

***Parartotrogus minutus* n. sp. (Copepoda, Siphonostomatoida, Cancerillidae) Parasitic on the Brittle Star *Ophiuroglypha kinbergi* (Echinodermata) from the Yellow Sea Coast of Korea**

Il-Hoi Kim^{1,*}

¹Korea Institute of Coastal Ecology, Bucheon 14449, Korea

ABSTRACT

Parartotrogus minutus n. sp. is described as a parasite of the brittle star *Ophiuroglypha kinbergi* (Ljungman) from the intertidal zone on the Yellow Sea coast of Korea. The new species is characterized by a combination of morphological features that the body is small, less than 0.5 mm long, the caudal ramus is 1.73 times longer than wide, leg 3 bears three-segmented rami, and the exopod of leg 5 is armed with two setae. The new species is the third known species in the genus, following *P. richardi* Scott T. and Scott, A., 1893 known from European waters and *P. arcticus* Scott T., 1901 known from both North Atlantic and North Pacific.

Keywords: copepod parasite, new species, intertidal, taxonomy

INTRODUCTION

Parartotrogus Scott T. and Scott A., 1893 is the primitive genus among six genera within the family Cancerillidae (Boxshall and Halsey, 2004). The genus currently consists of two known species. *Parartotrogus richardi* Scott T. and Scott A., 1893, the type species of the genus, was discovered among dredged material from Scottish waters (Scott and Scott, 1893). Scott and Scott (1901) recorded *Parartotrogus richardi* var. *arcticus* from the depth of 100 fathoms in the Arctic Sea, which was erected to the species rank by Sars (1915) as *P. arcticus* Scott and Scott, 1901. *Parartotrogus richardi* was rediscovered from the Mediterranean Sea (Giesbrecht, 1899) and Kim (2016) redescribed *P. arcticus* based on a specimen newly collected as an associate of the ophiuroid *Ophiopholis aculeata* (Linnaeus, 1767) on the eastern coast of Korea.

The present paper is the description of the third species of the genus *Parartotrogus*. It was found on the external surface of the brittle star *Ophiuroglypha kinbergi* (Ljungman, 1866) that lived on the tidal flat of low tidal zone.

MATERIALS AND METHODS

The copepod material studied in the present work was found from external washings of about 20 samples of the brittle star

Ophiuroglypha kinbergi collected on the tidal flat of low tidal zone in the Yellow Sea coast of Korea. The brittle stars were small, about 7 to 8 mm in the diameter of central disc. The brittle stars along with the copepod associates were preserved in 80% ethanol immediately after the collection. Before microscopic observation the selected copepod specimens were immersed in lactic acid for about 10 min and then dissected using the reversed slide method (Humes and Gooding, 1964). Figures were drawn with the aid of a drawing tube equipped on the Olympus BH-2 microscope (Japan). In the armature formula of legs 1–4 given in the description, Roman and Arabic numerals indicate spines and setae, respectively. Intact type specimens have been deposited in the Honam National Institute of Biological Resources (HNIBR), Mokpo, Korea.

SYSTEMATIC ACCOUNTS

Order Siphonostomatoida Burmeister, 1835
Family Cancerillidae Giesbrecht, 1897
Genus *Parartotrogus* Scott T. and Scott A., 1893

Parartotrogus minutus n. sp. (Figs. 1, 2)

Type material. Holotype (intact ♀, HNIBRIV49), intact

© This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

***To whom correspondence should be addressed**
Tel: 82-32-624-2030, Fax: 82-32-624-2039
E-mail: ihkim@gwnu.ac.kr

paratypes (11 ♀♀, HNIBRIV50), and dissected paratypes (2 ♀♀, 1 ♂) from external surface of the brittle star *Ophiuroglypha kinbergi* on the tidal flat (low tidal zone), Korea: Chungcheongnam-do, Taean-gun, Shinjin Fishing Port, 36°40'46"N, 126°07'42"E, 8 Oct 2021, coll. I.-H. Kim. Intact type specimens have been deposited in the Honam National Institute of Biological Resources (HNIBR), Mokpo, Korea. Dissected paratypes are kept in the collection of the author.

