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A new species of the genus *Eurycletodes* Sars G.O., 1909 (Copepoda: Harpacticoida: Argestidae) from South Sea of Korea

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The genus *Eurycletodes* Sars, 1909 is reported for the first time in Korea. A new species of the genus *Eurycletodes* was collected from Hansando Island, South Sea of Korea. So far, *Eurycletodes* comprises 27 species, with no previously recorded species reported in East Asia, including Korea. *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. is morphologically most closely related to *E.* (*O.*) *denticulatus* Por, 1967, *E.* (*O.*) *aculeatus* Sars, 1920, and *E.* (*O.*) *diva* Menzel, 2011, but clearly distinguishable from the others based on the following morphological characteristics: absence of A2 exopodal seta, A1 last segment with two inner setae, P4 exp-3 proximal inner seta modified, the ratio of length and of caudal rami (1.6 times), and mandibular palp with three setae. Together with the new species, the number of valid species in this genus has risen to 28. A key to species of the genus *Eurycletodes* is provided.

Keywords: benthic Harpacticoida, East Asia, Meiofauna, taxonomy

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Introduction

The family Argestidae Por, 1986 is one of the most abundant group of deep-sea Harpacticoida (Hicks and Coull, 1983; George, 2004). Among them, *Eurycletodes* Sars, 1909 is one of the most dominant taxa, accounting for more than 25% of deep-sea benthic Argestidae samples (Menzel, 2011). The genus *Eurycletodes* is the second dominant genus in the family Argestidae after *Mesocletodes* Sars G.O., 1909, and is composed of 27 species, but so far, no species have been reported in South Korea.

Not long ago, the biodiversity of the harpacticoid copepods in Korean waters was reported to be relatively low compared to other regions, such as the United States, Europe, Caribbean Sea, and Japan (Song *et al.*, 2012). This is because the history of biodiversity research in Korea is relatively short, so there are not many studies (NIBR, 2019). However, the list of biodiversity along the coast of Korea is expected to grow very fast as many new and unrecorded species are discovered each year through various taxonomic studies, including the "Project of Discovery of Korean Indigenous Species" started in 2006. Until now, a total of 270 harpacticoid species have been recorded in Korea belonging to 127 genera and 33 families.

As part of an ongoing taxonomic study of harpacticoid copepods along Korean coasts, harpacticoid copepods have been collected. In the present paper, the author describes *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. from sediments of South Sea of Korea, based on female morphology, and provides an updated key to species of *Eurycletodes*.

Materials and Methods

Samples were collected from Hansando Island in South Sea of Korea in May 2019 (Fig. 1). Sediments were sampled with a gravity corer, were fixed with 70% ethanol, and then stained with Rose Bengal. Meiofauna was extracted from sediments by Ludox isopycnic centrifugation (Burgess, 2001). Harpacticoids were sorted and enumerated under a Leica S APO dissecting microscope and stored in 70% ethanol. Specimens were dissected in lactic acid, and the dissected parts were mounted on slides in lactophenol mounting medium. Preparations were sealed with transparent nail varnish. All drawings have been prepared using a camera lucida on an optical microscope (Leica DM 4000B), and captured using a digital camera (Leica DFC420). Specimens were deposited at the National Institute of Biological Resources (NIBR) of Korea.

Morphological terminology is adopted from Huys *et*

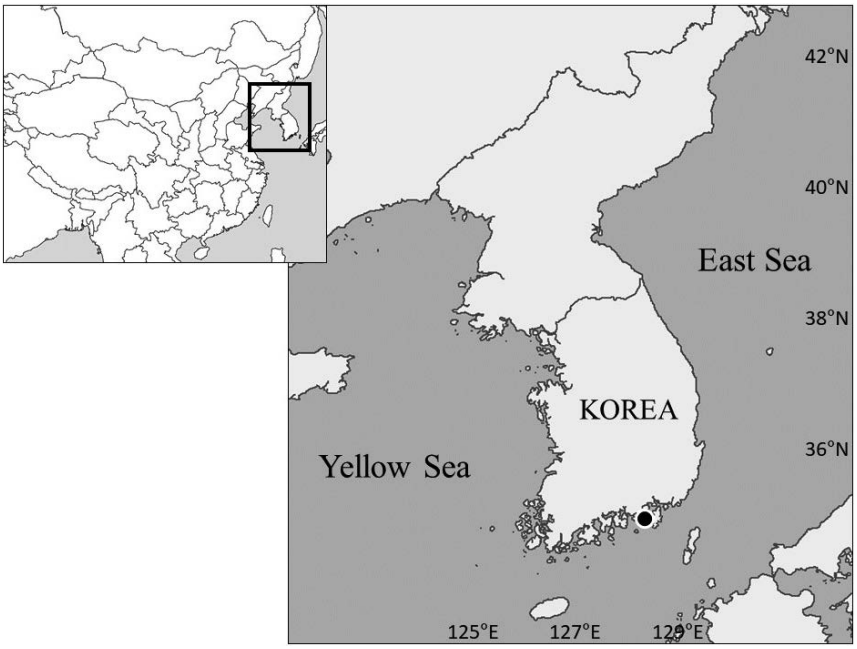

Fig. 1. Location of sampling sites in Korea. Type locality indicated by dot (Hansando Island, Korea).

al. (1996). Abbreviations used in the text are: A1, antennule; A2, antenna; ae, aesthetasc; exp, exopod; enp, endopod; P1–P6, first to sixth thoracopod; exp (enp)-1 (2, 3) to denote the proximal (middle, distal) segment of a ramus. Scale bars in figures are indicated in μm.

