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Cletocamptus goenchim **sp. nov., a new harpacticoid (Copepoda: Harpacticoida) from India**

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Abstract.---A new species of harpacticoid copepod, Cletocamptus goenchim sp. nov., was found in the mouth of the Mandovi estuary, Goa, India. This species seems to be the same reported in 1979 from Lake Kolleru (east coast of India) as *C. deitersi*, but until new specimens are studied, the 1979 record will remain as doubtful. The new species seems to be related to *C. stimpsoni*. They can be separated by the armature of the mandibular palp, the shape of the outer element of basis of P2, the ornamentation of the posterior margin of cephalothorax, pro-, and urosomites, and anal operculum of both male and female, the armature formula of male P5EXP, the armature formula of the male P2ENP2, and the relative length and shape of the inner apophysis of the male P3ENP2. Some comments on specimens of *Cletocamptus* from Korea and China are given.

During the course of the short-term project “A system biology approach to delineate web-dynamics from primary to tertiary levels” about the bentho-pelagic coupling and ecosystem functioning, specimens of the harpacticoid genus *Cletocamptus* Shmankevich, 1875 were found in sediment samples taken at the mouth of the Mandovi estuary, Goa, India. The specimens turned out to belong to a new species of *Cletocamptus* related, to some extent, to the American *C. stimpsoni* Gómez, Fleeger, Rocha-Olivares & Foltz, 2004. Ranga Reddy & Radhakrishna (1979) reported what they thought might be *C. deitersi* (Richard, 1897) from Lake Kolleru, east coast of India. Unfortunately, Ranga Reddy & Radhakrishna (1979) omitted any description of their material, and Gómez et al. (2004) considered this record as doubtful. Probably Ranga Reddy & Radhakrishna (1979) noted that, in particular, the female P3 was similar to that shown in Lang (1948) for *C. brehmi*, Kiefer, 1933 (considered at that time as a synonym of *C. deitersi*) and to Hamond’s (1973) record of *C. deitersi*. It is feasible that the new species herein presented is the same found by Ranga Reddy & Radhakrishna (1979), but the latter record will remain as doubtful until specimens from Lake Kolleru are fully described. The present paper deals with the full description of both sexes of a new species of harpacticoid copepod, *Cletocamptus goenchim* sp. nov. from the west coast of India.

Material and methods

Sediment samples were collected from the mouth of the Mandovi estuary, Goa, India, during the course of a short-term project about the bentho-pelagic coupling and ecosystem functioning. This area is well known for the impact of sewage disposal from the Panjim Municipality (Anasri et al. 1984; Nanajkar & Ingole 2010). Description of the study site is provided in Singh & Ingole (2011). The sediment samples were collected using hand held meiocorers of 25.5 cm^2 and harpacticoids were isolated alive from the sediment for life cycle studies, and ecology and culture analyses. A number of adult males and females were fixed and preserved in 70% ethanol for further analyses and description. Observations and drawings were done at a magnification of 1000X from whole and dissected specimens mounted in lactophenol with a Leica compound microscope equipped with phase contrast and a drawing tube. The type material was deposited in the collection of the Instituto de Ciencias del Mar y Limnología, Unidad Académica Mazatlán (Mexico) (EMUCOP) and in the collection of the National Institute of Oceanography, Dona Paula Goa (India) (NIO). The terminology proposed by Huys and Boxshall (1991) for the general description was adopted. Abbreviations used in the text and tables are: P1-P6, first to sixth swimming legs; EXP, exopod;

ENP, endopod; P1(P2-P4)EXP(ENP)1(2, 3) denotes the proximal (middle, distal) exopodal (endopodal) segment of P1, P2, P3 or P4.

Taxonomic account

Family CANTHOCAMPTIDAE Sars, 1906 (*incertae sedis*) *sensu* Por, 1986

Genus *Cletocamptus* Shmankevich, 1875

Cletocamptus goenchim sp. nov.

(Figs. 1-10)

Type material.---One female holotype (EMUCOP 070709-01) preserved in ethanol and five dissected female paratypes (EMUCOP 070709-02, EMUCOP 070709-03, EMUCOP 070709-04, EMUCOP 070709-05, EMUCOP 070709-06) (P1-P5 dissected; entire habitus and mouth parts intact); one male allotype (EMUCOP 070709-07) preserved in ethanol and eight dissected male paratypes (EMUCOP 070709-08, EMUCOP 070709-09, EMUCOP 070709-10, EMUCOP 070709-11, EMUCOP 070709-12, EMUCOP 070709-13, EMUCOP 070709-14, EMUCOP 070709-15) (P1-P5 of six male paratypes dissected; entire habitus and mouth parts intact), and 5 female and 5 male paratypes preserved in ethanol (NIO H/Copepod No. 003); collected from sediment samples taken at the mouth of the Mandovi estuary, Goa, India; area under the impact of sewage disposal from the Panjim Municipality; surface water temperature, 27º C; surface water salinity, 13 psu; 7 July 2009; coll. B. Ingole, M. Sawant, and R. Singh.

Type locality.---Mouth of the Mandovi estuary, Goa, India (15º 30' N, 73º 55' E).

Etymology.---The specific name *goenchim* is proposed in apposition from the local language of Goa, Konkani, and means "pertaining to Goa".

Female.---Habitus (Fig. 1A, B) tapering posteriorly; total body length measured from tip of rostrum to posterior margin of caudal rami ranging from 520 to 620 µm (mean, 576 µm; n= 5; total length of holotype, 620 µm). Rostrum (Fig. 3A) defined at base, triangular, with pair of setules subapically and ornamented with small spinules distally on ventral surface. Cephalic shield covered by small depressions, with fine spinules along its posterior margin dorsally and laterally. Dorsal and lateral surface of free thoracic somites (P2-P4-bearing somites) with transverse rows of minute spinules, with longitudinal row of tiny spinules close to and with longer spinules along posterior margin. Dorsal and lateral surface of first urosomite (P5-bearing somite) with transverse rows of tiny spinules, with row of tiny spinules close to and with spinules (shorter and stronger than in preceding somites) along posterior margin. Genital double-somite with subcuticular rib dorsally and laterally indicating former division between second and third urosomites (Figs. 1A, B; 2A), but completely fused ventrally (Fig. 2B); dorsal and lateral surface of second and third urosomite (first and second genital somites) with transverse rows of spinules and with row of spinules along posterior margin (Figs. 1A, B; 2A), and with ventral spinules as illustrated (Fig. 2B). Fourth and fifth urosomites as in previous somite dorsally, with ventral spinular pattern as illustrated (Fig. 2B). Dorsal surface of anal somite (Fig. 2A) with transverse rows of spinules and with dorsolateral strong spinules close to joint with caudal rami; rounded anal operculum furnished with two rows of strong spinules. Caudal rami about 1.7 times as long as wide; dorsal and ventral surface smooth except for inner spinules and for spinules close to posterior margin; with seven elements (Fig. 2A, B).

