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A new species of the genus *Halectinosoma* (Copepoda, Harpacticoida, Ectinosomatidae) from Korea

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Abstract.—A new species of harpacticoid copepod, *Halectinosoma foveolata*, was described from sandy sediments on several intertidal areas of Korea. This new species is mostly similar to *H. dimorphum* Coull, 1970, but differs from the latter by the following characteristics combined: (1) the third segment of antennule is longest; (2) the first exopodal segment of antenna has a row of spinules; (3) the mandibular gnathobase is composed of chitinous teeth without dorsal seta; (4) the female P5 has an incomplete boundary between the exopod and the baseoendopod; (5) the female P5 baseoendopod has two rows of spinules. We also discuss the state of *H. arenicola sensu* Itô (1973), reported from the Japanese coast, which is considered here a synonym with the new species.

Keywords: copepods, East Asia, *Halectinosoma*, new species, taxonomy

The genus *Halectinosoma* Vervoort, 1962 is a large group composed of about 70 nominal species within the family Ectinosomatidae (Soyer 1972, Huys & Bodin 1997, Clément & Moore 2000, Karanovic & Pesce 2001, Wells 2007, Huys 2009, Boxshall et al. 2010, Suárez-Morales & Fuentes-Reinés 2015). The name of this genus was first proposed as a subgenus of the genus *Ectinosoma* Boeck, 1865 by Lang (1944), and Vervoort's (1962) consequently designated *Ectinosoma* (*Halectinosoma*) *sarsi* Boeck, 1873 as the type species of the subgenus (Suárez-Morales & Fuentes-Reinés 2015). Lang (1965) lately upgraded it to the genus level without an awareness on Vervoort's (1962) fixation. It is presently accepted that Vervoort's designation of the type species for the genus *Halectinosoma* is available (Huys 2009). *Halectinosoma* shows high abundance and diversity in the harpacticoid copepod assemblage from marine sediments (Clément & Moore 2000, 2007). The study of this genus is taxonomically confusing due to insufficient descriptions, lack of type materials, and small differences between species (Clément & Moore 2007, Kihara & Huys 2009). Recently, *Halectinosoma* was revised by Clément & Moore (1995, 2000, 2007) and the mouthpart features and body ornamentation patterns, which had long been ignored in previous records, are presently regarded as important characteristics to distinguish the *Halectinosoma* species (Kihara & Huys 2009).

In East Asia, the *Halectinosoma* species are poorly known despite being one of the largest groups in the family Ectinosomatidae. Known species have been recorded in

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Japan [*H. arenicola* (Rouch 1962), *H. japonicum* (Miura 1964) (but, present in the *species inquirendae* by Karanovic & Pesce 2001), and *H. perforatum* Itô, 1981 (Miura 1964, Itô 1973, 1981, Karanovic & Pesce 2001); and Korea [*H. perforatum* (Kim et al. 2015)]. According to some ecological studies on benthic harpacticoids in this region (Mu et al. 2002, Back et al. 2009), however, many species belonging to this genus are still awaiting description.

During a taxonomic study of harpacticoid copepods along Korean coasts, we collected a new species of *Halectinosoma* from sandy beaches. In the present study, we describe the new species, and the taxonomic state of *H. arenicola sensu* Itô, 1973 reported from Japanese coast, which is closely related to the new species, is discussed.

Materials and Methods

Sediment samples were collected from sandy beaches on Korean and Japanese coasts (Fig. 1). Samples were washed over a standard 212 μm sieve and fixed with 5% formaldehyde-seawater solution. Harpacticoid copepods were sorted in the laboratory and preserved in vials with 99.9% ethyl alcohol. Three specimens of the new *Halectinosoma* species were dissected under a stereo microscope (Discovery, V8; Carl Zeiss, Germany), mounted on slides in lactophenol solution, and sealed with Canada balsam. Drawings were made using a drawing tube mounted on a light microscope (ECLIPSE 80*i*; Nikon, Japan). Several specimens were prepared for scanning electron microscopy (SEM) study. Prior to SEM each specimen was submitted to ultrasonic cleaner (3 sec; one time; Power sonic 405) to remove attached debris, prefixed with 4% glutaraldehyde, postfixed with 2% OsO_4, dehydrated through graded ethanol series (60%, 70%, 80%, 90%, 100%; 30 min per change), air-dried, and sputter coated with gold for 90 sec (OM-SC7620) and examined under the SEM (VEGA 3 LM; Tescan, Czech Rebublic). All materials examined were deposited in Chosun University and the National Institute of Biological Resources (NIBR), Korea.

The terminology used to describe the body and appendages morphology follows Huys & Boxshall (1991). The setal formula of thoracic legs is after that of Huys & Boxshall (1991) and Huys et al. (1996). Abbreviations used in the text are: ae, aesthetasc; exp, exopod; enp, endopod; P1–P6, first to sixth thoracic legs; exp (enp)-1 (2, 3) to denote the proximal (middle, distal) segment of a three-segmented ramus. Abbreviations used in the table are: A1, antennule; A2, antenna; exp, exopod; enp, endopod; L:W, length to width; Md, mandible; P1, first thoracic leg; P4, fourth thoracic leg; P5, fifth leg; seg., segments.

This work has been registered in ZooBank with the registration number LSID-E9B45E-BA-D15B-43D2-86D0-C4B2932D2007.

Systematics

Family Ectinosomatidae Sars, 1903
Genus *Halectinosoma* Vervoort, 1962
Halectinosoma foveolata, new species
Figs. 2–10

Synonym. *Halectinosoma arenicola* (Rouch 1962): Itô, 1973, p. 524, figs. 5–7.

Type locality.—Myeongsasipri beach (34°19′35.87"N, 126°48′34.67"E), Sin-ri, Sinji-myeon, Wando-gun, Jeollanam-do, Korea.

Type materials examined.—Holotype ♀ (NIBRIV0000326509), allotype ♂ (NIBRIV0000326510), both undissected and preserved in 99.9% ethyl alcohol. Paratypes: 1 ♀ (NIBRIV0000326511) dissected and mounted on nine slides; 1 ♀ (NIBRIV0000326512) dissected and mounted on two slides; 1 ♂ (NIBRIV0000326513)

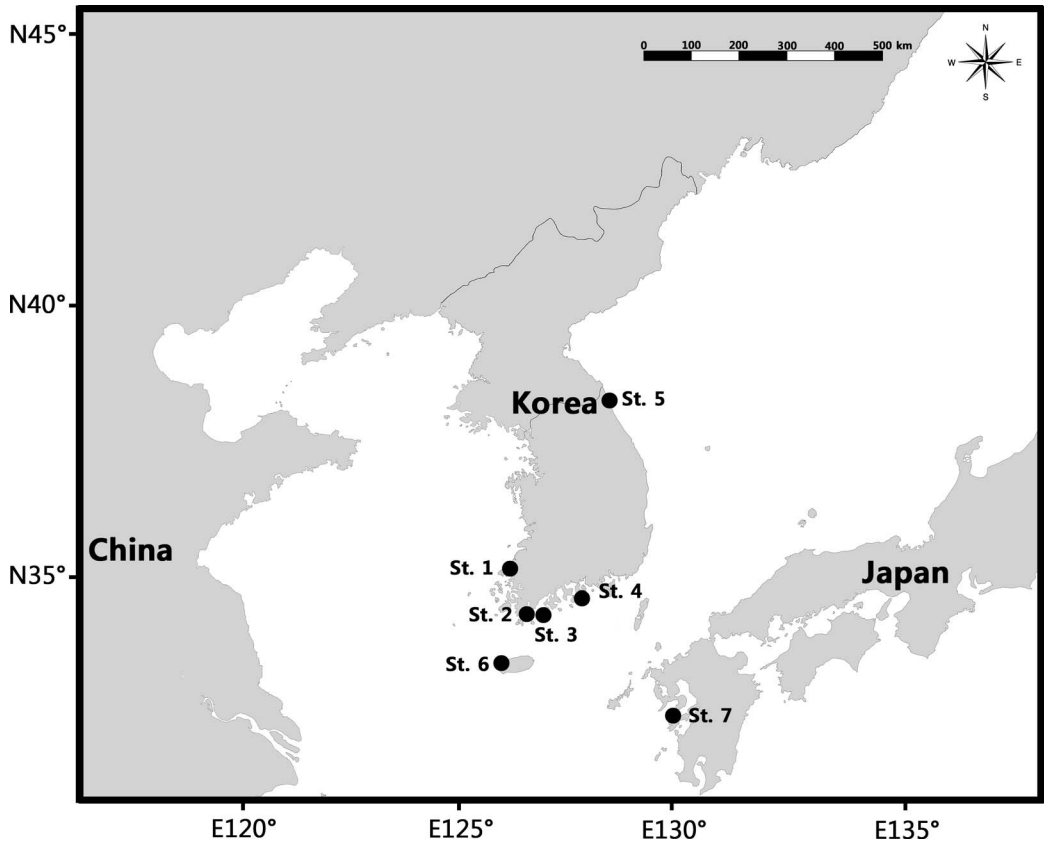

Fig. 1. Localities of the sampling stations of the present study. Korea: St. 1, Baekbawi beach, Yeonggwang-gun; St. 2, Myeongsasipri beach, Wando-gun (type locality); St. 3, Haedanghwa beach, Wando-gun; St. 4, Sangju beach, Namhae-gun; St. 5, Daejin beach, Gosung-gun; St. 6, Hyeopjae beach, Jeju-si. Japan: St. 7, Siki beach, Amakusa.

dissected and mounted on three slides; 26♀♀, 11 ♂♂ (NIBRIV0000470359) preserved in 99.9% ethyl alcohol. All specimens were collected from the type locality (St. 2) on 25 Jun 2013 (Fig. 1).