Systematics

Order Harpacticoida Sars, 1903
Family Argestidae Por, 1986
Genus *Eurycletodes* Sars G.O., 1909
Subgenus *Eurycletodes* (*Oligocletodes*) Lang, 1944

***Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. (Figs. 2–5)**

Type locality. Hansando Island, 12 m water depth, South Sea of Korea. (34°46′33.2″N, 128°31′35.0″E).

Material examined. Holotype 1♀ (KDELIV0000003114) dissected on eight slides. Paratype 2♀♀ (KDELIV0000003115, KDELIV0000003116) dissected on eight slides. All from the type locality, collected by H.W. Bang and H. Moon in May 2019.

Etymology. The species name is derived from the Latin '*vadum*', meaning shallow water, referring to the depth of water of the type locality.

Description. Female. Body (Fig. 2A, 2B) cylindrical, no clear distinction between prosome and urosome. Total body length 619 μm (n = 3; range: 585–645 μm), measured from anterior margin of rostrum to posterior margin of caudal rami. Largest width measured at posterior margin of cephalic shield: 172 μm.

Rostrum (Figs. 2A, 2B, 3A) triangular, well-developed, fused to cephalothorax, with two sensilla. Cephalothorax (Fig. 2A) with reticulate pattern, pedigerous somites with posterior margin strongly serrated dorsally and laterally. Cephalothorax and free thoracic somites with sensilla arising from tubercles, sensillar pattern and tube pores on cephalothorax and body somites as figured.

Urosome (Fig. 2A, 2B) 5-segmented, comprising P5-bearing somite, genital double-somite and three free abdominal somites. All urosomites with coarsely denticulated posterior margin dorsally and laterally, covered with minute spinules dorsally, laterally and ventrally. Second and third urosomites partly fused forming genital-double somite. Genital field (Fig. 5C) positioned situated proximally on first half of genital double-somite, with a copulatory pore, and P6 reduced, represented by bifid processes (arrowed in Fig. 5C). Anal somite (Figs. 2A, 3H) as long as board, almost square laterally and dorsally, with tube pores ventrally, anal operculum with several denticles and dorsal pair of sensillate tubercles.

Caudal rami (Fig. 3I) semi cylindrical, about 1.6 times as long as wide, with conspicuous tube pore ventrally (arrow in Figs. 2A, 3I), each ramus with seven setae: setae I–II bare, short, of subequal lengths, seta III arising from small protrusion, seta IV bare, seta V longest, seta VI bare and short, arising at inner distal corner, seta VII