Additional non-type material. 7 ♀♀, 5 ♂♂ from washing of *O. kinbergi*, on tidal flat at Eulwang, Incheon (37°26'11"N, 126°22'36"E), 7 Nov 2021.

Female. Body (Fig. 1A) of dissected and figured paratype small, 440 µm long. Prosome 230 µm long, consisting of cephalothorax and 3 pedigerous somites. Cephalothorax 207 × 198 µm, divisible into expanded anterior three quarters (cephalic region) and narrow posterior quarter (region of first pedigerous somite); rostral apex prominent, with rounded anterior margin. Second to fourth pedigerous somites 36 × 104, 22 × 67, and 16 × 45 µm, respectively. Fourth pedigerous somite narrow, almost as wide as fifth pedigerous somite. Urosome (Fig. 1B) 6-segmented. Fifth pedigerous somite 42 µm wide. Genital double-somite 50 × 52 µm, widest across anterior quarter; genital apertures positioned dorsolaterally at about 40% region of double-somite length. Three free abdominal somites 29 × 31, 22 × 29, and 23 × 27 µm, respectively. Anal operculum distinct. Caudal ramus (Fig. 1C) 1.73 times longer than wide (19 × 11 µm), with 6 naked setae and several fine setules; seta II positioned subdistally; seta V longest, 56 µm long; seta IV second longest, 32 µm long.

Rostrum as anterior prominence of cephalothorax (Fig. 1A). Antennule (Fig. 1D) 107 µm long, 9-segmented; armature formula 1, 11, 4, 2, 1, 3, 2, 2, and 12 + aesthetasc; distal seta on penultimate segment obscure; all setae naked; aesthetasc on terminal segment shorter than twice length of segment; one small seta of terminal segment inserted into proximal region of larger apical seta. Antenna (Fig. 1E) consisting of coxa, basis, 1-segmented exopod, and 2-segmented endopod; exopod narrow, about 4.8 times longer than wide (19 × 4 µm), widest across middle, armed with 2 setae (apical and subdistal), apical one of them bearing articulation proximally, ornamented with several setules; proximal endopodal segment, as longest segment, unarmed, but ornamented with minute spinules on inner surface; distal endopodal segment slightly wider than long, armed with 2 claws (inner and terminal) and 3 setae; inner claw tipped with droplet-like hyaline material; large terminal claw strongly curved.

Oral cone short, wider than long. Mandible (Fig. 1F) represented by stylet (32 µm long), bearing minute denticles at truncate tip. Maxillule (Fig. 1G) consisting of precoxa and palp; precoxa bearing large, tongue-like outer extension near

base of palp; precoxal endite (inner lobe) defined by suture line from remaining proximal region precoxa, armed distally with 5 thick setae (2 pinnate, 1 plumose, and 2 naked), largest second outer one very long, pinnate, directed outwards, second largest outermost seta plumose; palp (outer lobe) smaller than precoxal endite, clearly articulated from precoxa, distally armed with 3 setae (1 pinnate and 2 naked). Maxilla (Fig. 1H) 2-segmented; proximal segment (syncoxa) unarmed; distal segment (basis) slender, tipped with long, curved claw and small seta. Maxilliped (Fig. 1I) 4-segmented; first segment (syncoxa) with 1 seta at inner distal corner; second segment (basis) armed with 1 seta at distal third of inner margin, ornamented with several thin spinules along distal third of outer margin; third segment (proximal endopodal segment) unarmed; fourth segment about 1.5 times longer than third segment, tipped with 1 seta and 1 long claw bearing spinules along inner margin and short serrate membrane at distal region of outer margin.