Additional materials examined.— Korea: 2♀♀(NIBRIV0000470363,NIBRIV0000470364), Baekbawi beach (St. 1; 35°14′43.20"N, 126°18′18.80"E), Duu-ri, Yeomsan-myeon, Yeonggwang-gun, Jeollanam-do on 20 Apr 2015; 17 ♀♀, 3 ♂♂ (NIBRIV0000470360), Haedanghwa beach (St. 3; 34°19′35.51.07"N, 127°3′31.40"E), Wolsong-ri, Geumil-eup, Wando-gun, Jeollanam-do on 30 Jun 2014; 9 ♀♀, 2 ♂♂ (NIBRIV0000470362), Sangju beach (St. 4; 34°43′14.90"N, 127°59′19.90"E), Sangju-ri, Snagju-myeon, Namhae-gun, Gyeongsangnam-do on 15 Mar 2014; 4 ♀♀, Daejin beach (St. 5 in Fig. 1; 38°30′16.00"N, 128°25′32.90"E), Daejin-ri, Hyeonnea-myeon, Goseong-gun, Gangwon-do on 19 Jul 2016; 8 ♀♀, 2 ♂♂, (NIBRIV0000470361), Hyeopjae beach (St. 6; 33°23′41.05"N, 126°14′25.10"E) , Hyeopjae-ri, Hallim-eup, Jeju-si, Jeju-do on 25 Jun 2014 (Fig. 1). Japan: 1 ♀, 5 ♂♂, Siki beach (St. 7 in Fig. 1; 32°31′15.70"N, 130°01′53.20"E), Amakusa, Kumamoto, Kyushu on 13 Aug 2016 (Fig. 1).

Description of female.—Based on paratype (NIBRIV0000326511). Body (Figs. 2A, B, 8A) fusiform; total length including tip of rostrum and caudal rami

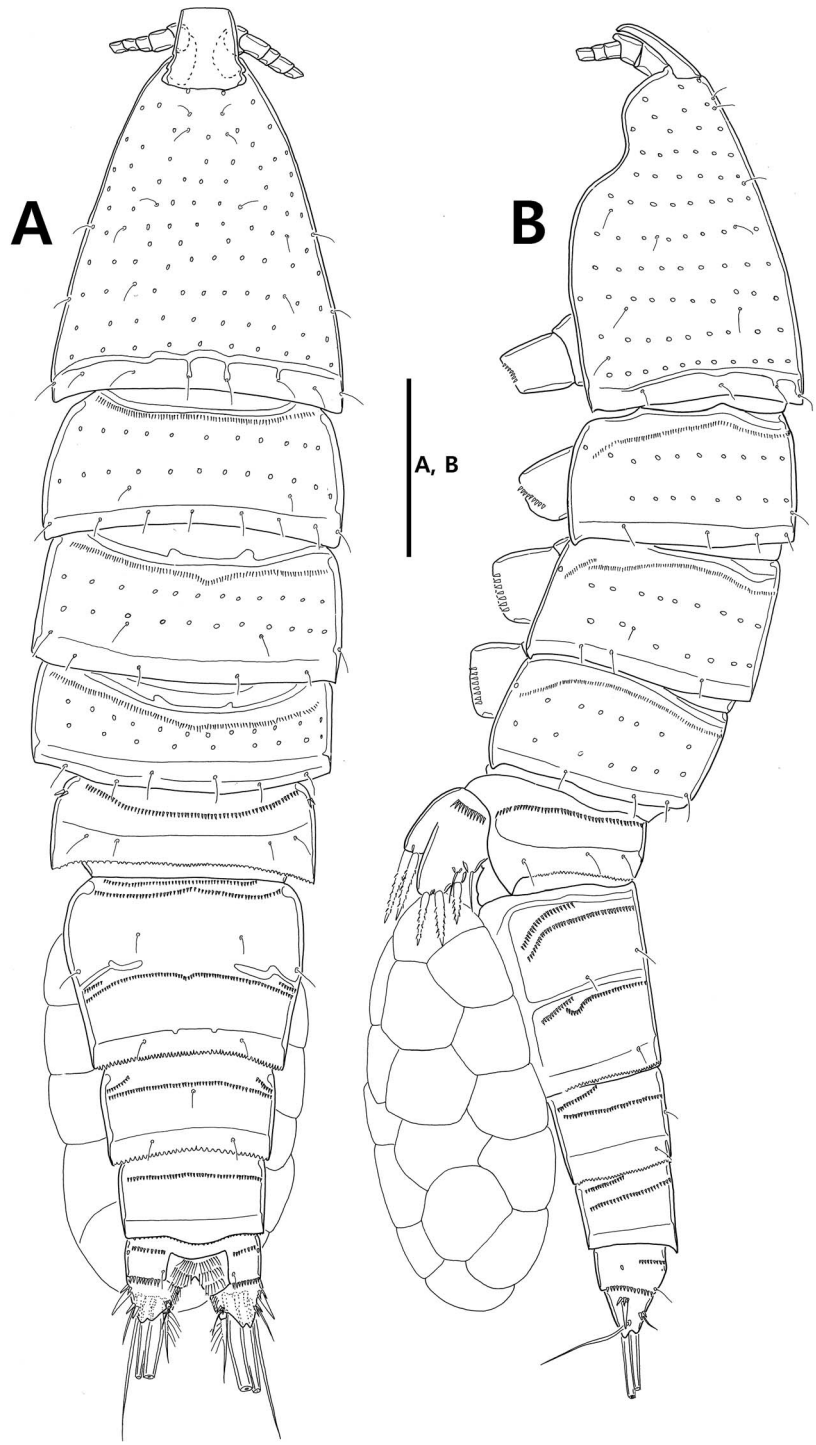

Fig. 2. *Halectinosoma foveolata*, female (paratype, NIBRIV0000326511). A, habitus, dorsal; B, habitus, lateral. Scale bar: 100 μm.

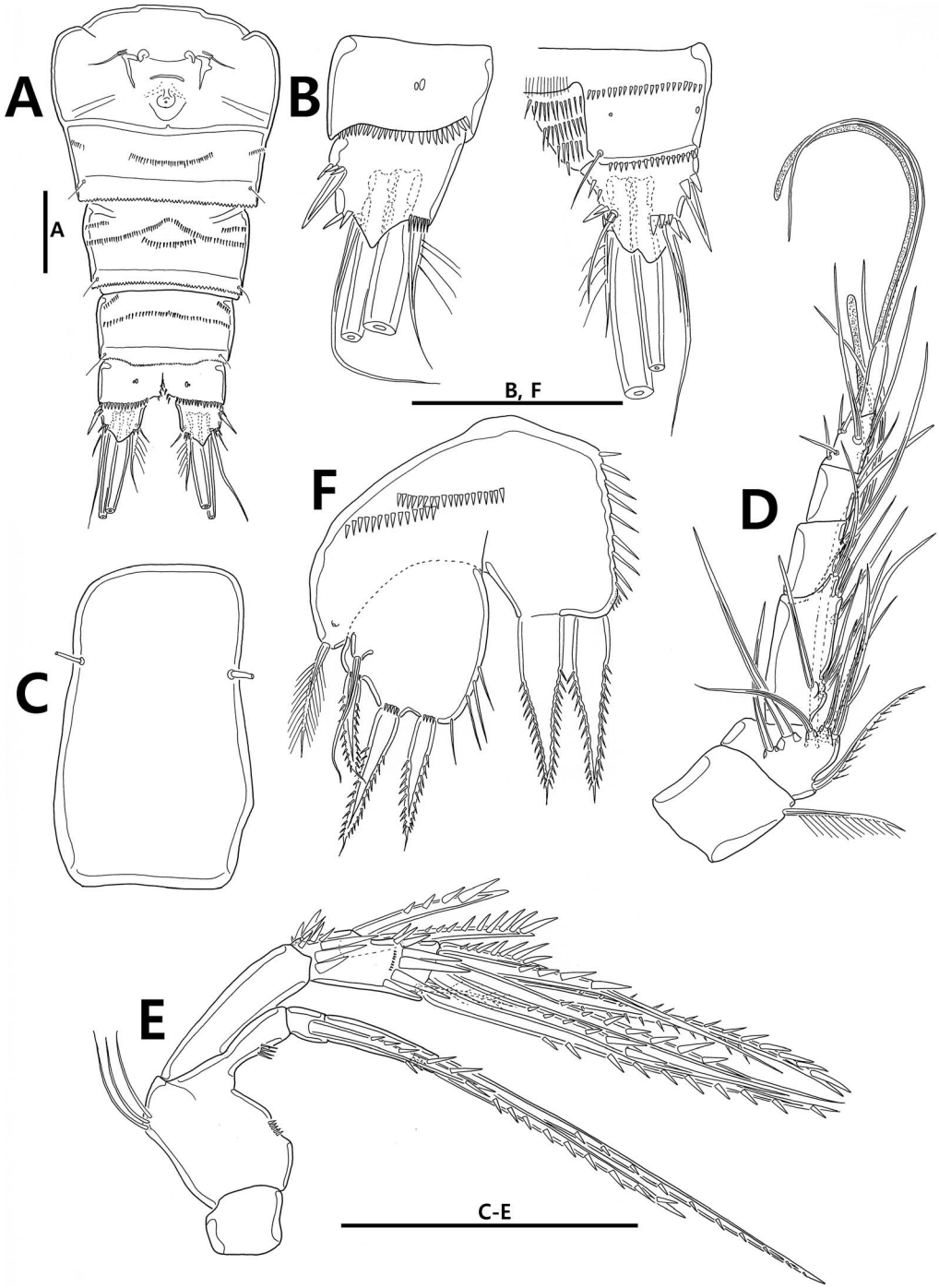

Fig. 3. *Halectinosoma foveolata*, female (paratype, NIBRIV0000326511). A, urosome, ventral; B, anal somite, dorsal (right) and ventral (left); C, rostrum; D, antennule; E, antenna; F, P5. Scale bars: 50 μm.