Antennule (Fig. 3B) six-segmented, surface of segments smooth except for two spinular rows on first segment. Armature formula, 1-(1), 2-(9), 3-(6), 4-(1 + [1+ae]), 5-(1), 6-(9 + [1+ae]).

Antenna (Fig. 3C) with small coxa. Allobasis armed with two abexopodal setae. Free endopodal segment with inner spinules proximally and subdistally, with two lateral inner spines and a slender seta (the latter arrowed in figure), and five distal elements. Exopod one-segmented; about five times as long as wide, with few spinules, and with one lateral and two apical setae (one of them reduced –arrowed in figure-).

Mandible (Fig. 3D) robust; chewing edge with bi- and multicuspidate teeth, one pyriform element and one lateral seta. Palp one-segmented, with two setae; with one small seta arising nearby.

Maxillule (Fig. 3E) robust; arthrite of praecoxa with few spinules, with one surface seta, seven distal spines, two slender spinules, and one slender lateral seta ornamented by small spinules. Coxa with some spinules and with two elements. Basis with some median spinules. Homology of the setae of basis, exopod and endopod difficult to determine. Basis seemingly with three apical and two lateral setae, endopod and exopod seemingly represented by three and one seta, respectively.

Maxilla (Fig. 3F). Syncoxa with spinules along inner margin; with two endites bearing three setae each. Allobasis drawn into strong claw with one accompanying strong seta. Endopod represented by three elements.

Maxilliped (Fig. 6A) subchelate. Syncoxa with spinular rows as illustrated and with small seta on inner distal corner. Basis unarmed; with anterior and posterior longitudinal row of inner spinules; with small outer spinules medially and subapically. Endopod drawn into long and slender claw with one accompanying small seta.

P1 (Fig. 4A). Intercoxal sclerite as figured. Coxa with spinular rows as illustrated. Basis with inner and outer spine; with median spinular row, and with stronger spinules at base of inner and outer spine and between rami. Exopod three-segmented; endopod two-segmented; both rami of about the same length.

P2 (Fig. 4B). Praecoxa with spinules close to joint with coxa. The latter as in P1. Basis as in P1 except for lack of inner spine; outer element spine-like. Exopod three-segmented and ornamented as illustrated; EXP2 and EXP3 with inner seta. Endopod two-segmented, reaching beyond tip of EXP1; first segment small, about as wide as long and ornamented as illustrated; second segment long, about four times as long as wide, ornamented as depicted and armed with one outer spine, one apical long seta and one inner element.

P3 (Fig. 5A). Praecoxa and coxa as in P2. Basis as in P2 except for outer seta-like element in P3. Exopod as in P2. Endopod as in P2 except for two additional inner elements in P3.

P4 (Fig. 5B). Praecoxa, coxa and basis as in P3. Exopod as in P3 except for the presence of one inner seta only in P4EXP3. Endopod two-segmented, reaching middle of EXP1; first segment very small; second segment about three times as long as wide, armed with one inner and one apical seta.

P5 (Fig. 6B). Both legs distinct. Exopod and baseoendopod fused. Exopodal lobe reching the middle of the baseoendopodal lobe. Exopodal and baseoendopodal lobes ornamented with spinules as shown; the former with five elements plus outer seta of basis, the latter with one outer, one apical and four inner setae; relative length of setae as shown.

Armature formula of female P1-P5 as follows:

	P1	P2	P3	P4	P5
EXP	I-0;I-1;I,I1,1	I-0;I-1;II,2,1	I-0;I-1;II,2,2	I-0;I-1;II,2,1	5
ENP	0-1;0,I1,1	0-0;I,1,1	0-0;I,1,3	0-0;0,2,0	6

P6 (Fig. 2B) represented by median plate in anterior half of second urosomite (first genital somite); each vestigial leg represented by one outer long seta and one inner small element. Copulatory pore in the middle of genital double-somite.

Male.---Habitus more slender than in female, with second and third urosomites distinct (Fig. 7A, B); total body length measured from tip of rostrum to posterior margin of caudal rami ranging from 345 to 425 µm (mean, 388 µm; n= 6; total length of allotype, 385 µm). Rostrum sexually dimorphic, slender and elongate (Fig. 8A). Cephalic shield as in female. Spinular ornamentation of prosomites and urosomites less dense than in female (Fig. 7A, B). Caudal rami (Fig. 7A, B) as in female.

Antennule (Fig. 8A) subchirocer, six-segmented; surface of segments smooth except for spinular rows on first segment. Armature formula difficult to define but probably as follows: 1-(1), 2-(9), 3-(6), 4-(7+[1+ae]), 5-(0), 6-(8+ae). Last segment with three teeth.

Antenna, mandible, maxillule, maxilla and maxilliped (not shown) as in female.

P1 (Fig. 9A) as in female except for inner projection and more slender inner spine of basis.

P2 (Fig. 9B). Praecoxa, coxa and basis as in female. Exopod as in female except for stronger outer spines in male. Endopod as in female, except for dimorphic outer spine, and for apical and inner setae comparatively shorter.

P3 (Fig. 10A). Coxa as in P2. Basis as in P2 except for outer seta-like element in P3. Exopod as in female except for dimorphic and stronger outer spines; EXP2 with one, EXP3 with two inner setae. Endopod dimorphic, three-segmented; first segment very small, about two times as wide as long; second segment with inner apophysis reaching beyond third segment, the latter small and armed with two setae.

P4 (Fig. 10B). Coxa and basis as in female. Exopod as in P2, except for insertion site of inner seta of EXP3. Endopod as in female, except for being comparatively smaller and with comparatively shorter setae than in female.