Legs 1–3 (Fig. 2A–C) biramous; coxa of these legs lacking inner seta. Leg 1 with 2-segmented exopod and endopod; distal endopodal segment expanded. Legs 2 and 3 with 3-segmented exopod and endopod. Basis of legs 2 and 3 markedly broadened. Outer spines on exopod of leg 2 with serrate margins, but those of leg 3 with smooth membranes. Distal spine on third exopodal segment of legs 2 and 3 setulose along inner margins but rimmed with smooth membrane along outer margin. Inner distal process on third endopodal segment of leg 2 acute, curved outwards. Armature formula for legs 1–3 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	1-0	1-0; 3, 1, 4	0-1; 1, 2, 4
Leg 2	0-0	1-0	I-1; I-1; III, I, 4	0-1; 0-2; 1, 2, 3
Leg 3	0-0	1-0	I-1; I-1; III, I, 4	0-1; 0-1; 1, I, 2

Leg 4 (Fig. 2D) uniramous, consisting of protopod and 1-segmented exopod; protopod expanded medially, with 1 naked outer distal seta; exopodal segment twice longer than wide (10 × 5 µm), gradually broadened distally, with notch on distal margin, armed distally with 2 naked setae, shorter outer one 24 µm long, and longer inner one 31 µm long. Leg 5 (Fig. 2E) comprising protopod and free exopod; protopod completely fused with somite, bearing 1 naked outer seta; exopod short, wider than long, bearing 2 naked setae distally. Leg 6 represented by 1 small seta and 1 small spinule on genital operculum (Fig. 1B).

Male. Body (Fig. 2F) of dissected male paratype resembling that of female, but smaller and narrower. Body length 349 µm. Prosome 230 µm long. Cephalothorax 174 × 148 µm. Rostral prominence more produced anteriorly than that of female. Urosome 6-segmented. Genital somite wider than