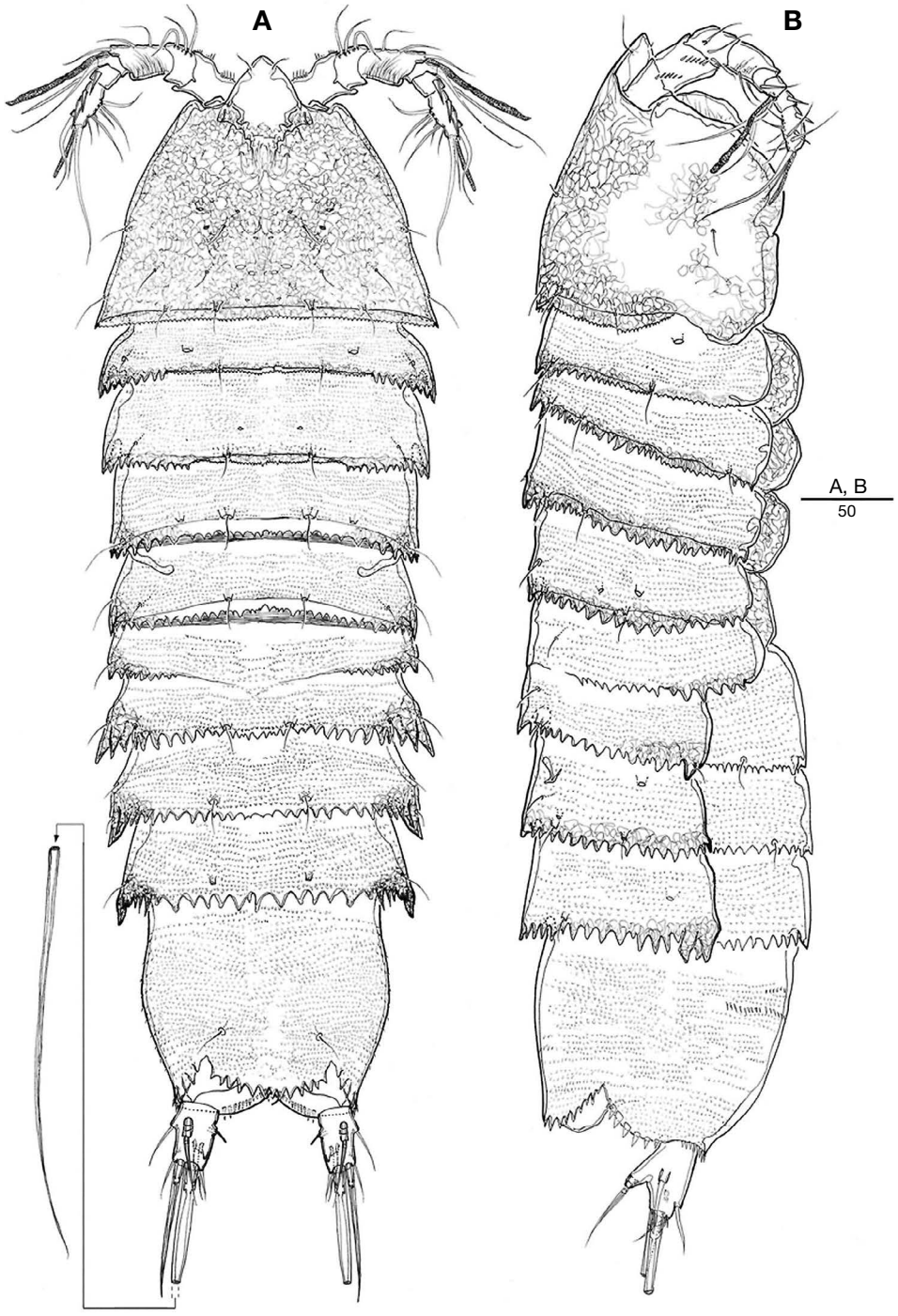

Fig. 2. *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. holotype female. A. habitus, dorsal; B. habitus, lateral.

tri-articulate at base.

Antennule (Fig. 3B). 6-segmented; segment 1 largest, with spinular rows, segment 3 with aesthetasc fused basally to seta and set on pedestal, segment 4 with modified element, last segment with six setae, two modified elements, one geniculate seta, and apical acrothek. Armature formula: 1-[0], 2-[3], 3-[3 + (1 + ae)], 4-[1], 5-[1], 6-[9 + acrothek]. Apical acrothek consisting of an aesthetasc fused basally to one bare and one geniculate seta.

Antenna (Fig. 3C). Allobasis, without abexopodal seta. Exopod reduced to an almost indiscernible bulb without