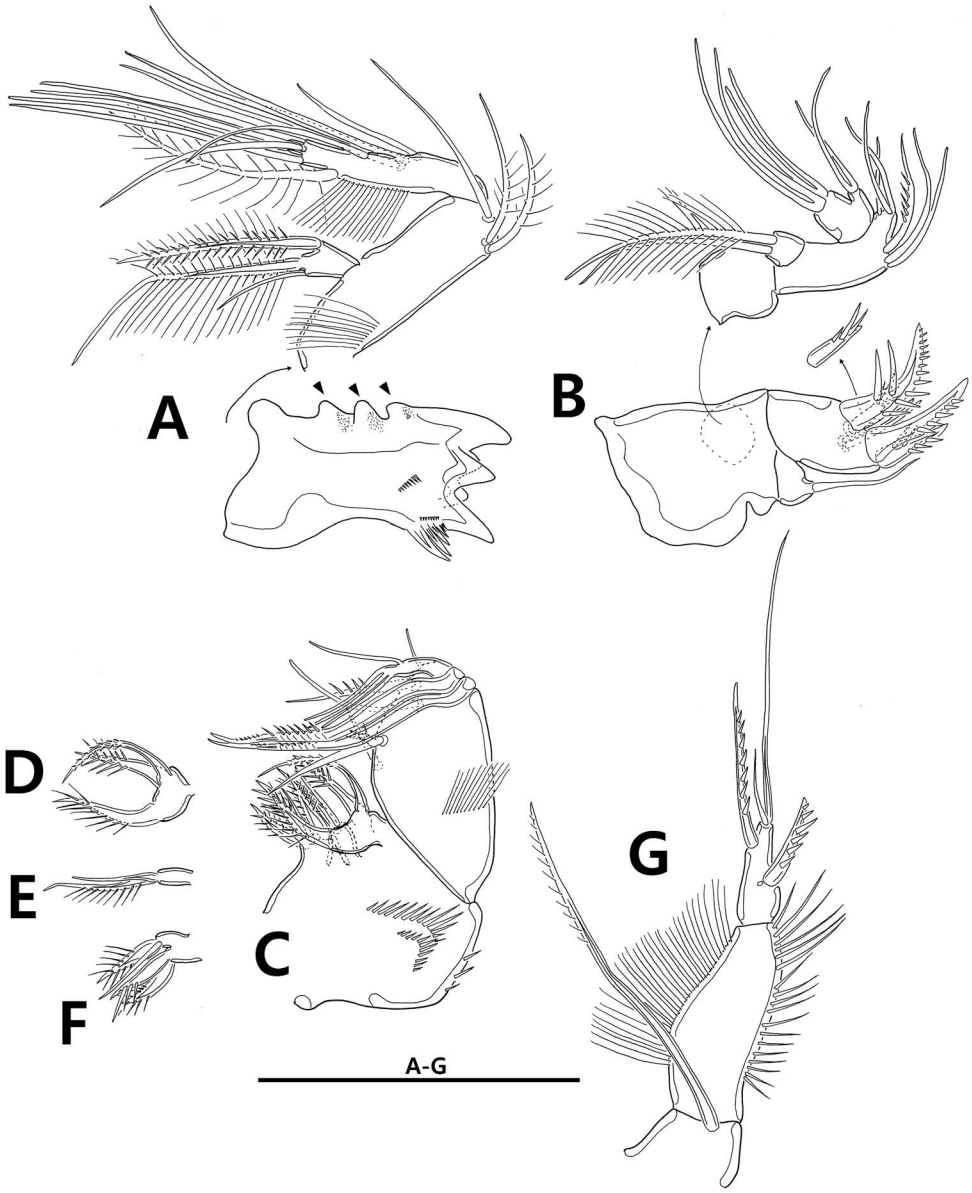

Fig. 4. *Halectinosoma foveolata*, female (paratype, NIBRIV0000326511). A, mandible; B, maxillule; C, maxilla; D, distal endite on syncoxa of maxilla; E, middle endite on syncoxa of maxilla; F, proximal endite on syncoxa of maxillar; G, maxilliped. Scale bar: 50 μm. Arrowheads indicate the unique feature on the mandibular gnathobase.

about 798 μm in lateral view (range from 662.4 to 872.8 μm, mean = 752.5 μm, n = 62); surface sculptured with longitudinal furrows (Fig. 10B). Rostrum (Fig. 3C) well-developed, subrectangular in shape, separated from cephalothorax at its base, twice as long as wide, and with 1 pair of lateral sensilla subdistally.

Prosome (Figs. 2A, B, 8A–D) 4-segmented, comprising cephalothorax and 3 free pedigerous somites. Cephalothorax slightly shorter than 3 succeeding somites

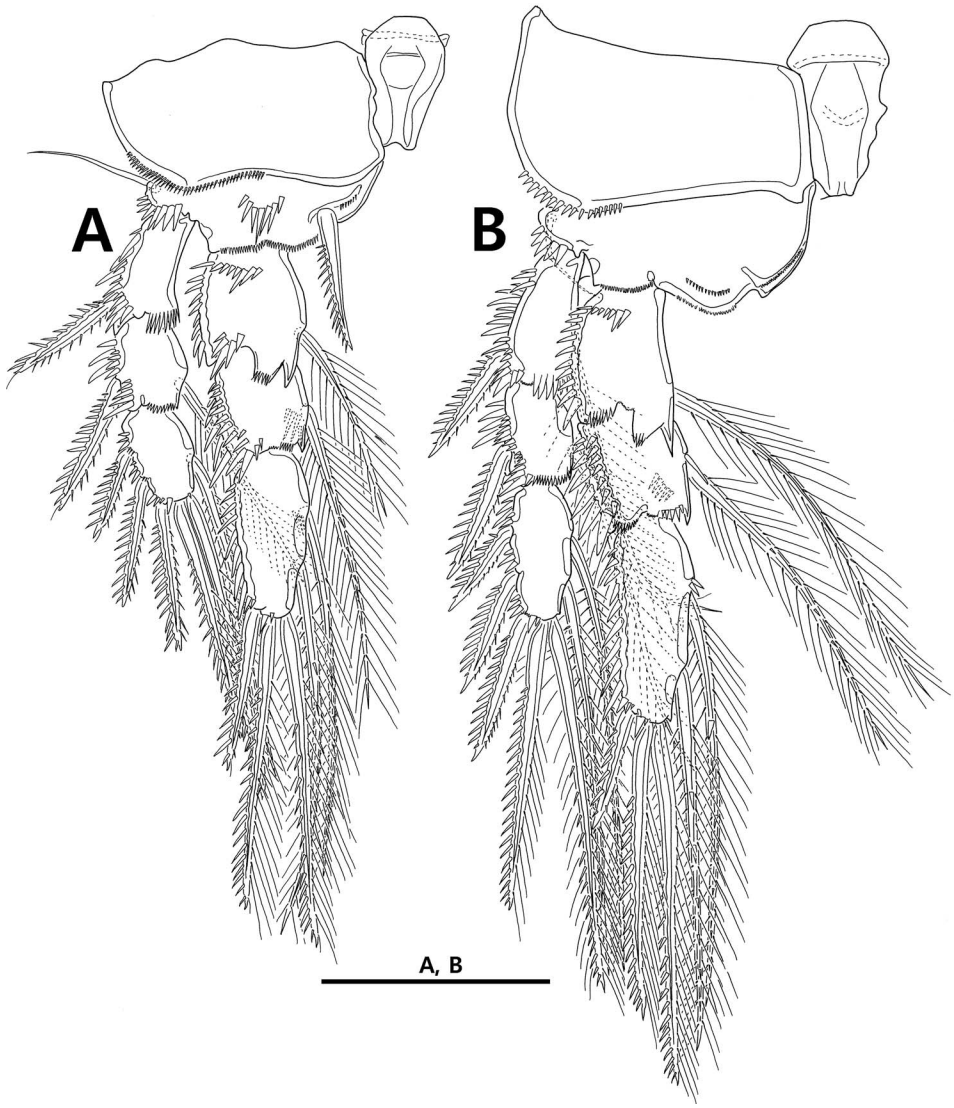

Fig. 5. *Halectinosoma foveolata*, female (paratype, NIBRIV0000326511). A, P1; B, P2. Scale bar: 50 μm.

combined; surface (Fig. 10B) ornamented with small foveae, with 13 pairs of sensilla. P2-bearing somite with row of fine spinules and 5 pairs of sensilla on surface. P3- and P4-bearing somites with row of fine spinules and 4 pairs of sensilla, respectively. Each surfaces of 3 free pedigerous somites ornamented with small foveae.

Urosome (Figs. 2A, B, 3A, 8D–F, 9A–C) 5-segmented, comprising P5-bearing, genital double-, and 3 postgenital somites. P5-bearing somite with row of fine spinules and 2 pairs of sensilla on dorsal surface; posterior margin serrate minutely. Genital double-somite (Fig. 3A) subdivided by cuticular suture ventrally and laterally, while fused dorsally; anterior somite with 2 rows of fine spinules and 2 pairs of sensilla on dorsal surface; each posterior somite with rows of dorsal, lateral and ventral fine spinules, and 2 pairs of sensilla