P5 (Fig. 8B). Both legs fused medially. Exopod and baseoendopod fused. Baseoendopodal lobe as long as exopodal lobe; with three apical setae. Exopodal lobe with three setae plus outer seta of basis.

P6 (Fig. 12B) represented by median plate. Without armature.

Variability.---Females. The right P1ENP1 of one female lacks the inner seta, and the right P5EXP of two other females was observed bearing four setae (Fig. 6C).

Males. The left P4EXP of one male, aberrant (markedly slender than in the opposite limb, EXP1 without outer spine, and inner seta of EXP3 reduced). Another male bears two setae plus outer seta of basis in right P5EXP, and P1EXP3 smaller than in opposite limb. Another male showed four setae plus outer seta of basis in left P5EXP, and another male exhibits two-segmented and dwarfed left P1EXP, and left P3EXP aberrant (EXP1 and EXP2 without outer spine, EXP3 abnormal. Another male lacks the inner most apical seta of left P2EXP3 (with four elements in all only). One male possesses an aberrant right P1EXP (EXP2 abnormal, with inner spine). Another male showed and aberrant inner most apical seta of right P4EXP3, and right P2EXP3 shorter than in opposite limb.

Discussion

Ranga Reddy & Radhakrishna (1979) reported the presence of *C. deitersi* in Lake Kolleru (16º32' and 16º47' N, 81º4' and 81º22' E), eastern coast of India. In their report, they omitted any comment about the morphology of their specimens since "the species is one, already well defined, presenting no problem of identification" and "any mention of its characters appears redundant" (Ranga Reddy & Radhakrishna 1979), and based the identification of their material on the figures and description found in Lang (1948: 1281, Abb. 510) and on the description presented by Hamond (1973). It has to be noted that Lang (1948) adopted Chappuis' (1933), Kiefer's (1936) and Brehm's (1937) views and considered *C. brehmi* and *C. bermudae* Willey, 1930 as synonyms of *C. deitersi* (later, Yeatman (1963) considered *C. bicolor* (Wilson, 1932) and *C. bermudae* as synonyms of *C. deitersi*) and that, at present, *C. brehmi* and *C. bermudae* are considered as *species inquirendae* (Gómez et al. 2004).

Also, Gómez et al. (2004) noted that Hamond's (1973) *C. deitersi* differs from Richard's (1897) description in several aspects, that Hamond's (1973) *C. deitersi* is similar to *C. stimpsoni* in some relevant features, and suggested to consider Hamond's (1973) *C. deitersi* as *species inquirenda*. Hamond's (1973) *C. deitersi* seems to be similar to the figure of the female P3 of *C. brehmi* presented by Lang (1948: 1281, Abb. 510, 1f). It seems as if Ranga Reddy & Radhakrishna (1979) based their identification on the presence, in their material, of a similar female P3 with five setae on the second endopodal segment. If this is the case, the new species herein presented from the western coast of India, could well be the same reported by Ranga Reddy & Radhakrishna (1979) from Lake Kolleru in the eastern coast of that country. Unfortunately, Ranga Reddy & Radhakrishna (1979) omitted any description of their material, and this forced Gómez et al. (2004) to consider Ranga Reddy & Radhakrishna's (1979) record as doubtful.

Following Gómez et al. (2004), Gómez (2005), Gómez, et al. (2007) and Gómez & Gee (2009), as well as the key to the species of the genus *Cletocamptus* by Gómez & Gee (2009) and the new species presented herein, 23 are the valid species within this genus. These are: *C. retrogressus* Shmankevich, 1875, *C. confluens* (Schmeil, 1894), *C. trichotus* Kiefer, 1929, *C. feei* (Shen, 1956), *C. affinis* Kiefer, 1957, *C. gravihiatus* (Shen & Sung, 1963), *C. mongolicus* Stěrba, 1968, *C. helobius* Fleeger, 1980, *C. merbokensis* Gee, 1999, *C. axi* Mielke, 2000, *C. schmidti* Mielke, 2000, *C. deborahdexterae* Gómez, Fleeger, Rocha-Olivares & Foltz, 2004, *C. stimpsoni*, *C. sinaloensis* Gómez, Fleeger, Rocha-Olivares & Foltz, 2004, *C. fourchensis* Gómez, Fleeger, Rocha-Olivares & Foltz, 2004, *C. levis* Gómez, 2005, *C. nudus* Gómez, 2005, *C. cecsurirensis* Gómez, Scheihing &

Labarca, 2007, *C. assimilis* Gómez & Gee, 2009, *C. pilosus* Gómez & Gee, 2009, *C. tertius* Gómez & Gee, 2009, *C. spinulosus* Gómez & Gee, 2009, and *C. goenchim* sp. nov. Previous to the description of *C. goenchim* sp. nov., eight species (*C. stimpsoni*, *C. confluens*, *C. mongolicus*, *C. trichotus*, *C. affinis*, *C. gravihiatus*, *C. retrogressus*, and *C. pilosus*) have been described with five setae on the second endopodal segment of the female P3. *Cletocamptus goenchim* sp. nov. seems to be most closely related to *C. stimpsoni* from Alabama (USA). These two species share the armature formula of the female P1-P5, and the rather slender lateral seta of the maxillulary arthrite. The length:width ratio of the P1EXP:ENP and of the caudal rami are similar also, but can be separated by the armature of the mandibular palp (palp one segmented, with two seta and without accessory seta in *C. stimpsoni*, but with two setae, plus accesory seta nearby in *C. goenchim* sp. nov.), in the shape of the outer element of basis of P2 (seta-like in *C. stimpsoni*, but spine-like in *C. goenchim* sp. nov.), in the ornamentation of the posterior margin of cephalothorax, pro-, and urosomites, and anal operculum of both male and female, armature formula of male P5EXP (with four elements plus outer seta of basis in *C. stimpsoni*, but with only three setae plus outer seta of basis in *C. goenchim* sp. nov.), armature formula of the male P2ENP2 (with four setae in *C. stimpsoni*, but with only three elements in *C. goenchim* sp. nov.), and relative length and shape of the inner apophysis of the male P3ENP2.