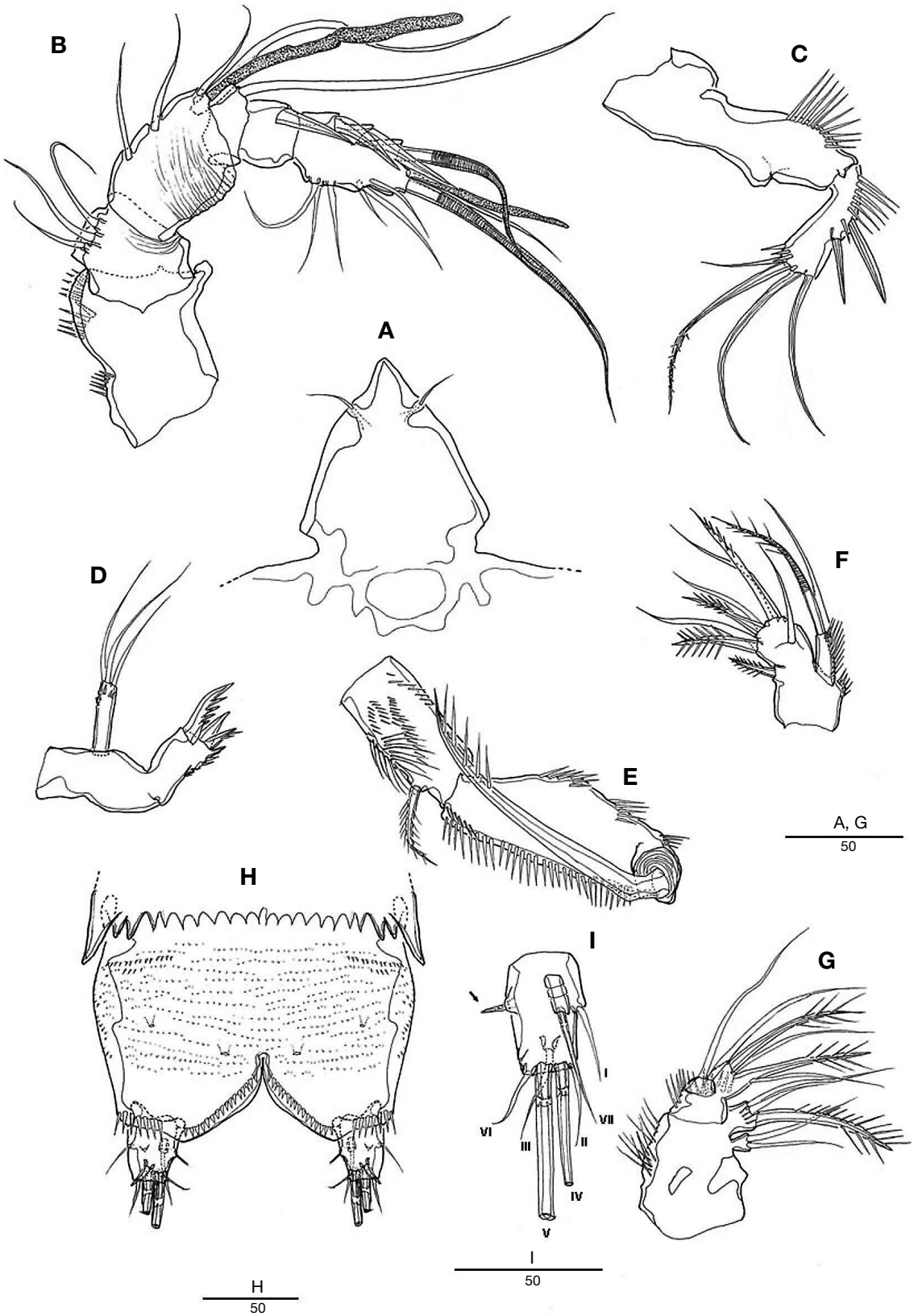

Fig. 3. *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. holotype female. A. rostrum; B. antennule (arrow indicating modified elements); C. antenna (arrow indicating reduced exopod); D. mandible; E. maxilliped; F. maxillule; G. maxilla; H. anal somite and caudal rami, ventral; I. caudal ramus, dorsal (arrow indicating tube pore).