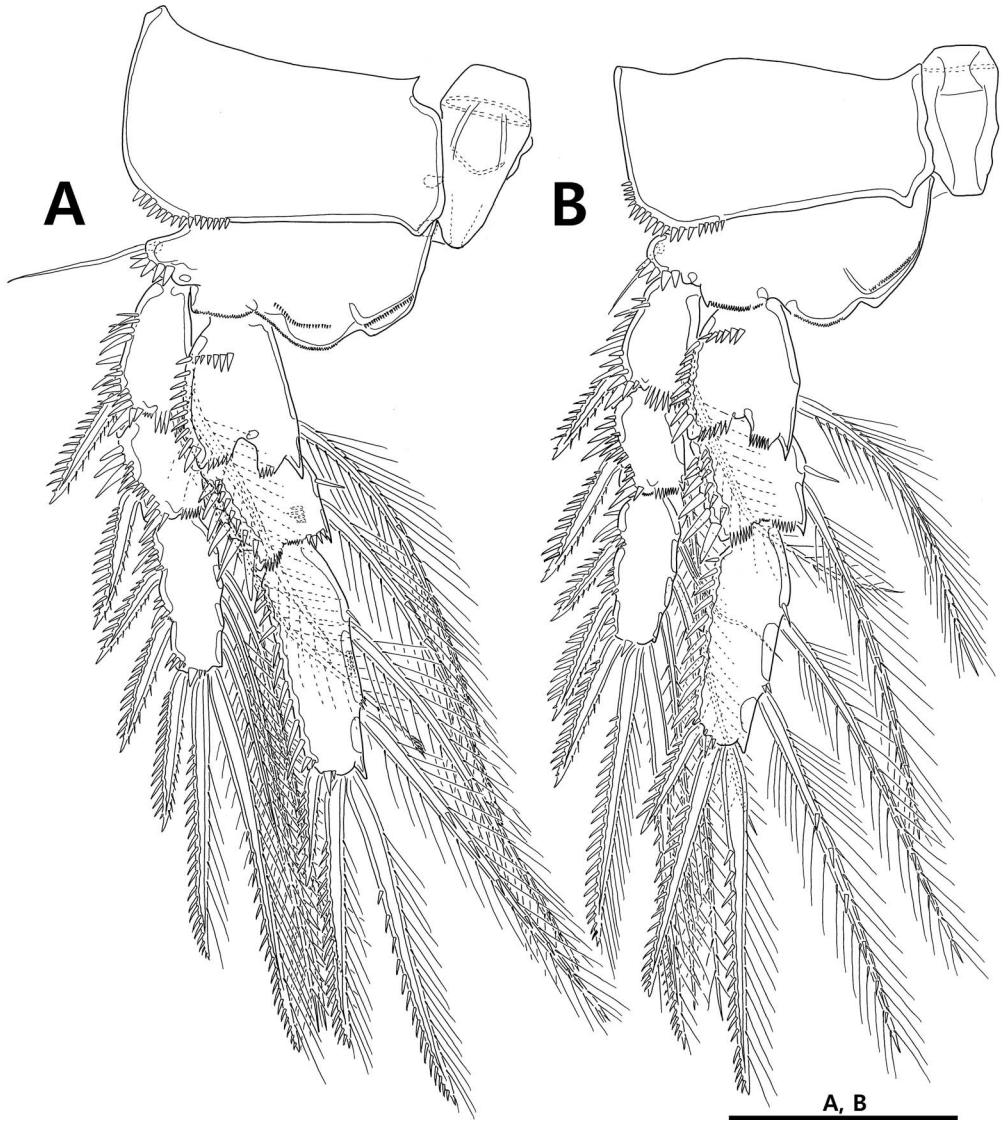

Fig. 6. *Halectinosoma foveolata*, female (paratype, NIBRIV0000326511). A, P3; B, P4. Scale bar: 50 μm.

on surface; posterior margin of posterior somite serrate minutely. Genital field with copulatory pore medially and vestigial P6 represented by seta. Urosomite 4, dorsal surface with 1 row of fine spinules and 3 sensilla; lateral surface with 2 rows of fine spinules; ventral surface with 2 rows of fine spinules and 1 pair of sensilla. Urosomite 5, dorsal surface with 1 row of fine spinules; lateral surface with 2 rows of fine sinules; ventral surface with 1 row of fine spinues and 1 pair of sensilla. Anal somite (Figs. 3B, 9D–F), dorsal surface deeply cleft medially, with several rows of delicate setules, 1 row of spinules, 2 small pores, and 2 sensillia; ventral surface with pair of large and small pores on each side; lateral surface with small pore; posterior border ornamented with spinules; operculum obscure, with row of delicate setules.

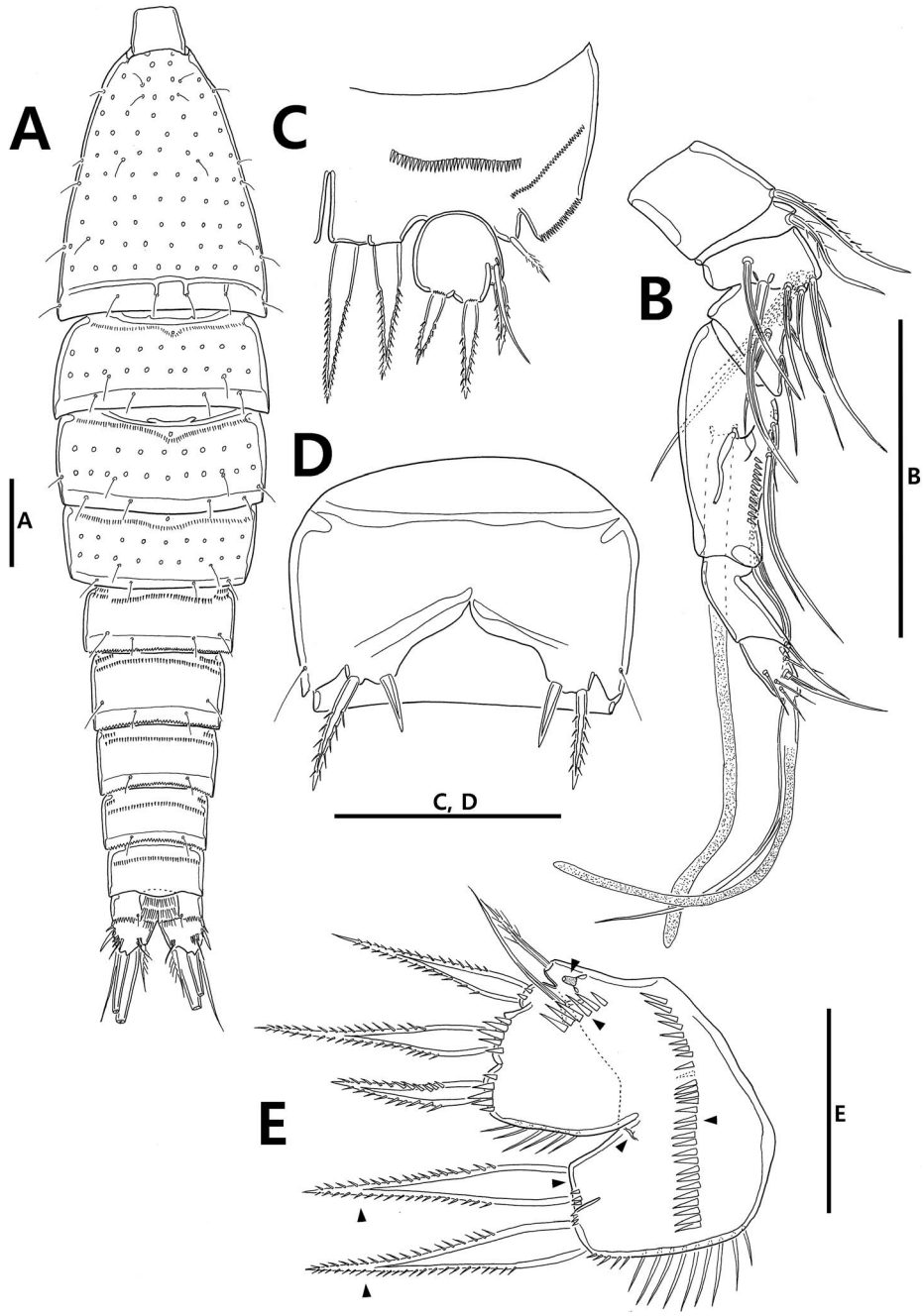

Fig. 7. *Halectinosoma foveolata*, male (A–D, paratype, NIBRIV0000326513), female (E, NIBRIV0000470363). A, habitus; B, antennule; C, P5, D, urosomite 2, ventral; E, P5. Scale bars: 50 μm.

Caudal rami (Figs. 3B, 9D–F) as long as anal somite in dorsal view, with dorsal and ventral transparent lappets, and furnished with 7 setae: seta I short and stout; seta II short and slender; seta III about 3.6 times of seta I in length and slender; setae IV and V (Fig. 10A) well-developed, each side ornamented with spinules; seta VI stout,

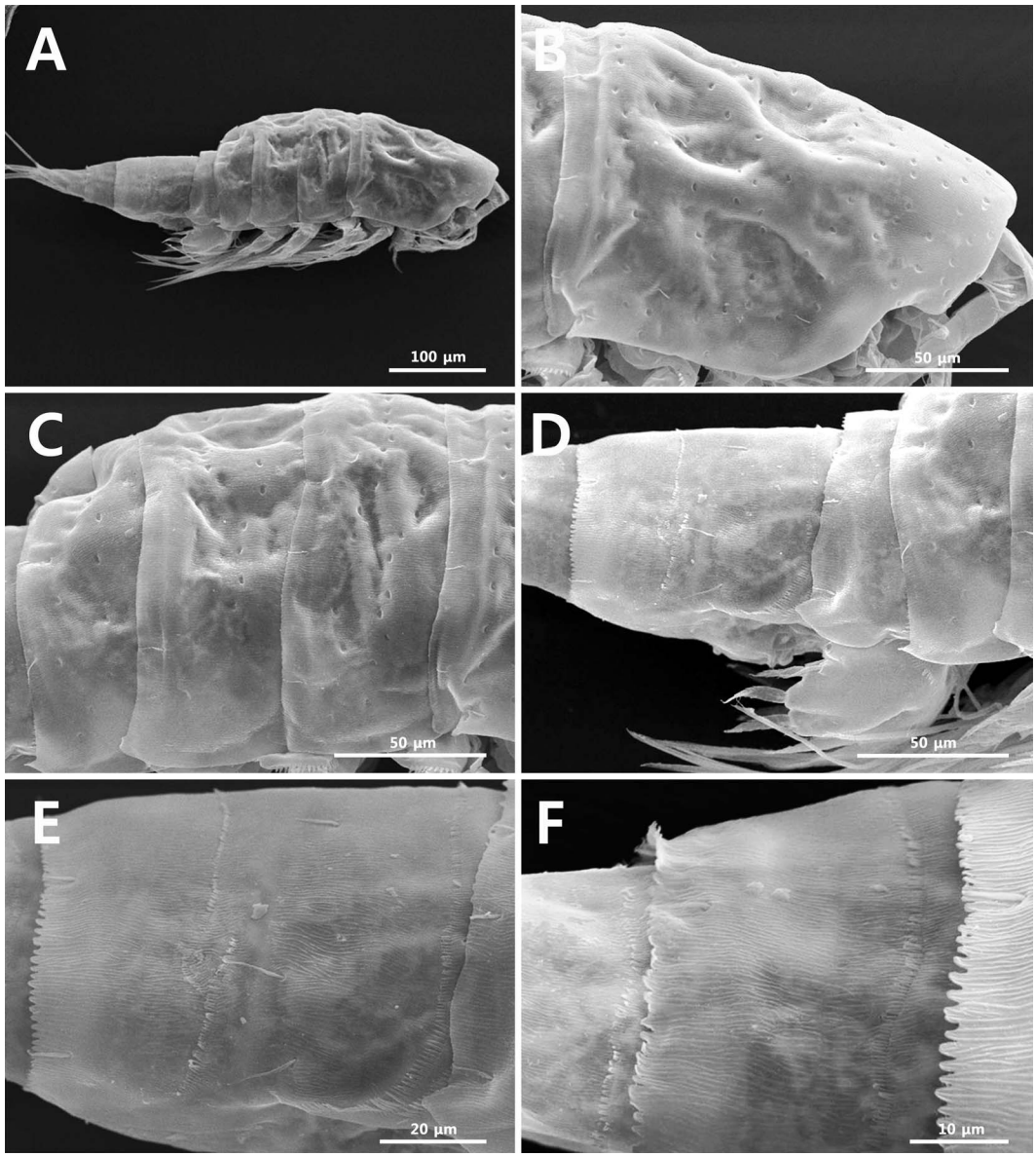

Fig. 8. Scanning electron microscope photographs. *Halectinosoma foveolata*, female: A, habitus, lateral (rostrum hidden); B, cephalothorax, lateral (rostrum hidden); C, thoracic somites 2-4, lateral; D, P5 bearing-somite and genital double somite, lateral; E, genital double somites, lateral; F, urosomite 4, lateral.