Cletocamptus goenchim sp. nov. shows the typical sexual dimorphism for the genus in A1, basis of P1, outer spines of P2-P4EXP, P2ENP, P3ENP, P5, and P6. Gómez et al. (2007) noted that *C. retrogresus*, *C. albuquerquensis* (Herrick, 1894) (currently considered as *species inquirenda* (Gómez & Gee 2009), and *C. levis* share the dimorphic male rostrum. With the addition of four species from Argentina (Gómez & Gee 2009) and after revision of male specimens of several species previously described by Gómez et al. (2004), it is now known that *C. goenchim* sp. nov., *C. deborahdexterae*, *C. stimpsoni*, *C. sinaloensis*, *C. fourchensis*, *C. levis*, *C. cecsurirensis*, *C. axi*, *C. spinulosus*, *C. pilosus* and *C. tertius* share the dimorphic male rostrum (Fig. 8A, C-I). Unfortunately, the male of *C. nudus* and *C. assimilis* remains unknown.

Tai & Song (1979) reported the presence of *C. deitersi* from China. Gómez et al. (2004) noted that Tai & Song's (1979) specimens resemble *C. stimpsoni* in the armature formula of female P1-P5, but considered Tai & Song's (1979) *C. deitersi* as *species inquirenda* because of the poor description of the Chinese specimens.

In his book, Chang (2009) reported the presence of the genus *Cletocamptus* from a sandy delta at the mouth of the Nakdong river (Jinudo islet) and from a coastal marsh in Imjado island (Korea), and noted that their specimens, despite some differences, resemble *C. schmidti*, *C. stimpsoni*, *C. nudus* and *C. levis*. The senior author had the opportunity to check additional drawings kindly sent by Dr Chang during a brief communication. Chang's (2009) specimens from Korea and the specimens from India described herein showed to belong to the same species. Also, Tai & Song's (1979) *C. deitersi* is very similar to *C. goenchim* sp. nov., and given the armature formula, in particular of the female P3, and based also on its geographic distribution, it is highly probable that the Chinese specimens belong also to *C. goenchim* sp. nov. It is suggested to consider provisionally Tai & Song's (1979) material as conspecific of the Korean and Indian *C. goenchim* sp. nov. until careful inspection of the Chinese material.

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Figure captions:

Fig. 1. *Cletocamptus goenchim* sp. nov. Female. A, habitus, dorsal; B, habitus, lateral. Scale bar: 316 µm.

Fig. 2. *Cletocamptus goenchim* sp. nov. Female. A, urosome, dorsal (P5-bearing somite omitted); B, urosome, ventral (P5-bearing somite omitted). Scale bar: 100 µm.

Fig. 3. *Cletocamptus goenchim* sp. nov. Female. A, rostum, dorsal; B, antenmnule; C, antenna; D, mandible; E, maxillule; F, maxilla. Scale bar: A, 71 µm; B, 71 µm; C-F, 50 µm.

Fig. 4. *Cletocamptus goenchim* sp. nov. Female. A, P1; B, P2. Scale bar: A, 100 µm; B, 140 µm.

Fig. 5. *Cletocamptus goenchim* sp. nov. Female. A, P3; B, P4. Scale bar: 100 µm.

Fig. 6. *Cletocamptus goenchim* sp. nov. Female. A, maxilliped; B, P5; C, aberrant P5EXP, with four setae plus outer seta of basis. Scale bar: A, 70 µm; B-C, 100 µm.

Fig. 7. *Cletocamptus goenchim* sp. nov. Male. A, urosome, dorsal; B, urosome, ventral. Scale bar: 100 µm.

Fig. 8. *Cletocamptus goenchim* sp. nov. Male. A, rostrum and antennule; B, P5; C-G, dimorphic male rostrum of *C. stimpsoni* (C), *C. deborahdexterae* (D), *C. sinaloensis* (E), *C. fourchensis* (F), *C. axi* (G), *C. tertius* (H) and *C. pilosus* (I). Scale bar: 50 µm.

Fig. 9. *Cletocamptus goenchim* sp. nov. Male. A, P1; B, P2. Scale bar: 100 µm.

Fig. 10. *Cletocamptus goenchim* sp. nov. Male. A, P3; B, P4. Scale bar: A, 50 µm; B, 63 µm.