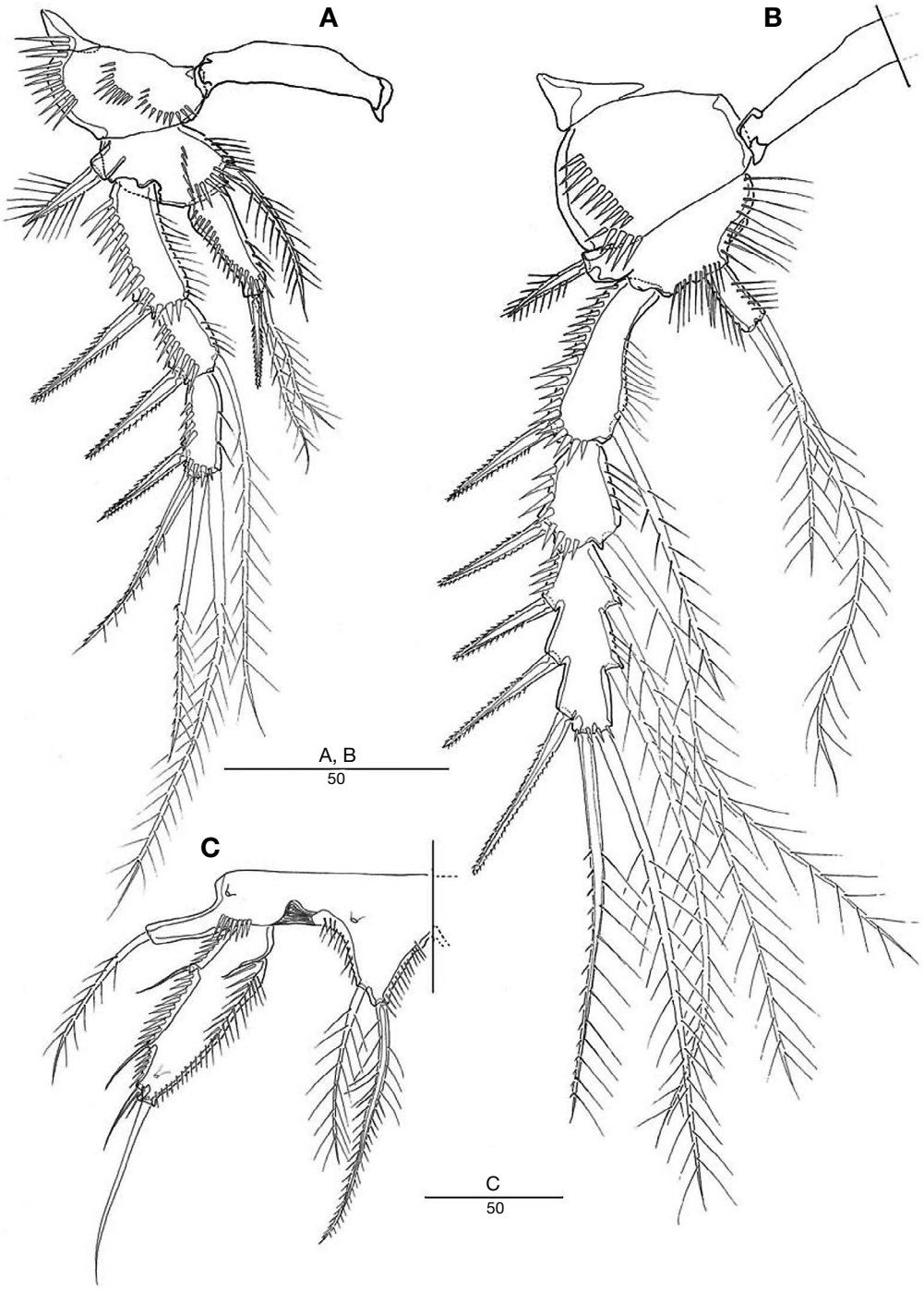

Fig. 4. *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. holotype female. A. P1, anterior; B. P2, anterior; C. P5, anterior (arrow indicating anterior surface cleavage).

armature (arrowed in Fig. 3C). Allobasis and endopod with spinular row along inner margin, endopod with two bare inner spines, and four distal elements distally.

Mandible (Fig. 3D) with gnathobase bearing three strong teeth around distal margin, without seta. Mandibular palp 1-segmented, with spinules subdistally, with three bare setae distally.

Maxillule (Fig. 3F). Praecoxal arthrite well-developed, with two bipinate, one unipinnate, and three bare spines distally, with bipinnate spine laterally, and with one bare

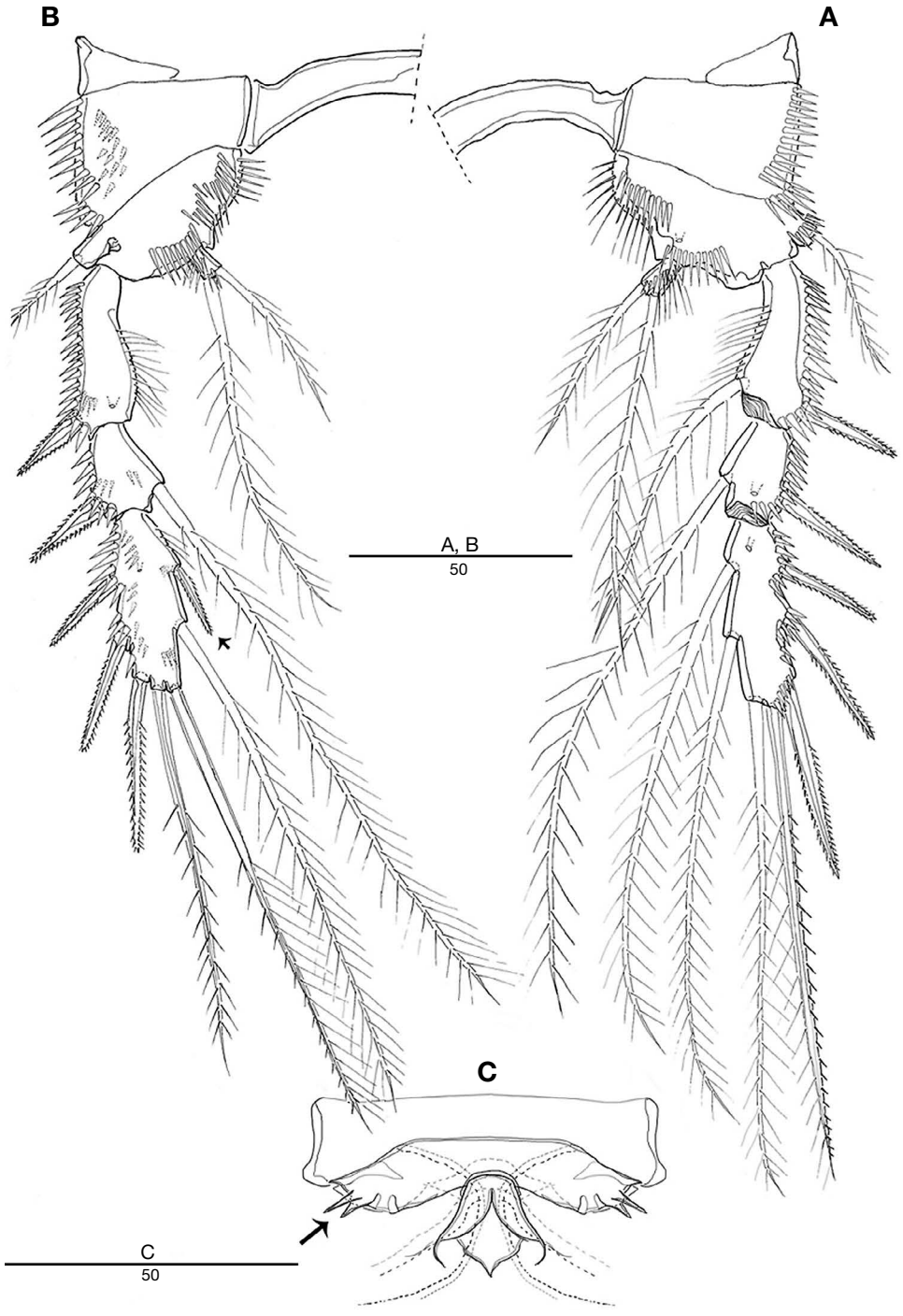

Fig. 5. *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. holotype female. A. P3, anterior; B. P4, anterior (arrow indicating short proximal inner seta); C. genital field, ventral (arrow indicating P6).

surface seta. Coxa with one geniculate seta and one bare seta apically. Basis, endopod and exopod reduced.