shorter than seta III, and furnished with outer setules proximally; seta VII short, slender, and articulated.

Antennule (Fig. 3D) 6-segmented, short, and slender; segment 1 short; segment 2 shorter than preceding one; segment 3 longest, with 1 peduncle at distal corner; peduncle on segment 3 with aesthetasc; segment 6 incompletely separated from preceding one, with long peduncle-like process bearing long seta and aesthetasc; each aesthetasc fused with seta basally.

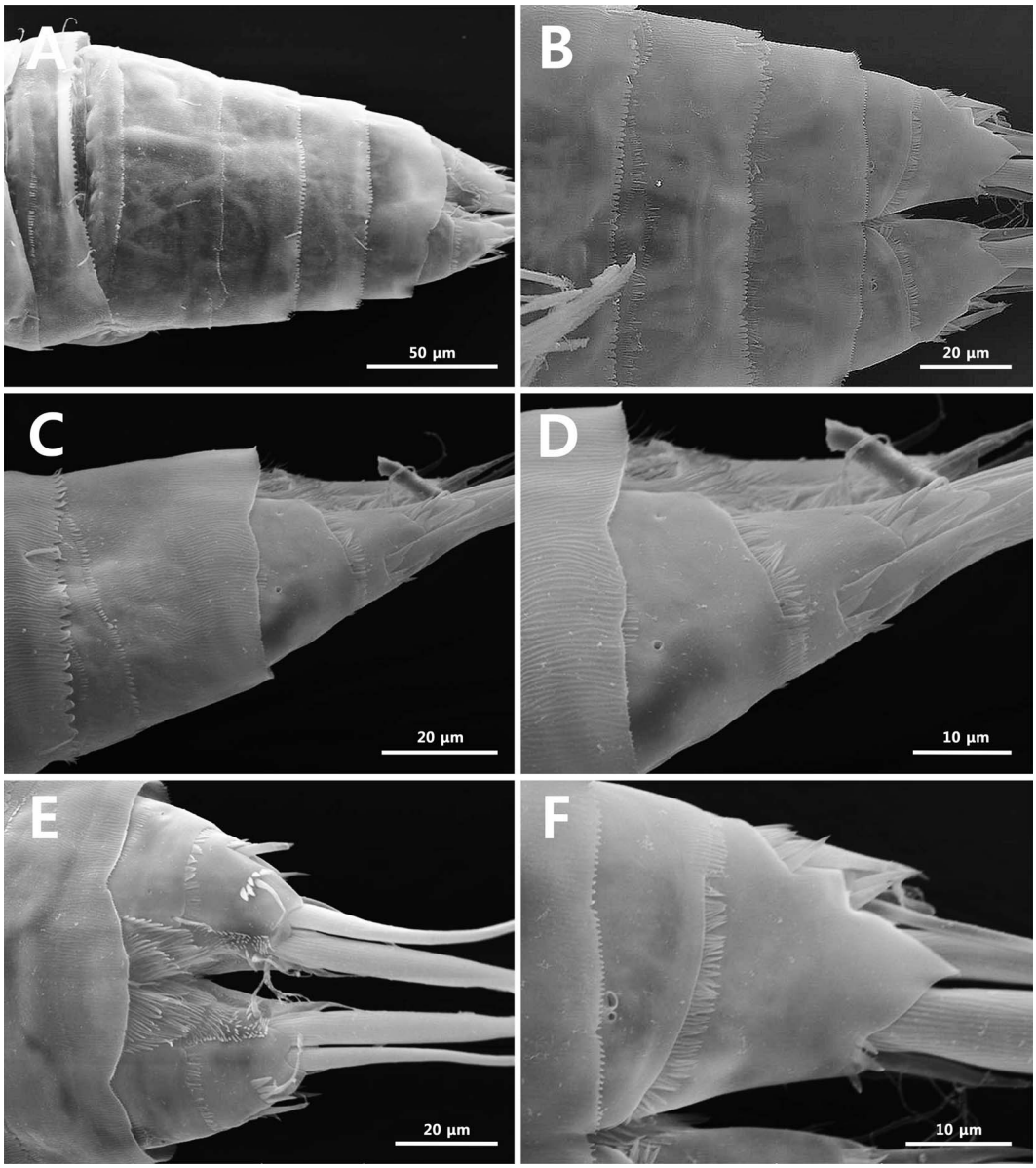

Fig. 9. Scanning electron microscope photographs. *Halectinosoma foveolata*, female: A, urosome, dorsal; B, postgenital somites, ventral; C, urosomite 5, anal somite and caudal ramus, lateral; D-F, anal smite and caudal rami, lateral (D), dorsal (E), ventral (F).

Setal formula as follows: 1-[1], 2-[10], 3-[7 + ae], 4-[1], 5-[1], 6-[8 + ae].

Antenna (Fig. 3E): Coxa small. Basis with 1 group of long setules on anterior margin and 1 group of small spinules on inner margin. Exopod 3-segmented; proximal segment elongate, fused to basis, with 1 row of spinules medially; middle segment shortest, with 1 spinulose seta; distal segment longest, with 2 long spinulose setae. Endopod 2-segmented; proximal segment elongate, longer than basis, with-

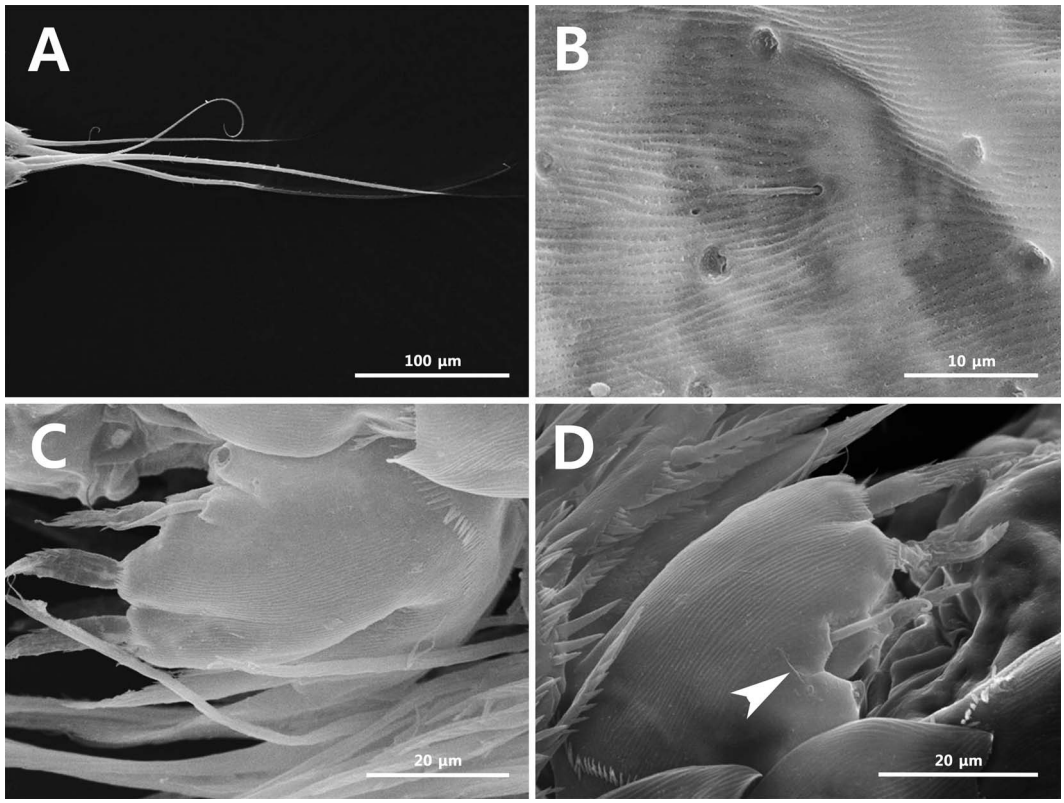

Fig. 10. Scanning electron microscope photographs. *Halectinosoma foveolata*, female: A, caudal setae; B, surface of cephalosome; C, D, P5. Arrowheads indicate the vestiges of spinules.

out ornamentation; distal segment with 2 groups of spinules and 1 row of small spinules on surface, 2 spinulose setae on abexopodal margin, and 6 spinulose and 1 slender plumose setae on distal margin.

Mandible (Fig. 4A): Gnathobase well-developed, with 5 unicuspid teeth on cutting edge, 3 sclerite protrusions (see arrowheads in Fig. 4A) on dorsal margin, and 2 rows of small spinules on surface; ventrodistal corner with 1 group of spinules. Basis elongate, 3.5 times as long as greatest width, and with 1 row of long setules proximally on lateral margin and 3 setae on distal corner. Exopod 1-segmented, small, with 1 spinulose, 1 plumose, and 1 small naked setae. Endopod 1- segmented, elongate, and with 10 naked and 1 plumose setae; lateral margin ornamented with 1 row of long hairs.