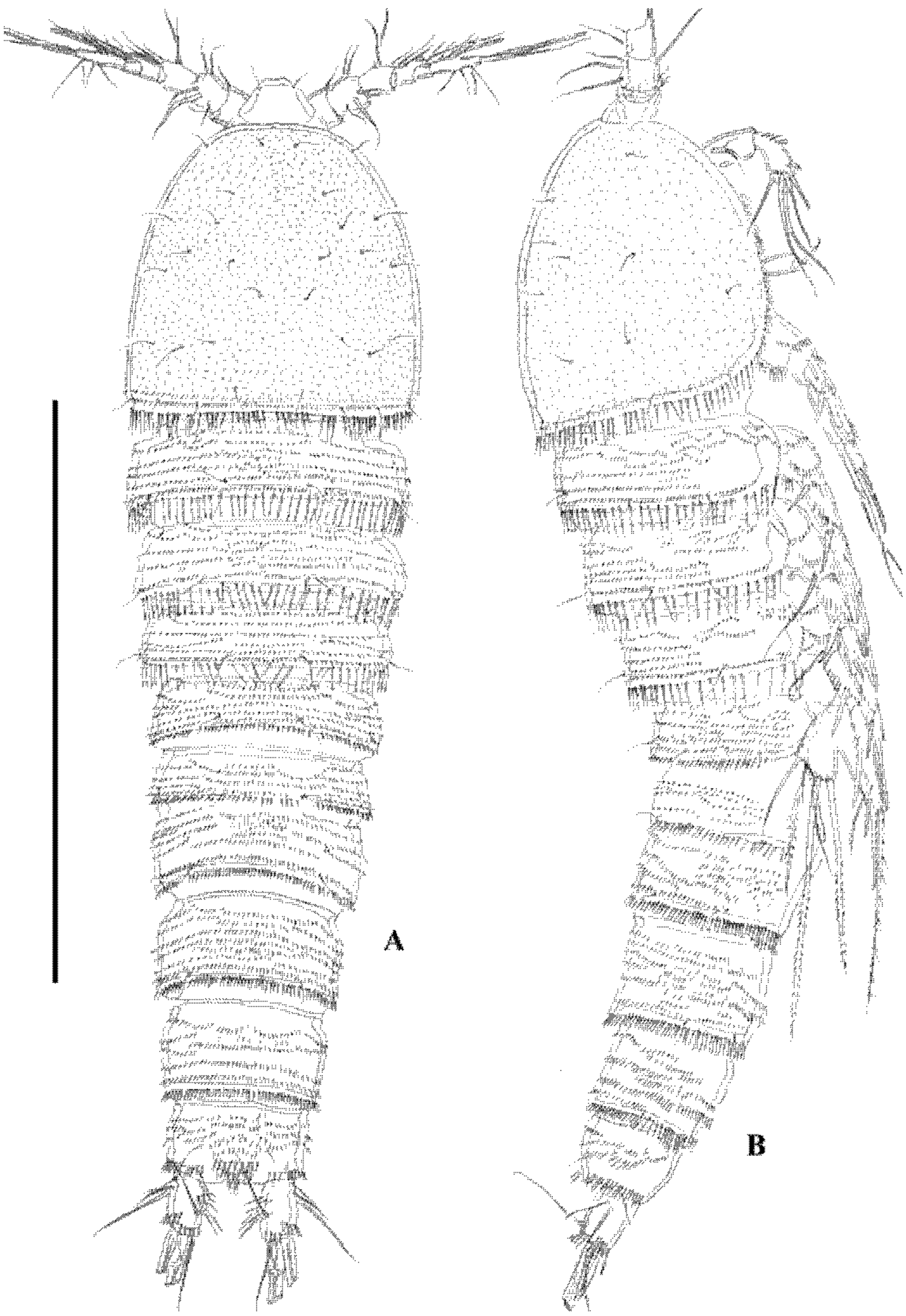

Fig.1

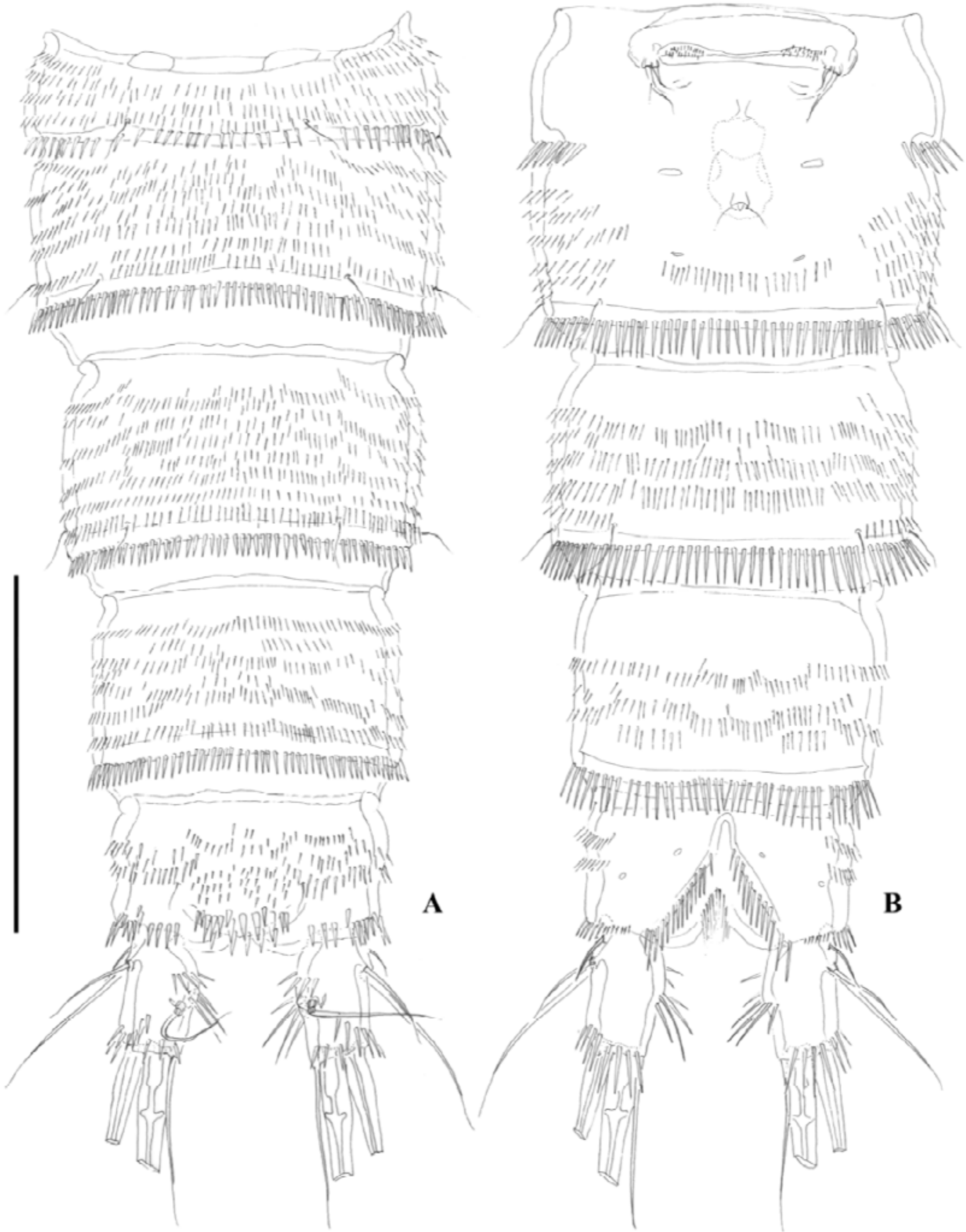

Fig.2