Maxilla (Fig. 3G). Syncoxa with two endites and a row of long spinules along outer margin, proximal endite with two bare setae, distal endite with two slender setae and one strong spinulose element. Allobasis with spinules, drawn out into strong, slightly curved, distally bipinnate claw, with two bare setae. Endopod 1-segmented, small, with two naked setae.

Maxilliped (Fig. 3E). Subchelate. Syncoxa with one plumose seta on inner distal corner and with long setules or spinules. Basis with a row of spinules along palmar

region, unarmed. Endopodal segment produced into strong and distally pinnate curved claw.

Swimming legs 1−4 with wide intercoxal sclerite and praecoxae, biramous, endopods 1-segmented, exopods 3-segmented. Coxae and bases with surface ornamentations of spinules as figured.

P1 (Fig. 4A). Coxa slightly bigger than basis, with two spinular rows on anterior surface, and row of spinules along outer margin. Basis with strong bipinnate outer spine on outer margin and bipinnate spine on inner distal surface, with several spinules and setules as figured. Exopod 3-segmented, exp-1 longest, without inner seta; exp-2 with one stout, pinnate outer spine and one long, plumose inner seta; exp-3 with two pinnate distal setae and two well-developed pinnate outer spines. Endopod 1-segmented, with two distal setae and one pinnate outer spine.

P2−P4 (Figs. 4B, 5A, 5B) with small triangular praecoxa. Coxa large, with row of spinules on anterior surface. Basis with pinnate outer spine. Exp-1 twice as long as exp-2, with one pinnate outer spine, and one long plumose inner seta, except P4; exp-2 shortest, with one inner plumose long seta, and one bipinnate outer spine; third segment longest, with three bipinnate outer spines, two apical and two inner elements, P4 exp-3 proximal inner element bipinnate, short (arrowed in Fig. 5B). Endopod 1-segmented, with spinules along inner to outer distal margins, with two pinnate distal setae.

Armature formula for swimming legs:

	Exopod	Endopod
P1	0.1.022	021
P2	1.1.223	020
P3	1.1.223	020
P4	0.1.223	020

P5 (Fig. 4C) fused medially, and exopod and baseoendopod separate. Baseoendopod with a long outer setophore bearing one plumose basal seta, and with one pore near proximal area of setophore. Endopodal lobe with spinules at inner and outer margin, with two bipinnate setae and one pore on anterior surface. Exopod elongated, 3.4 times as long as wide, with one pore on anterior surface near apical margin, with three outer and two terminal setae, and with one oblique cleavage ornamented on anterior surface near proximal area (arrowed in Fig. 4C).

Male. Unknown.

Discussion

Lang (1944) proposed the subdivision of the genus *Eurycletodes* Sars, 1909 into the subgenera, *E.* (*Eurycletodes*) Sars G.O., 1909 and *E.* (*Oligocletodes*) Lang, 1944 based on the presence of P1 exp-2 inner seta, and the setae number of P5 endopodal lobe. As a result, most species belonging to *Eurycletodes* were organized, but some taxonomic ambiguity of Argestidae remains a problem.

To rectify the uncertainty, Menzel (2011) discussed the genus belonging to Argestidae using some taxonomic features, and organized the characteristics of the genus *Eurycletodes* using the following characteristics: antennule segmentation, the loss of the mandibular basal seta, and reduced exopod. To summarize the results, the key character in *Eurycletodes* (*Oligocletodes*) is the absence of the inner seta of P5 endopodal lobes, and in *E.* (*Eurycletodes*) the loss of inner seta on P1 exp-2 is an important feature, and which can be used to the taxonomic key to subgenera.

Eurycletodes is distributed worldwide at the genus level (Menzel, 2011; Gómez, 2018), but in fact, all species have been reported around the Atlantic, Mediterranean, and waters near Europe, and has not been reported in Asia, including Korea (George, 2004).

As the other genus in family Argestidae, *Eurycletodes* was found mainly in the deep sea, for example, *E.* (*Oligocletodes*) *diva* Menzel, 2011 was found at a depth of 5,035 meters, and *E.* (*O.*) *peruanus* Becker, Noodt & Schriever, 1979 at a depth of 6,300 meters. However, the new species was found in shallow waters of 12 meters deep, the shallowest depth where the genus *Eurycletodes* has ever been found. George (2004) provided a list of all species in Argestidae, including geographical information such as water depth.