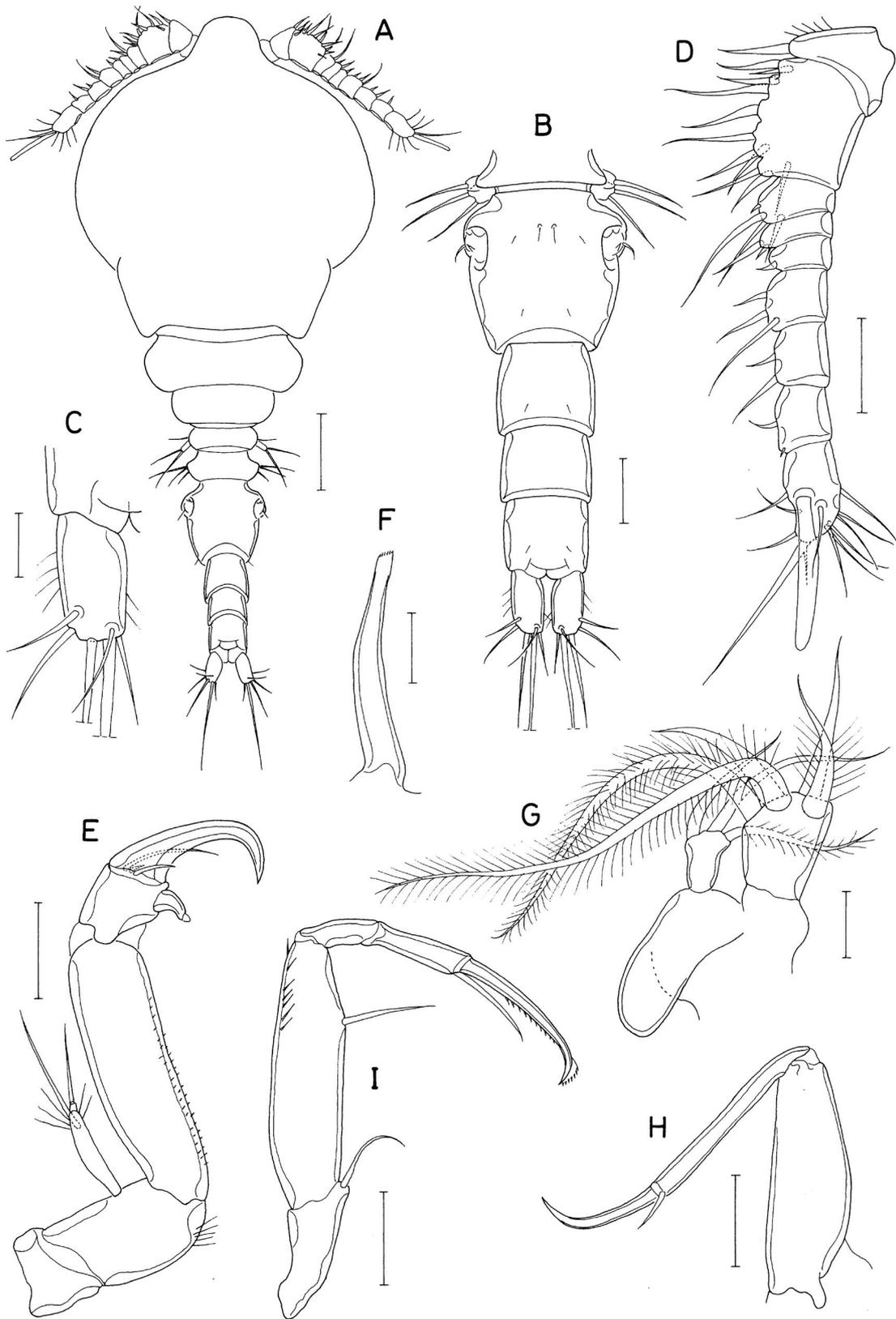


Fig. 1. *Parartotrogus minutus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Left caudal ramus, dorsal; D, Antennule; E, Antenna; F, Mandible; G, Maxillule; H, Maxilla; I, Maxilliped. Scale bars: A=0.05 mm, B, D, E, H, I=0.02 mm, C, F, G=0.01 mm.

