 and 4 without ornamentation, those of legs 2 and 3 with 3 or 4 spinules on each posterolateral margin.

Male: Range and mean of 6 specimens excluding caudal setae 0.58-0.62mm and 0.61mm. Body (Fig. 6a) more slender than that of female. Second to 4th urosomites with continuous row of spinules on distal margin ventrally. Caudal ramus (Fig. 6b) tapering posteriorly; middle caudal seta 4 times longer than length of ramus. Antennule geniculate. Antenna and mandible as in female.

Leg 1 and leg 2 exopodite as in female; leg 2 endopodite (Fig. 6c) article 2 with 1 or 2 medial setae, and 2 terminal setae, inner one well developed and outer one short. Leg 3 (Fig. 6d), exopodite with enlarged spines and setae: endopodite article 3 with 2 terminal setae, outer one extending beyond tip of exopodite terminal seta, inner one short. Leg 4 exopodite similar to that of female, except distomedial seta of article 3 shorter than that of female; endopodite (Fig. 6e) article 2 with 1 outer subapical spine, 1 spine and seta apically. Leg 5 (Fig. 6f), exopodite with 5 setae, apical one longest; basoendopodite reaching to midlength of exopodite, with 2 spines.

Variation within Japanese populations: Thirty-five of 48 females from Fukuoka Prefecture were equipped with male type caudal rami, whereas 120 females of Tsushima Island were all normal. Leg 2 endopodite article 2s of 13 females from Fukuoka Pref. bore no medial seta, on the other hand, 20 out of 26 endopodites of 13 females from Tsushima I. were equipped

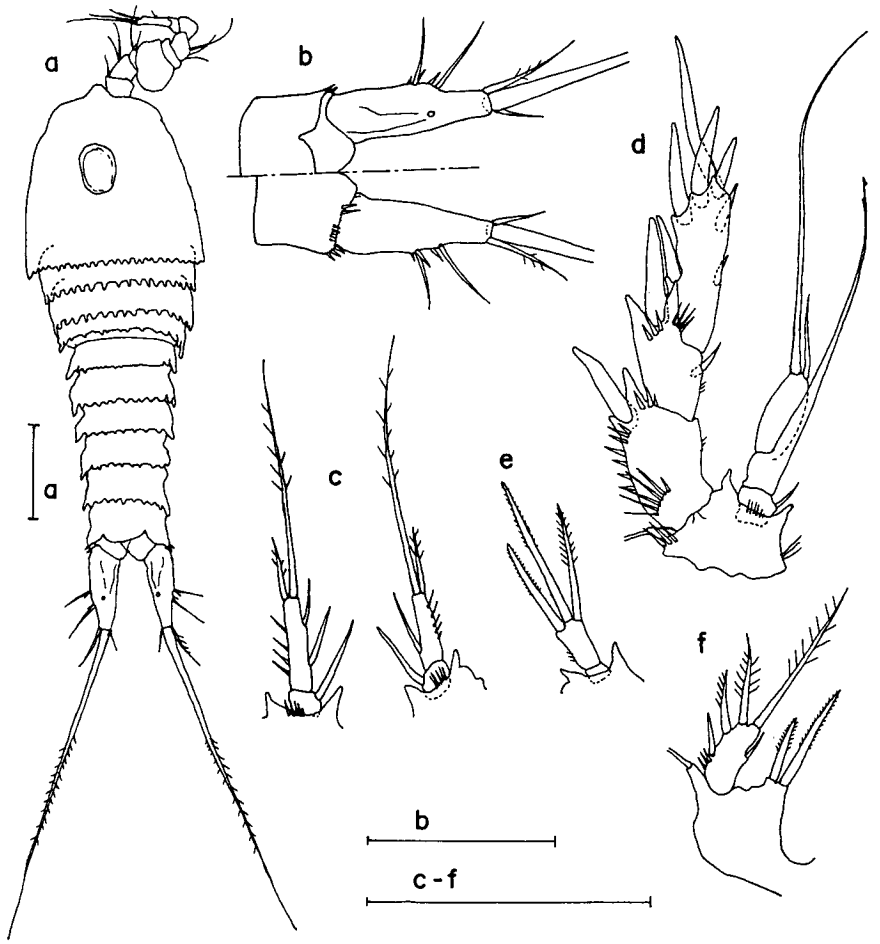

Fig. 6 *Attheyella coreana* MIURA, male from Tsushima Island: a, habitus, dorsal; b, anal somite and caudal ramus; c, leg 2 right and left endopodites of a specimen; d, leg 3; e, leg 4 endopodite; f, leg 5. Scales=100μm.

with one medial seta at this location (Fig. 5b).

Remarks: The proved distribution range of the species is South Primorye, South Korea, and Tsushima I. and Kyushu, Japan. This species turned out to be the most abundant and frequently occurring species of *Attheyella* in mountain waters, especially in the springs of Korea (CHUNG, 1993), and Tsushima I. (ISHIDA, 1990).

Differences between the cave and surface water populations exist in the caudal rami of both sexes. Specimens from Korean caves show no sexual dimorphism of their caudal rami, *i.e.* the males are equipped with the female type caudal rami (MIURA, 1969). On the other hand, males collected in surface water exhibit sexually transformed caudal rami (ISHIDA and ITO, 1991; CHANG, 1993). The spinule row situated medial to the dorsal seta on the caudal ramus of the cave water individuals disappears in the surface water ones, except in the males of the South Primorye population (ISHIDA and ITO, 1991).

4. Discussion

Attheyella coiffaiti inhabiting cave waters of Akiyoshi-Do are missing several setae of their appendages, including those of the mandibular palp. On the other hand *A. coreana* in cave waters in Korea are equipped with normal appendages, the same as those of surface water

specimens. Further, they show no sexual dimorphism on their caudal rami, and the caudal rami are equipped with 1 row of spinules on the dorsal surface. This row is lost in the surface water populations, except the males of South Primorye. The situation in *A. coiffaiti* suggests degeneration from normal surface individuals in subterranean waters. The state of *A. coreana* hints at the conservative effects of cave waters for the ancestral characteristics of the animals. Both situations are contradictory to each other, but each is reasonable. Further comparative studies for surface and groundwater copepods (REID, 1992) must be required.

Retention of the female type caudal rami in some males of *A. coreana* is very interesting. This fact adds to our knowledge of sexual dimorphism and reversal of secondary sexual characters in caudal rami of the Canthocamptidae (ISHIDA, 1991, 1994), and perhaps for the similar problem of the Parastenocarididae (SCHMINKE, 1991), as well.

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摘　　要

ソコミジンコ *Attheyella coiffaiti* CHAPPUIS と *A. coreana* MIURA の再記載

山口県秋吉洞と韓国の洞穴水からそれぞれ採集された標本で記載命名されたソコミジンコ *Attheyella coiffaiti* と *A. coreana* の両種について、地表水からえられた標本で再記載した。模式標本と地表水からの標本に見られた差異について論議した。

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(著者：石田昭夫，〒046 北海道余市町入舟町 372：Teruo ISHIDA, 372 Irifunecho, Yoichimachi, Hokkaido 046)

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