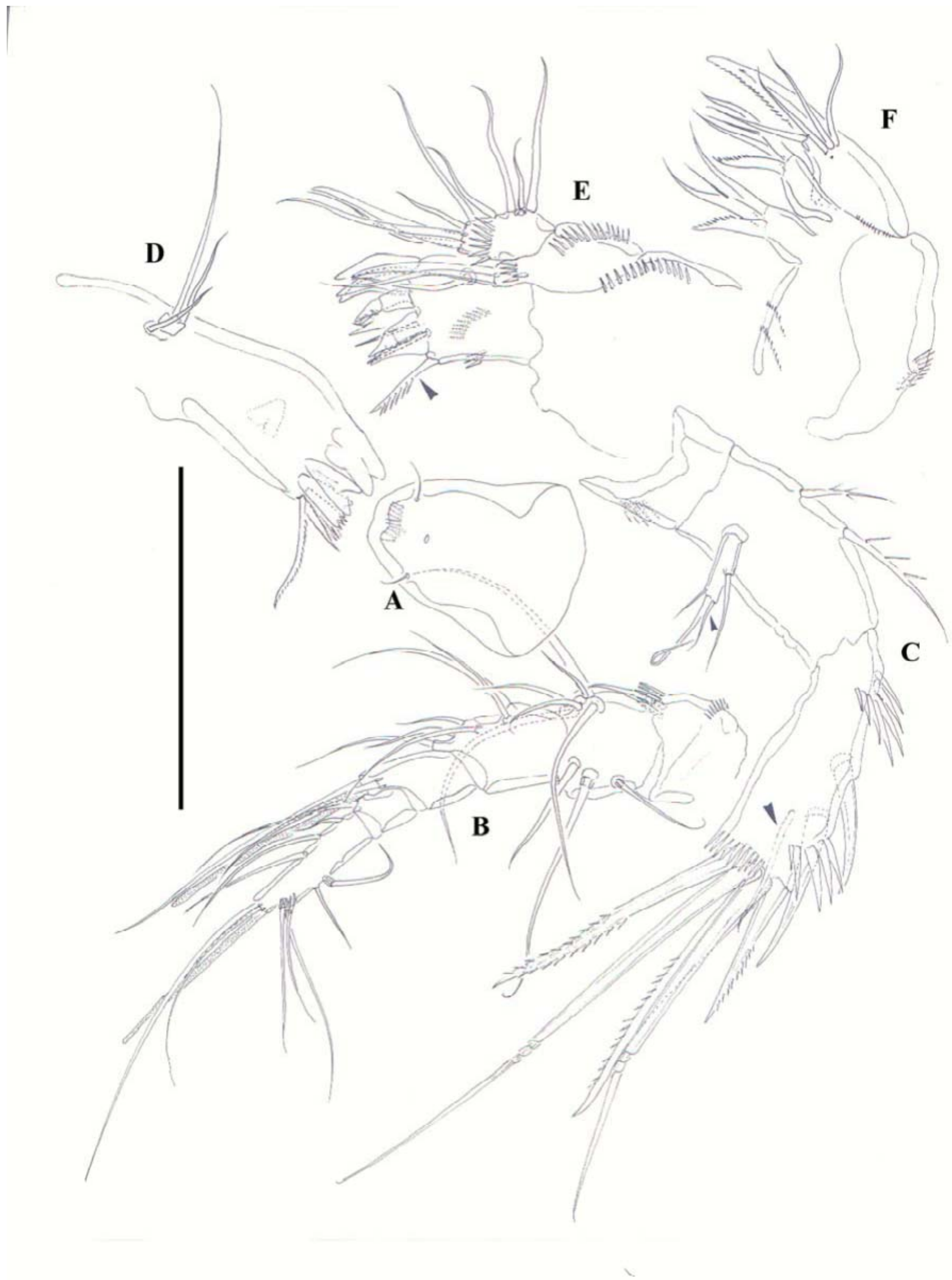

Fig.3

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