Eurycletodes (*Oligocletodes*) *vadumus* sp. nov. is placed in the genus *Eurycletodes* based on the diagnostic characters defined by Por (1986), George (2004), and Menzel (2011): fusion of the third and fourth segment of A1, reduction of mandibular palp exopod and basal seta.

According to the arrangement of Menzel (2011), the new species clearly belongs to the subgenus *Eurycletodes* (*Oligocletodes*) given the loss of inner seta of P5 endopodal lobe. *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. is closely related to *E.* (*O.*) *denticulatus* Por, 1967, *E.* (*O.*) *aculeatus* Sars, 1920, and *E.* (*O.*) *diva* Menzel, 2011 based on combination of four characters: (1) P1−P4 endopod unisegmented, (2) P1 exp-3 with 4 setae, (3) P1−P4 with 3, 2, 2, 2 setal elements on endopod, and 4) P2−P3 exp-1 with inner seta.

However, *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov. can be differentiated from the congeners by following characteristics: (1) absence of A2 exopodal seta, while *E.* (*O.*) *aculeatus* has an A2 exopodal seta, (2) A1 last segment with two anterior elements (arrowed in Fig. 3B), but *E.* (*O.*) *denticulatus* has one inner seta on the last segment of A1, (3) P4 exp-3 proximal inner seta is short, whereas *E.* (*O.*) *aculeatus* has a long inner seta, (4) about 1.6 times as long as greatest width of caudal rami

(1.5 times in *E.* (*O.*) *denticulatus*, 1.8 times in *E.* (*O.*) *aculeatus*, and 3.0 times in *E.* (*O.*) *diva*), (5) mandibular palp with three setae, whereas *E.* (*O.*) *denticulatus* has four setae.

Together with *Eurycletodes* (*Oligocletodes*) *vadumus* sp. nov., the number of valid species in this genus has risen to 28. A key to species of the genus *Eurycletodes* is provided. It is amended from Wells (2007).

Key to the species of the genus *Eurycletodes*

1. P1 exp-2 with inner seta, and P5 endopodal lobes with inner element ····· 2
– P1 exp-2 without inner seta, and P5 endopodal lobes with inner seta ····· subgenus *Eurycletodes* (*Eurycletodes*) ····· 3
– P5 endopodal lobes without inner element ····· subgenus *E.* (*Oligocletodes*) ····· 6
2. Maxillule exopod and endopod each represented by one seta; maxilliped with one seta on syncoxa ····· *E. ephippiger**
– Maxillule endopod reduced, and exopod represented by one seta; maxilliped with two setae on syncoxa ··· *E. paraephippiger**
3. P1 exp-3 with four elements ····· 4
– P1 exp-3 with five elements ····· 5
4. Mandibular palp 2-segmented ····· *E.* (*E.*) *serratus*
– Mandibular palp 1-segmented ····· *E.* (*E.*) *laticaudata*
5. Anal operculum with denticles ····· *E.* (*E.*) *gorbunovi*
– *Anal operculum* with *smooth* distal margin ····· *E.* (*E.*) *rectangulatus*
6. P1 endopod 2-segmented ····· 7
– P1 endopod 1-segmented ····· 15
7. P1 endopod distal segment with four elements ····· 8
– P1 endopod distal segment with three elements ···· 10
8. P4 endopod-2 with four setae ····· 9
– P4 endopod-2 with five setae ····· *E.* (*O.*) *peruanus*
9. P5 exopod ovate about twice as long as wide, with five setae ····· *E.* (*O.*) *pori*
– P5 exopod rectangular and elongated, with three setae ····· *E.* (*O.*) *profundus*
10. P1 exp-3 with five setae, and P4 endopod 2-segmented ····· 11
– P1 exp-3 with five setae, and P4 endopod 1-segmented ····· *E.* (*O.*) *arcticus*
– P1 exp-3 with four setae, and P4 endopod 2-segmented ····· *E.* (*O.*) *latus*
11. P2 exp-1 with inner seta, and exp-3 with seven setae; P3 enp-3 with four or five setae ····· 12
– P2 exp-1 with inner seta, and exp-3 with six setae; P3 enp-3 with three setae ····· *E.* (*O.*) *verisimilis*
– P2 exp-1 without inner seta, and exp-3 with six setae; P3 enp-3 with 3 setae ····· *E.* (*O.*) *irelandica*
12. P2–P4 exp-1 with inner seta ····· 13
– P2–P4 exp-1 with 1, 1, 0 inner seta, respectively ·· 14
– P3–P4 exp-1 without inner seta ····· *E.* (*O.*) *quadrispinosa*
13. P2 and P3 enp-2 with five elements ····· *E.* (*O.*) *echinatus*
– P2 and P3 enp-2 with three and four elements ····· *E.* (*O.*) *parasimilis*
14. P2 endopod distal segment with three elements ····· *E.* (*O.*) *petiti*
– P2 and P3 endopod distal segment with four elements ····· *E.* (*O.*) *similis*
– P3 endopod distal segment with five elements ····· *E.* (*O.*) *monardi*
15. P4 endopod 1-segmented ····· 16
– P4 endopod absent ····· *E.* (*O.*) *minutus*
16. P1 exp-3 with five elements ····· 17
– P1 exp-3 with four elements ····· 19
17. P2 exp-3 with seven elements ····· 18
– P2 exp-3 with six elements ····· *E.* (*O.*) *hoplurus*
18. P3 exp-2 without inner seta, and P1–P4 endopod with 4, 4, 2, 2 setae ····· *E.* (*O.*) *oblongus*
– P3 and P4 exp-2 with inner seta; P1–P4 endopod with 4, 3, 1, 2 setae ····· *E.* (*O.*) *abyssi*
– P1–P4 endopod with 3, 2, 4, 2 setae, respectively ····· *E.* (*O.*) *uniarticulatus*
19. P2–P4 exopod with seven setae; P1 and P2 endopod with three and two setae ····· 20
– P2–P4 exopod with 6, 6, 5 setae, respectively, and P1–P2 endopod with four setae ····· *E.* (*O.*) *major*
20. P5 exopod with four setae, and P1 endopod reaches only to end of exp-1 ····· 21
– P5 exopod with five setae ····· 22
21. A2 exopodal seta absent; caudal rami more than 3 times as long as wide ····· *E.* (*O.*) *diva*
– A2 with exopodal seta; caudal rami not much longer than their width ····· *E.* (*O.*) *aculeatus*
22. A1 last segment with two inner setae; mandibular palp with three setae ····· *E.* (*O.*) *vadumus* sp. nov.
– A1 last segment with one inner seta; mandibular palp with four setae ····· *E.* (*O.*) *denticulatus*