Maxillule (Fig. 4B): Praecoxal arthrite with 4 stout spinulose claws on distal margin and 2 naked setae on surface. Coxa small, with 1 seta. Basis with 4 spinulose setae distally and subdistally; surface with 2 bare setae. Exopod 1-segmented, small, and with 2 apical plumose setae. Endopod 1-segmented, bilobate; small lobe with 2 setae and large lobe with 4 setae; each seta on lobes fused with neighboring one at its base.

Maxilla (Fig. 4C): Syncoxa with 3 spinules on outer margin and 2 rows of spinules on surface, and bearing 3 endites (Fig. 4D–F); proximal endite with 1 slender, 1 spinulose, and 2 plumose setae; middle endite slender, with 1 spinulose and

1 bare setae; distal endite with 2 spinulose and 1 plumose setae. Allobasis with 4 bare and 1 spinulose setae, and 1 spinulose spine fused with lateral margin basally; surface with 1 row of long setules. Endopod composed of 3 setae; proximal and middle setae spinulose and geniculated; distal seta divided into 4 small setae.

Maxilliped (Fig. 4G): Syncoxa small, with 1 long seta. Basis elongate, furnished with setules along each lateral margin. Endopod small, about 3 times as long as greatest width, and with 1 long and 1 short bare setae on apical margin and 1 subdistally and 1 medially inserted spinulose setae on lateral margin.

P1 (Fig. 5A): Intercoxal sclerite small, without ornamentation. Coxa large, subrectangular, and with 1 row of spinules along distal corner. Basis smaller than coxa, with 1 outer seta and 1 inner spine; outer margin with 1 row of stout spinules; anterior surface with 1 row of stout spinules and 1 row of minute spinules; distal margin behind endopod with hyaline frill. Both rami 3-segmented; each segment ornamented with outer spinules; exp-1 without inner seta; distal margins of exp-1 and exp-2 with hyaline frill; enp-1, anterior margin with 1 row of horizontal spinules, distal margin partially protruded and with hyaline frill; enp-2, posterior surface with several stout spinules, and distal margin with small hyaline frill.

P2–P4 (Figs. 5B, 6A, B): Intercoxal sclerite larger than that of P1. Coxa subrectangular, with row of spinules along distal corner. Basis smaller than coxa, with 1 row of stout spinules along outer margin and 1 (P4) or 2 (P2 and P3) rows of minute spinules on anterior margin; distal margin midway produced, with small hyaline frill and notch. Both rami 3-segmented; each segment ornamented with outer spinules; distal margins of exp-1 and exp-2 with hyaline frill; enp-1 with 1 row of horizontal spinules on anterior surface; distal margins of enp-1 and enp-2 midway concave, with small hyaline frill; enp-2 except for P4 with several stout spinules on posterior margin.

Setal formula of P1–P4 as follows:

	Exopod	Endopod
P1	0.1.123	1.1.221
P2	1.1.223	1.1.221
P3	1.1.323	1.1.221
P4	1.1.323	1.1.221

P5 (Figs. 3F, 10C, D): Baseoendopod shorter than width, with 2 rows of spinules on anterior surface and 1 plumose outer seta; endopodal lobe reaching to approximately 1/3 of exopod, with 1 row of spinules along inner margin and 2 stout pinnate setae on distal margin; outer seta on distal margin partially fused with endopodal lobe. Exopod slightly longer than wide, fused to baseoendopod anteriorly, with incomplete posterior separation; inner margin ornamented with spinules; distal margin with 3 pinnate setae bearing row of spinules basally; anterior surface with small peduncle bearing 1 seta near outermost distal seta.

Description of male.—Based on paratype (NIBRIV0000326513). Body (Fig. 7A) smaller than female; total length about 546 μm (range from 502.1 to 623.8 μm, mean = 550.8 μm, n = 18).

Urosome (Fig. 7A): 6-segmented.

Antennule (Fig. 7B): 7-segmented, subchirocer. Segment 1 as long as width. Segment 2 smallest. Segment 3 narrower than preceding one. Segment 4 slightly shorter than segment 1, gradually broad towards distal margin. Segment 5 longest, slightly swollen proximally; surface with 1 spine-like process, 1 tube-like seta, 1 row of minute spinules, and 1 aesthetasc. Segment 6 fused with preceding one. Segment 7 elongate, with peduncle bearing aesthetasc fused with seta basally. Setal formula as follows: 1-[1], 2-[1], 3-[8], 4-[3], 5-[6 + ae], 6-[1], 7-[6 + ae].

P5 (Fig. 7C): Baseoendopod small, with 1 finely bipinnate outer seta; endopodal lobe small, reaching to approximately 1/3

of exopod, and with 2 subequal pinnate setae on distal margin. Exopod separated from baseoendopod, slightly longer than wide, and with 3 terminal and 1 surface setae.

P6 (Fig. 7D) represented by 1 bare and 1 spinulose stout setae.

Variability.—Most morphological features are conservative except for the female P5. Ovigerous females lack a row of spinules on the P5 exopod (Fig. 3F), and some ovigerous specimens have small spinules or the vestiges of spinules positioned near the surface seta (arrowhead in Fig. 10D). Among seven populations examined in the present study (Fig. 1), the non-ovigerous form with a distinct spinular row (Fig. 7E) was observed from two specimens collected from Baekbawi beach, Yeonggwang-gun (St. 1). Especially, these two specimens of the non-ovigerous form display additional variability in the detailed characteristics of the female P5 as follows: the outer peduncle has a tube pore (vs. a small pore in the ovigerous form); two spinular rows on the baseoendopod are in a line (vs. two distinguishable rows in the ovigerous form); the boundary between the distal margin of the baseoendopodal lobe and its inner seta is completely separated (vs. partially fused in the ovigerous form); both setae on the baseoendopodal lobe are longer than the length of the baseoendopodal lobe (vs. as long as the baseoendopodal lobe in the ovigerous form); the baseoendopodal lobe has a pore near the outer margin (vs. absent in the ovigerous form).

Etymology.—The epithet of the specific name, *foveolata*, is derived from Latin *foveola*, meaning 'small pit' or 'fovea'. This name refers to the foveate ornamentation on the surface of prosome of the new species.

Discussion

Lang (1948) proposed the division of *Halectinosoma* into the *sarsi*- (where the P3–P4 exp-3 have three outer spines) and *curticone*-groups (where the P4 exp-3 has two outer spines) on the basis of the number of outer spines on the P1–P4 exp-3. However, Lang (1965) subsequently declared that it was impracticable because of the uncertainty of these characteristics. Later, Clément & Moore (2000) proposed the *herdmani*-group in the genus based on the body shape, the setal formula of P1–P4, and the structures of the antennule, antennary exopod, mandibular exopod, and maxillipedal syncoxa. Among these three groups, only the *herdmani*-group is currently acknowledged in the genus, but additional groups could be recognized with further studies as previously observed in the revision for the species related with *H. sarsi* (Boeck, 1873) (present in the *species inquirendae*; see Huys 2009) by Clément & Moore (1995).

Within the genus, *H. foveolata* sp. nov. is close to the species belonging to the *herdmani*-group in the following characteristics: (1) the rostrum is elongate; (2) the body surface is sculptured with longitudinal furrows; (3) the female antennule is composed of six segments; (4) the first exopodal segment of antenna has a row of spinules; (5) the outer distal seta on the mandibular exopod is smaller than the other two setae; (6) the maxillipedal syncoxa has only one seta; (7) the surface seta on the P5 exopod clearly extend beyond its distal margin; (8) the setal formula of P1–P4 coincides with those of species belonging to the *herdmani*-group (Clément & Moore 2000). However, *H. foveolata* differs from the *herdmani*-group by the absence of chitinous patches near the posterior margin of the cephalothorax and the first exopodal segment of antenna has no seta.

Most *Halectinosoma* species not dealt in the revisions by Clément & Moore (1995, 2000, 2007) have more or less incomplete and inaccurate descriptions. This presently causes a problem in the taxonomy of the genus (Clément & Moore 1995, 2000, 2007,

Table 1.—Morphological characteristics of *Halectinosoma* species.

Species	A1 seg.	A1 shape	A2 exp setae	Md gnathobase	Md gnathobase no. of setae	P1 exp/enp
H. curticorne (Boeck, 1873)	6	robust, with spot	1.1.2	typical[a]	2	0.1.122/1.1.221
H. abrau (Krichagin, 1877)	7	robust, with spine	0.1.2	typical	0	0.1.123/1.1.221
H. erythrops (Brady, 1880)	5 (or 6)	elongate	1.1.2	multi dentate	1	0.1.123/1.1.221
H. gothiceps (Giesbrecht, 1881)	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. chrystalli (T. Scott, 1894) (syn. *H. propinquum*)	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. herdmani (T. & A. Scott, 1896) (synonymous with *H. herdelongatum*)	6	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. armiferum (T. & A. Scott, 1896)	5 (or 6)	robust	1.1.2	3 large teeth	2	0.1.123/1.1.221
H. gracile (T. & A. Scott, 1896)	7	elongate	1.1.2	-	-	0.1.122/1.1.221
H. tenuireme (T. & A. Scott, 1896)	7	elongate	1.1.2	-	-	0.1.122/1.1.220
H. longicorne (T. & A. Scott, 1896)	6	elongate	1.1.2	2 large, 2 small teeth	1	0.1.122/1.1.221
H. neglectum (Sars, 1904)	5 or 6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. elongatum (Sars, 1904) (syn. *H. intermedium*)	6	elongate	1.1.2	4 large teeth	1	0.1.123/1.1.221
H. mixtum (Sars, 1904)	6	robust	-	-	-	-.-.123/-
H. brevirostre (Sars, 1904)	6	elongate	-	-	-	-.-.123/-
H. brunneum (Brady, 1905)	6	robust	1.1.2	typical	1	0.1.123/1.1.221
H. proximum (Sars, 1919)	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. angulifrons (Sars, 1919)	6	robust	1.1.2	typical	1	0.1.123/1.1.221
H. tenerum (Sars, 1920)	6	elongate	-	-	-	-.-.123/-
H. clavatum (Sars, 1920)	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. distinctum (Sars, 1920)	6	robust	0.1.2	-	-	0.1.023/1.1.221
H. concinnum (Akatova, 1935)	5	robust, with spot	-	-	-	-
H. littorale (Nicholls, 1939)	7	robust	0.1.2	typical	0	1.2.122/1.1.221
H. oblongum (Kunz, 1949)	6	elongate	1.1.2	typical	2	0.1.212/1.1.221
H. spinicauda (Wells, 1961)	6	robust	1.1.3	-	-	0.1.123/1.1.221
H. arenicola (Rouch, 1962)	6	-	1.1.2	-	-	0.1.123/1.1.221
H. diops (Por, 1964)	5	elongate	-	-	-	0.1.123/1.1.221
H canaliculatum (Por, 1964)	6	robust	1.1.2	typical	1	0.1.123/1.1.221
H. inopinatum (Por, 1964)	6	-	-	-	-	0.1.123/1.1.221
H. similidistinctum Lang, 1965	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. ornatum Lang, 1965	5	robust	1.1.2	typical	2	0.1.123/1.1.221
H. longisetosum Lang, 1965	6	elongate	1.1.2	typical, serrate	1	0.1.123/1.1.221
H. kunzi Lang, 1965	5	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. unicum Lang, 1965	6	elongate	0.1.2	typical	2	0.1.123/1.1.221
H. inhacae Wells, 1967	5	elongate	1.1.3	typical	1	0.1.123/1.1.221