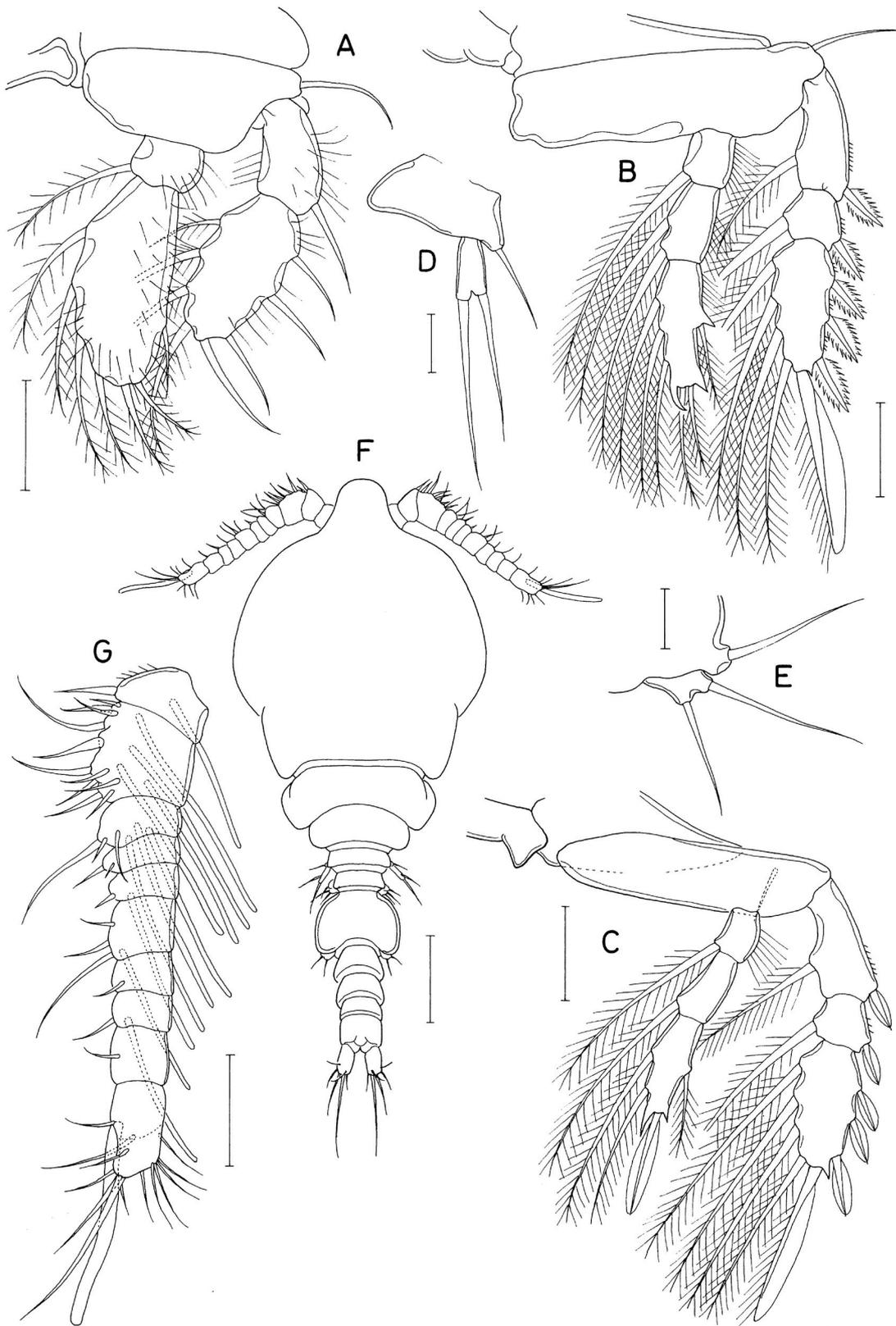


Fig. 2. *Parartotrogus minutus* n. sp. Female: A, Leg 1; B, Leg 2; C, Leg 3; D, Leg 4; E, Leg 5. Male: F, Habitus, dorsal; G, Antennule. Scale bars: A-C, G=0.02 mm, D, E=0.01 mm, F=0.05 mm.

long ($42 \times 54 \mu\text{m}$). Four abdominal somites 16×33 , 15×30 , 11×28 , and $19 \times 28 \mu\text{m}$, respectively. Caudal ramus 1.73 times longer than wide ($19 \times 11 \mu\text{m}$), as in female.

Antennule (Fig. 2G) $94 \mu\text{m}$ long, 10-segmented; terminal segment with suture line on ventral surface; armature formula 1 + aesthetasc, 11 + 4 aesthetascs, 3 + 3 aesthetascs, 2, 1 + aesthetasc, 3 + aesthetasc, 1, 1 + aesthetasc, 1, and 13 + aesthetasc. Antenna as in female.

Oral cone, mandible, maxillule, maxilla, maxilliped, and legs 1–5 as in female. Leg 6 represented by 2 small setae on genital operculum (Fig. 2F).

Etymology. The specific name of the new species is derived from the Latin *minut* (=small), referring to the small body size.

Remarks. The body of *Parartotrogus minutus* n. sp. is as small as *P. richardi* in which the body length of the female was recorded as 0.5 mm by Scott and Scott (1893) or 0.47 to 0.52 mm by Giesbrecht (1899). These two species also share the same armature condition (two setae) on the exopod of leg 5. But in other morphological respects *P. minutus* n. sp. is more related to *P. arcticus* than to *P. richardi*, since the latter species has the genital double-somite which is wider than long (cf. longer than wide in *P. arcticus* and *P. minutus* n. sp.), five setae (formula 0, 2, 3) on the second endopodal segment of leg 1 (cf. seven setae, formula 1, 2, 4, in *P. arcticus* and *P. minutus* n. sp.), three spines (formula II, I, 4) on the third exopodal segment of leg 3 (cf. four spines, formula III, I, 4, in *P. arcticus* and *P. minutus* n. sp.), and two-segmented endopod of leg 3 (cf. 3-segmented in *P. arcticus* and *P. minutus* n. sp.).