**E. paraephippiger* and *E. ephippiger*, they do not show any apomorphy of either of the 2 subgenera (Gomez, 2018).

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References

Becker, K.H., W. Noodt and G. Schriever. 1979. Eidonomie und Taxonomie abyssaler Harpacticoidea (Crustacea, Copepoda) Teil 2. Paramesochridae, Cylindropsyllidae und Cletodidae. Meteor Forschungsergebnisse, Reihe D - Biologie 31:1-37.

Burgess, R. 2001. An improved protocol for separating meiofauna from sediments using colloidal silica sols. Marine Ecology Progress Series 214:161-165.

George, K.H. 2004. Description of two new species of *Bodinia*, a new genus *incertae sedis* in Argestidae Por, 1986 (Copepoda, Harpacticoida), with reflections on argestid colonization of the Great Meteor Seamount plateau. Organisms Diversity and Evolution 4:241-264.

Gómez, S. 2018. New species of *Eurycletodes* Sars, 1909 and *Odiliacletodes* Soyer, 1964 from the deep Gulf of California (Copepoda, Harpacticoida, Argestidae). ZooKeys 764:1-25.

Hicks, G.R.F. and B.C. Coull. 1983. The ecology of marine meiobenthic harpacticoid copepods. Oceanography and Marine Biology Annual Review 21:67-175.

Huys, R., J.M. Gee, C.G. Moore and R. Hamond. 1996. Marine and Brackish Water Harpacticoid copepods. Part 1. In Synopses of the British Fauna (New Series). Field Studies Council: Shrewsbury, UK.

Lang, K. 1944. Monographie der Harpacticiden (Vorläufige Mitteilung). Almqvist & Wiksells Boktryckeri Ab, Uppsala.

Menzel, L. and K.H. George. 2012. Copepodid and adult Argestidae Por, 1986 (Copepoda: Harpacticoida) in the southeastern Atlantic deep sea: diversity and community structure at the species level. Marine Biology 159:1223-1238.

National Institute of Biological Resources. 2019. Discovery of Korean Indigenous Species (Invertebrates). NIBR, Korea (in Korean).

Por, F.D. 1967. Level bottom Harpacticoida (Crustacea, Copepoda) from Elat (Red Sea), Part I. Israel Journal of Zoology 16:101-165.

Por, F.D. 1986. A re-evaluation of the family Cletodidae Sars, Lang (Copepoda, Harpacticoida). Syllogeus 58:420-425.

Sars, G.O. 1909. Copepoda Harpacticoida. Parts XXV & XXVI Laophontidae (concluded), Cletodidae (part). An account of the Crustacea of Norway with short descriptions and figures of all the species. 5:277-304.

Sars, G.O. 1920. Copepoda Supplement. Parts III & IV. Harpacticoida (continued). An account of the Crustacea of Norway, with short descriptions and figures of all the species 7:25-52 + pls. 17-32.

Song, S.J., J. Park, B.O. Kwon, J. Ryu and J.S. Khim. 2012. Ecological checklist of the marine and brackish-water harpacticoid copepod fauna in Korean waters. Zoological Studies 51(8):1397-1410.

Wells, J.B.J. 2007. An annotated checklist and keys to the species of Copepoda Harpacticoida (Crustacea). Zootaxa 1568(1):1-872.

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