Table 1.—Extended.

P4 exp/enp	P5 endopodal lobe to exp	P5 exp L:W ratio	P5 exp surface seta/spinules	References
1.1.222/1.1.221	1/2	1.5:1	1/4 proximal/present	Scott T. & Scott A. 1896; Sars 1904; Wells 2007
1.1.323/1.1.221	1/3	1.5:1	1/4 proximal/absent	Broutsky 1952; Lang 1948; Wells 2007
1.1.122/1.1.121	1/4	1.4:1	proximal/absent[1]	Scott T. & Scott A., 1896
1.1.322/1.1.221	1/3	1.1:1	1/3 proximal/present	Clément & Moore, 2007
1.1.323/1.1.221	3/5	1.4:1	proximal/present	Clément & Moore, 1995
1.1.323/1.1.221	3/5	0.9:1	1/5 proximal/present	Clément & Moore, 2000
1.1.323/1.1.221	4/5	1.2:1	1/2/absent	Scott T. & Scott A., 1896
1.1.122/1.1.220	4/5	1.9:1	1/2/absent	Scott T. & Scott A., 1896
0.1.222/1.1.220	1/2	1.1:1	proximal/absent	Scott T. & Scott A., 1896
1.1.222/1.1.221	3/4	1.1:1	proximal/absent	Scott T. & Scott A., 1896
1.1.323/1.1.221	3/4	1.6:1	proximal/present	Sars 1904; Scott T. & Scott A. 1896; Lang 1965; Clément & Moore 2000
1.1.323/1.1.221	1/2	1.3:1	1/3 distal/present	Sars, 1904; Clément & Moore 2000
-.-.323/-	3/4	1.4:1	1/3 proximal/absent	Sars 1904; Lang 1965; Wells 2007
-.-.323/-	1/2	1.2:1	distal/absent	Sars 1904; Wells 2007
1.1.323/1.1.221	9/10	1.4:1	proximal/present	Clément & Moore 1995
1.1.323/1.1.221	1/2	1.5:1	proximal/present	Clément & Moore 1995
1.1.323/1.1.221	4/5	1.3:1	proximal/present	Clément & Moore 1995
-.-.323/-	2/3	1.2:1	1/3 proximal/absent	Sars 1920
1.1.323/1.1.221	4/5	1.8:1	1/8 proximal/present	Sars 1920; Clément & Moore 1995
-.-.322/-	2/5	1.5:1	1/8 proximal/absent	Sars 1920; Wells 2007
-.-.–2/-	2/5	1.6:1	1/3 proximal/absent	Akatova 1935; Wells 2007
1.1.323/2.1.221	1/2	1.5:1	absent/present	Nicholls 1939
1.1.222/1.1.221	1/2	1.6:1	1/10 proximal/present	Kunz 1949
1.1.223/1.1.221	2/3	1.8:1	2/5 proximal/present	Wells 1961
1.1.323/1.1.221	1/2	1.0:1	1/7 proximal/present	Rouch 1962
1.1.323/1.1.221	1/2	1.2:1	1/2/ present	Por 1964
1.1.323/1.1.221	1/1	1.5:1	proximal/present	Por 1964; Clément & Moore 1995
1.1.323/1.1.221	1/2	1.6:1	distal/absent	Por 1964
1.1.323/1.1.221	1/2	1.0:1	1/10 proximal/absent	Lang 1965
1.1.323/1.1.221	3/5	1.2:1	1/ 10 proximal/present	Lang 1965
1.1.323/1.1.221	2/3	1.3:1	1/2/present	Lang 1965
1.1.323/1.1.221	3/5	1.3:1	1/3 proximal/absent	Lang 1965
1.1.322/1.1.221	1/2	1.5:1	1/3 distal/present	Lang 1965
1.1.323/1.1.221	1/2	1.4:1	1/10 proximal/absent	Wells 1967

Table 1.—Continued.

Species	A1 seg.	A1 shape	A2 exp setae	Md gnathobase	Md gnathobase no. of setae	P1 exp/enp
H. fusiforme Wells, 1967	6	elongate	-	-	-	0.1.123/1.1.221
H. langi Wells, 1967	5	robust	0.1.2	2 large, 3 small teeth	2	0.1.122/1.1.221
H. fusum Wells, 1967	5	elongate	0.1.2	typical	1	0.1.123/1.1.221
H. smirnovi (Chislenko, 1967)	6	elongate	0.0.2	typcial	1?	
H. abyssicola Bodin, 1968	6	elongate	0.1.2	typical	1	0.1.122/1.1.221
H. gascognense Bodin, 1968	6	robust	1.1.2	-	-	0.1.123/1.1.221
H. dimorphum Coull, 1970	6	elongate	0.1.2	typical	0	0.1.123/1.1.221
H. cooperatum Bodin, Bodiou & Soyer, 1971 (syn. *H. candelabrum*)	5	robust	1.1.2	typical	1	0.1.123/1.1.221
H. paradistinctum Soyer, 1972	6	elongate	0.1.2	typical	1	0.1.123/1.1.221
H. travei Soyer, 1972	6	elongate	1.1.2	typical	2	0.1.123/1.1.221
H. valeriae Soyer, 1972	5	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. monardi Soyer, 1972	5	robust	1.1.2	typical	1	0.1.123/1.1.221
H. rouchi Soyer, 1972	5	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. pterinum Moore, 1974	8	robust, with spot	1.1.2	typical	2	0.1.123/1.1.221
H. winonae Coull, 1975	6	elongate	0.1.2	3 large teeth	1	0.1.123/1.1.221
H. paraspinicauda Bodin, 1979	6	robust	0.1.2	6 teeth, without dorsal seta	0	0.1.123/1.1.221
H. perforatum Itô, 1981	5	robust	1.1.2	typical	1	0.1.123/1.1.221
H. otakoua Wells, Hicks & Coull, 1982	6	robust	0.1.2	typical	1	0.1.123/1.1.221
H. hydrofuge Wells, Hicks & Coull, 1982	5	robust	1.1.2	5 teeth	1	0.1.123/1.1.221
H. pseudosarsi Clément & Moore, 1995	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. chislenki Clément & Moore, 1995	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. argyllensis Clément & Moore, 1995	6	robust	1.1.2	typical	1	0.1.123/1.1.221
H. crenulatum Clément & Moore, 1995	6	robust	1.1.2	typical	1	0.1.123/1.1.221
H. denticulatum Clément & Moore, 1995	6	robust	1.1.2	typical	1	0.1.123/1.1.221
H. bodotriaensis Clément & Moore, 2000	6	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. pilosum Clément & Moore, 2000	6	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. britannicum Clément & Moore, 2000	6	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. itoi Clément & Moore, 2000	6	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. huysi Clément & Moore, 2000	6	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. mandibularis Clément & Moore, 2007	6	robust	1.1.2	typical	1	0.1.123/1.1.221
H. latisetifera Clément & Moore, 2007	6	robust	1.1.2	typcial	2	0.1.123/1.1.221

Table 1.—Continued. Extended.

P4 exp/enp	P5 endopodal lobe to exp	P5 exp L:W ratio	P5 exp surface seta/spinules	References
1.1.323/1.1.221	3/4	1.3:1	proximal/present	Wells 1967
1.1.222/1.1.221	4/7	1.0:1	1/4 proximal/present	Wells 1967
1.1.223/1.1.221	1/2	1.1:1	1/4 proximal/present	Wells 1967
1.1.322/1.1.221	1/2	1.3:1	distal/absent	Chislenko 1967
1.1.222/1.1.221	1/2	1.2:1	1/3 proximal/absent	Bodin 1968
1.1.323/1.1.221	2/3	0.7:1	distal/present	Bodin 1968
1.1.323/1.1.221	4/5[b] (1/3)[c]	0.8:1[b] (1.0:1)[c]	distal/absent	Coull 1970
1.1.323/1.1.221	1/2	1.3:1	proximal/present	Bodin et al. 1971
1.1.323/1.1.221	1/2	1.3:1	1/3 proximal/absent	Soyer 1973
1.1.323/1.1.221	1/1	1.3:1	1/4 proximal/absent	Soyer 1973
1.1.323/1.1.221	3/4	1.0:1	proximal/absent	Soyer 1973
1.1.323/1.1.221	1/2	1.3:1	1/3 proximal/absent	Soyer 1973
1.1.323/1.1.221	3/5	1.2:1	proximal/absent	Soyer 1973
1.1.323/1.1.221	1/2	1.7:1	1/2/present	Moore 1974
1.1.323/1.1.221	1/2	0.9:1	distal/present	Coull 1975
1.1.323/1.1.221	1/2	1.7:1	1/3 proximal/present	Bodin 1979
1.1.323/1.1.221	4/5	1.3:1	proximal/present	Itô 1981
1.1.323/1.1.221	2/3	1.0:1	distal/present	Wells et al. 1982
1.1.223/1.1.221	1/2	1.4:1	1/4 proximal/present	Wells et al. 1982
1.1.323/1.1.221	4/5	1.3:1	proximal/present	Clément & Moore 1995
1.1.323/1.1.221	3/4	1.3:1	proximal/present	Chislenko 1967; Clément & Moore 1995
1.1.323/1.1.221	3/4	1.2:1	proximal/present	Clément & Moore 1995
1.1.323/1.1.221	1/1	1.3:1	proximal/present	Clément & Moore 1995
1.1.323/1.1.221	1/1	1.3:1	proximal/present	Clément & Moore 1995
1.1.323/1.1.221	3/5	0.9:1	proximal/present	Clément & Moore 2000
1.1.323/1.1.221	3/5	1.0:1	proximal/present	Clément & Moore 2000
1.1.323/1.1.221	3/4	0.9:1	1/3 proximal/present	Clément & Moore 2000
1.1.323/1.1.221	3/4	1.0:1	proximal/present	Clément & Moore 2000
1.1.323/1.1.221	3/5	1.1:1	proximal/present	Clément & Moore 2000
1.1.323/1.1.221	9/10	1.6:1	proximal/present	Clément & Moore 2007
1.1.323/1.1.221	1/2	0.9:1	1/4 proximal/present	Clément & Moore 2007

Table 1.—Continued.