Differences between *P. minutus* n. sp. and *P. arcticus* are slight but significant. Firstly, the body length of the female of *P. minutus* n. sp., 0.44 mm, is contrasted to that of *P. arcticus* which was measured as 0.80 mm by Sars (1915) or 935 μm by Kim (2016). Secondly, the caudal ramus of the female of *P. minutus* n. sp. is 1.73 times longer than wide, compared to 2.27 times longer than wide in *P. arcticus* as recorded by Kim (2016). Thirdly, the two distal armature elements on the exopod of leg 4 are setae in *P. minutus* n. sp., but spines in *P. arcticus*, as recorded or illustrated by Scott and Scott (1901), Sars (1915), and Kim (2016). Finally, the exopod of leg 5 is armed with two setae in *P. minutus* n. sp., but with three setae in *P. arcticus* as recorded by Sars (1915) or four setae as recorded by Scott and Scott (1901) and Kim (2016). The three-setae condition of the exopod of leg 4 recorded by Sars (1915) seems to be an infraspecific variety.

Ophiuroglypha kinbergi, the host of *P. minutus* n. sp., is a small brittle star, widely distributed in the Indo-West Pacific (WoRMS Editorial Board, 2022). In Korea, this brittle star is known to dwell in the Yellow Sea coast (Yoo et al., 1995).

ORCID

Il-Hoi Kim: <https://orcid.org/0000-0002-7332-0043>

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGMENTS

This research was supported by a grant from the Honam National Institute of Biological Resources (HNIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (HNIBR202101101).

REFERENCES

- Boxshall GA, Halsey SH, 2004. An introduction to copepod diversity. Vols. 1, 2. The Ray Society, London, pp. 1-966.
- Giesbrecht W, 1899. Die Asterocheriden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Fauna und Flora des Golfes von Neapel, 25:1-217. <https://doi.org/10.5962/bhl.title.10537>
- Humes AG, Gooding RU, 1964. A method for studying the external anatomy of copepods. Crustaceana, 6:238-240. <https://doi.org/10.1163/156854064X00650>
- Kim IH, 2016. Siphonostomatoid copepods (Crustacea) mainly associated with marine invertebrates from Korean water. Journal of Species Research, 5:393-442. <http://doi.org/10.12651/JSR.2016.5.3.393>
- Sars GO, 1915. Copepoda Cyclopoida. Parts IX & X. Ascomyzontidae (concluded), Acontiphoridae, Myzopontiidae, Dyspontiidae, Artotrogidae, Cancerillidae. An Account of the Crustacea of Norway, with short descriptions and figures of all the species, Vol. 6. Bergen Museum, Bergen, pp. 105-140.
- Scott T, Scott A, 1893. On some new or rare Scottish Entomostraca. Annals and Magazine of Natural History, Series 6, 11: 210-215. <https://doi.org/10.1080/00222939308677499>
- Scott T, Scott A, 1901. On some Entomostraca collected in the Arctic Seas in 1898 by William S. Bruce, F.R.S.G.S. Annals and Magazine of Natural History, Series 7, 8:337-356. <https://doi.org/10.1080/03745480109443332>
- WoRMS Editorial Board, 2022. World Register of Marine Species [Internet]. Accessed 15 Jul 2022, <<http://www.marine-species.org>>.
- Yoo JW, Hong JS, Park HS, 1995. A taxonomical reconsideration on the three species of genus *Ophiura* from Korean waters. The Korean Journal of Systematic Zoology, 11:417-434 (in Korean with English abstract).

Received August 4, 2022
 Revised August 27, 2022
 Accepted August 30, 2022