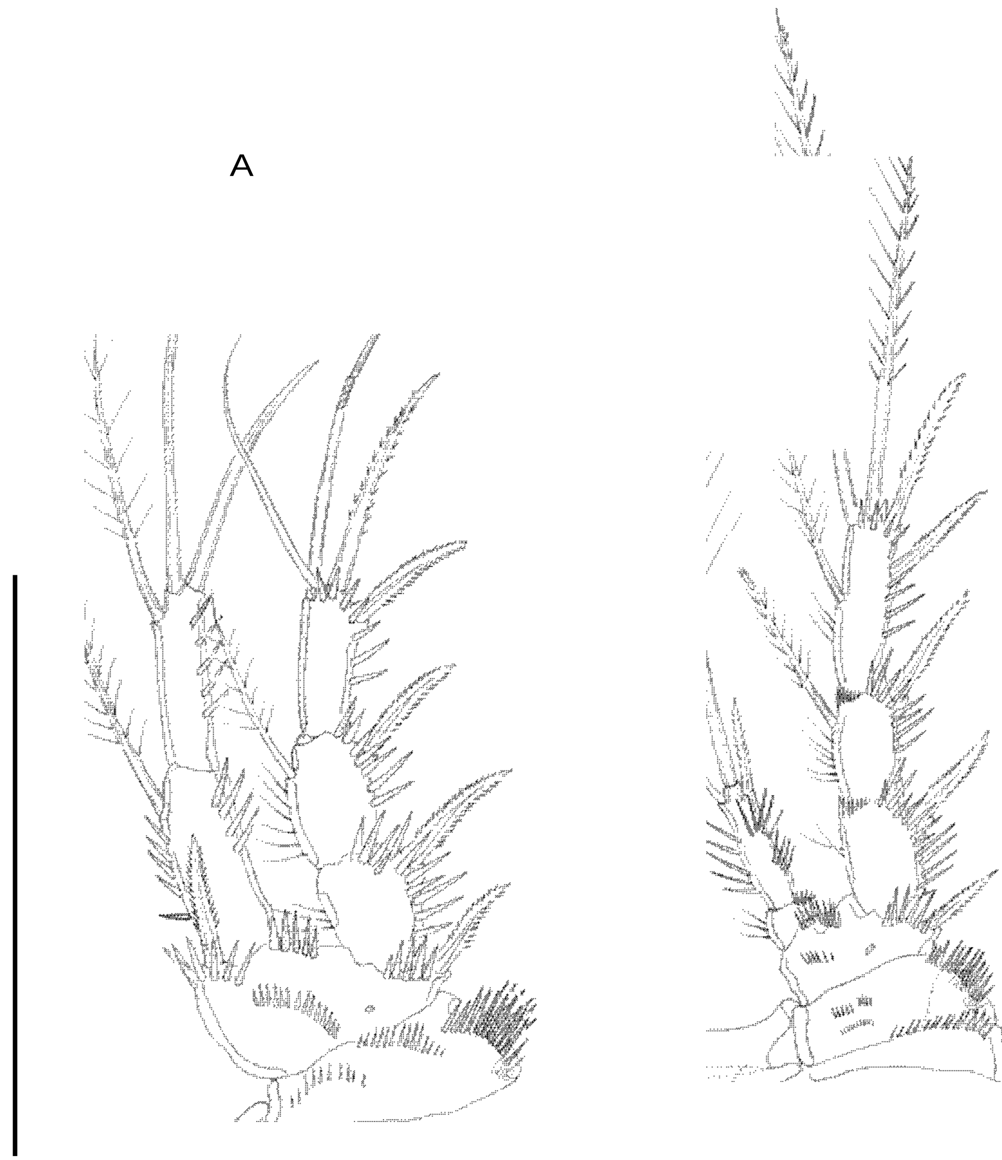
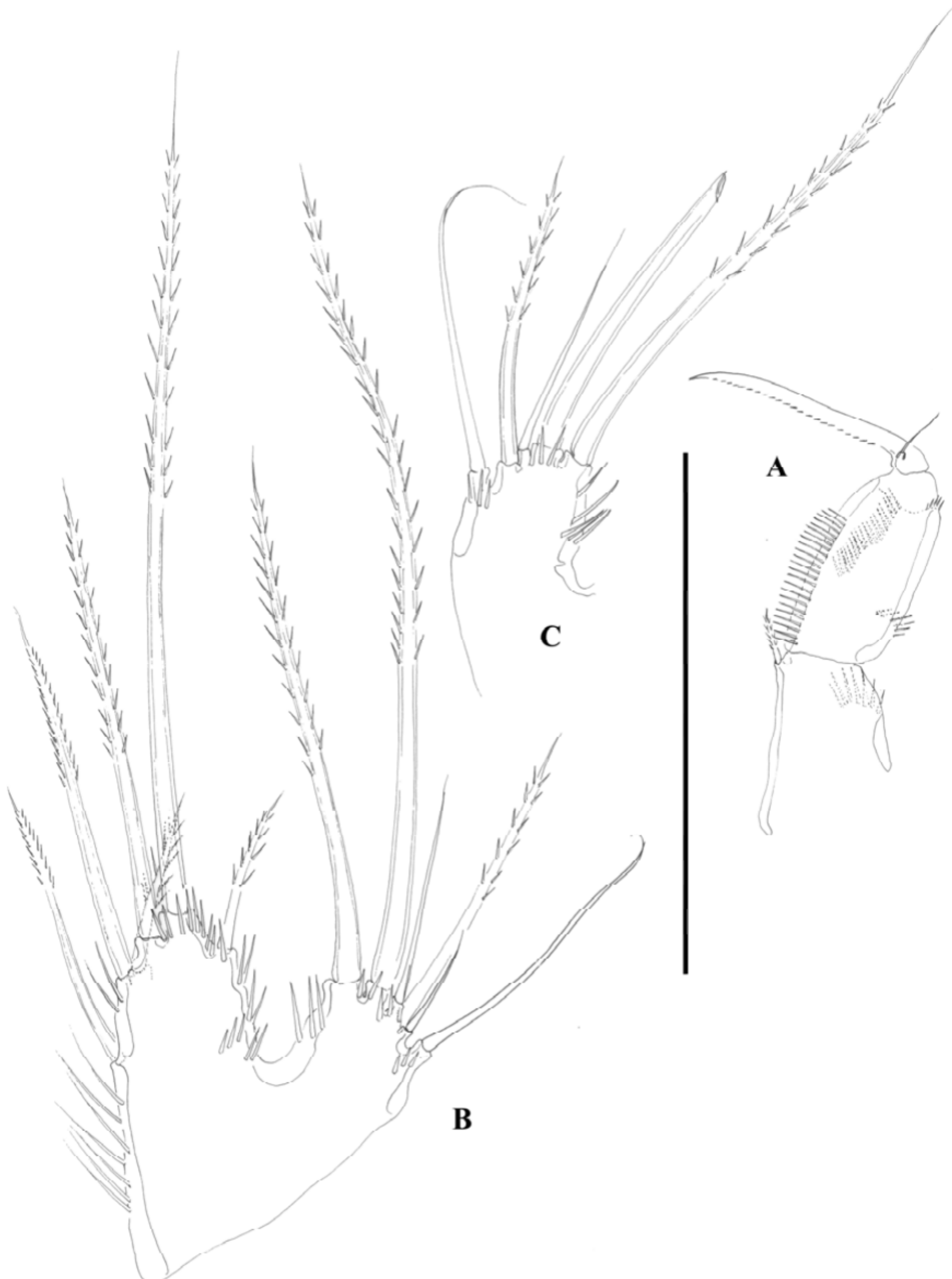