Species	A1 seg.	A1 shape	A2 exp setae	Md gnathobase	Md gnathobase no. of setae	P1 exp/enp
H. paragothiceps Clément & Moore, 2007	6	robust	1.1.2	typical	2	0.1.123/1.1.221
H. kliei Clément & Moore, 2007	6	elongate	1.1.2	typical	1	0.1.123/1.1.221
H. islandicum Apostolov, 2007	5	robust	1.1.2	typical	0	0.1.122/1.1.221
H. arangureni Suárez-Morales & Fuentes-Reinés, 2015	6	robust	1.1.2	5 teeth	1	0.1.122/1.1.221
H. foveolata sp. nov.	6	elongate	0.1.2	5 teeth, without dorsal seta	0	0.1.123/1.1.221

[a] The typical structure of mandibular gnathobase is composed of uni- or bi-dentate *pars incisiva* and a multidentate *lacinia*.
[b] The ovigerous form of P5.
[c] The non-ovigerous form of P5.
[d] The P5 of ovigerous females collected from Myeongsasipri beach, Wando-gun.
[e] The P5 of non-ovigerous females collected from Baekbawi beach, Yeonggwang-gun.

Kihara & Huys 2009, Suárez-Morales & Fuentes-Reinés 2015). Nevertheless, we believe that previous descriptions for antenna, antennary exopod, mandibular gnathobase, setal formula of P1–P4, and female P5 were relatively exact because of their simple structures. The morphological features of these characters in 70 nominal *Halectinosoma* species (Soyer 1972, Huys & Bodin 1997, Clément & Moore 2000, Karanovic & Pesce 2001, Wells 2007, Huys 2009, Boxshall et al. 2010, Suárez-Morales & Fuentes-Reinés 2015) are provided in Table 1.

In most *Halectinosoma* species, the armature formula of the antennary exopod is a typical "1.1.2", but the seta on the first segment is known to be absent in several species as well as *H. foveolata* (see Table 1). However, this new species differs from other species by the presence of a row of spinules on the first exopodal segment of antenna. As far as we know, the combination of the absence of seta and the presence of a row of spinules on the proximal segment is first recognizved in *H. foveolata*. However, we assume that the latter characteristic was possibly unnoticed or overlooked by previous authors before Clément & Moore (1995, 2000, 2007).

In ectinosomatid copepods, the mandibular gnathobase is armed with a dorsal seta, a character considered to be present in the ground pattern, which is considered an autapomorphy of the family (Seifried 2003, Seifried et al. 2007). *Halectinosoma* species typically possess one or two dorsal setae on the gnathobase and its cutting edge is composed of a unidentate *pars incisiva* and a multidentate *lacinia*. However, this structure of *H. foveolata* is composed of five chitinous teeth without dorsal seta. This type of mandibular gnathobase is a unique characteristic of the new species among *Halectinosoma* species except for *H. paraspinicauda* Bodin, 1979 (see Bodin 1979, fig. 3Md) and *H. arenicola sensu* Itô, 1973 (see Itô 1973, fig. 6-3). The new species represents another remarkable characteristic in having three protrusions on the mandibular gnathobase dorsally, which has not yet been reported in *Halectinosoma* species.

Table 1.—Continued. Extended.

P4 exp/enp	P5 endopodal lobe to exp	P5 exp L:W ratio	P5 exp surface seta/spinules	References
1.1.322/1.1.221	1/3	1.2:1	1/3 proximal/present	Clément & Moore 2007
1.1.323/1.1.221	1/1	1.5:1	proximal/ present	Clément & Moore 2007
1.1.222/1.1.221	3/5	1.4:1	1/7 proximal/present	Apostolov 2007
1.1.222/1.1.221	1/2	1.0:1	1/5 proximal/present	Suárez-Morales & Fuentes-Reinés 2015
1.1.323/1.1.221	1/3[d] (2/5)[e]	1.2:1[d] (1.0:1)[e]	distal/absent[d] (1/2/ present)[e]	Present study

The structure of female P5 has been considered as a useful diagnostic character to distinguish *Halectinosoma* species (Lang 1965, Clément & Moore 1995, 2000, Wells 2007). The general shape of the female P5 for *H. foveolata* is similar to those of *H. arenicola* (Rouch 1962), *H. dimorphum* Coull, 1970 (in the ovigerous female), *H. pterinum* Moore, 1974, *H. britannicum* Clément & Moore, 2000, and *H. itoi* Clément & Moore, 2000 (Rouch 1962, Coull 1970, Moore 1974, Clément & Moore 2000). However, *H. foveolata* clearly differs from these five species by the position of the surface seta inserted near the distal margin on the exopod, the presence of spinular rows on the baseoendopod, and the incomplete boundary between the baseoendopod and the exopod. Especially, *H. foveolata* shows variability in detailed features of the distal setae on the baseoendopodal lobe, the row of spinules on the exopod, and the tube pore on the outer peduncle. This kind of variability has been reported only from *H. dimorphum*, which represents a difference in the female P5 between ovigerous and non-ovigerous individuals (Coull 1970).

Taking into account the characteristic features mentioned above with those provided in Table 1, *H. foveolata* mostly resembles *H. dimorphum* described from Barbados in sharing the 6-segmented and elongate antennule, the first exopodal segment of antenna without seta, the position of surface seta (inserted distally) on the female P5 exopod, and the setal formula of P1–P4. However, the new species shows clear differences from *H. dimorphum* by the following characteristics: (1) the third segment of antennule is longest (vs. the fourth segment is longest in *H. dimorphum*); (2) the first segment exopod of antenna has a row of spinules (vs. with only one seta in *H. dimorphum*); (3) the cutting edge of mandibular gnathobase is composed of chitinous teeth (vs. a typical cutting edge comprising *pars incisiva* and *lacinia* in *H. dimorphum*); (4) the female P5 has an incomplete boundary (separated in the posterior part only) between the exopod and baseoendopod (vs. completely separated in *H. dimorphum*); (5) the female P5 baseoendopod has two rows of spinules (vs. absent in *H. dimorphum*). Furthermore, the new species shows distinct features not known from *Halectinosoma* species such as the foveate ornamentation on the body surface of the prosome (see Figs. 2A, B, 8B, C) and the presence of three protrusions on the mandibular gnathobase (see Fig. 4A).

Among *Halectinosoma* species, *H. arenicola* have been reported only from Brazilian and Japanese coasts (Rouch 1962, Itô 1973). However, Clément & Moore (2000) suggested that *H. arenicola sensu* Itô (1973) from Japan might not be

conspecific with Brazilian species of the original description on the basis of the discrepancy in the first exopodal segment of antenna. They realized that the morphological characteristics of the body surface and cephalosomic appendages are important characters to distinguish *Halectinosoma* species through the series of their revisions (Clément & Moore 1995, 2000, 2007). In this respect, *H. arenicola* was poorly and incompletely described in the original description by Rouch (1962). This author did not describe the habitus, antennary endopod, mandible, and maxillule of this species. Additionally, the structures of other appendages were also described and figured with some errors in the original description of the species. Itô (1973) subsequently reported *H. arenicola* from Japanese coast although he was aware that the Japanese specimens differ from Brazilian species in the structures of the maxillule and maxilliped, which were not considered to be key characteristics at that time. In modern view of *Halectinosoma* taxonomy, *H. arenicola sensu* Itô (1973) clearly differs from *H. arenicola* in the following features: (1) the female P5 baseoendopod has spinules, but it is naked in *H. arenicola*; (2) the female P5 exopod is fused to the baseoendopod anteriorly, but they are discrete in *H. arenicola*; (3) the surface seta on the female P5 exopod is inserted near the distal margin, while it is located near the proximal margin of the exopod in *H. arenicola*; (4) the first exopodal segment of antenna has only a spinular row without seta, while it has a delicate seta without spinules in *H. arenicola*; (5) the third exopodal segment of antenna is at least three times of second one in length, but it is about twice in *H. arenicola*.

Halectinosoma foveolata is very similar to *H. arenicola sensu* Itô (1973) reported from Japanese beach, but several minor differences exist between them in the structures of maxillule, maxilla, and body surface. To clarify whether this Korean species is conspecific with *H. arenicola sensu* Itô (1973), we tried to obtain Itô's (1973) materials. However, Itô's materials of *H. arenicola* does not exist any longer. So, we collected Japanese materials of *H. arenicola sensu* Itô (1973) from the beach on Siki, Amakusa in Japan, the sampling station of Itô (1973), and compared them with the Korean specimens of *H. foveolata*. The result revealed that *H. foveolata* and Japanese specimens of *H. arenicola sensu* Itô (1973) are similar in almost aspects including the characteristic features of body surface and cephalosomatic appendages.

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