B

Fig.4

Fig.5



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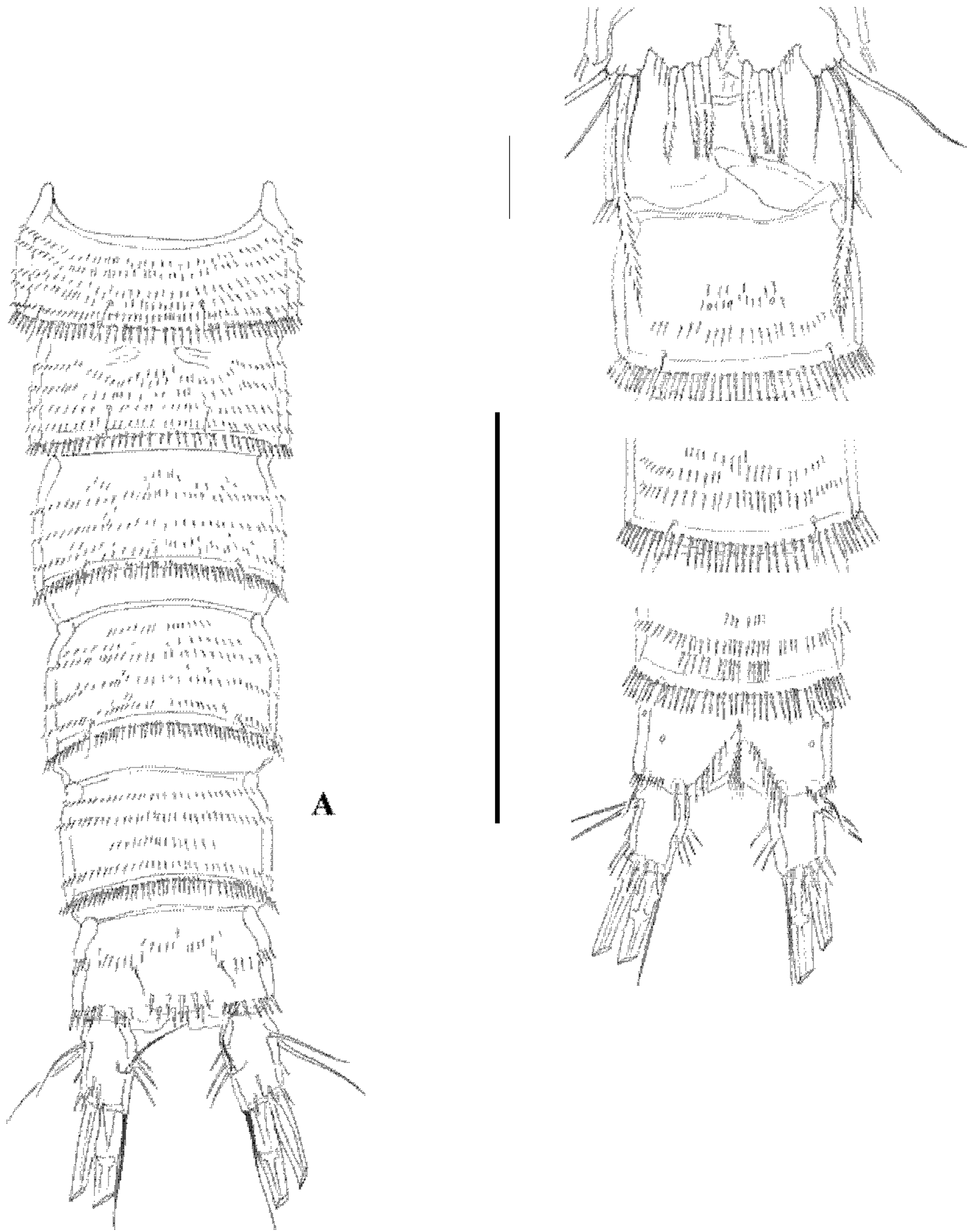

Fig.7

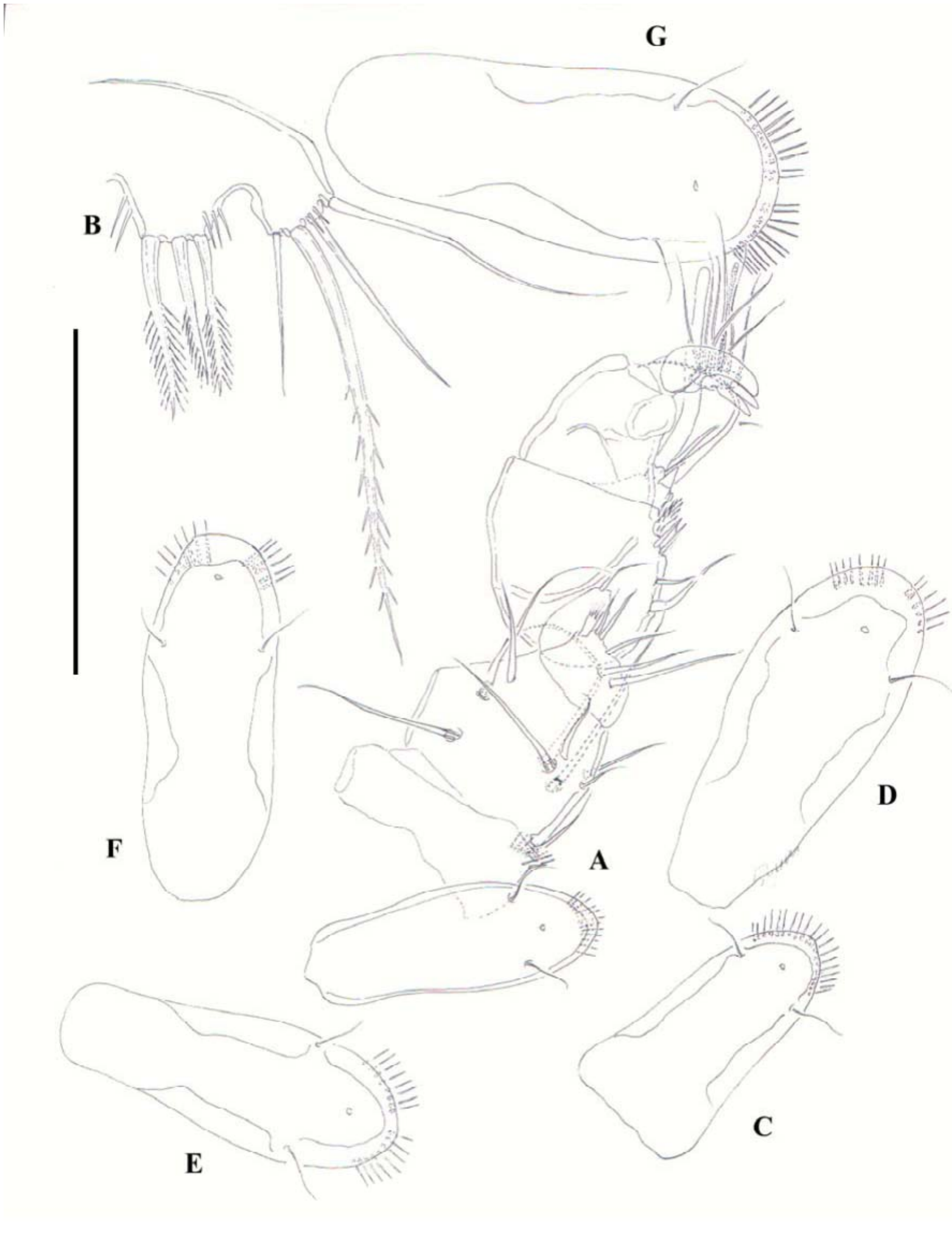

Fig.8

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Fig.9

A

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