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Two Newly Recorded Spionid Species (Polychaeta: Spionidae) in Korean Fauna, with New Record of the Genus *Malacoceros*

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ABSTRACT

Two new records of spionid polychaetes, *Malacoceros reductus* Blake & Kudenov, 1978 and *Pseudopolydora* cf. *kempi* (Southern, 1921), collected from Korean waters are reported here with detailed descriptions and illustrations. *Malacoceros reductus*, only reported in New South Wales, Australia, is distinguishable from its relatives by a prostomium with lateral horns, reduction of chaetiger 1, and the presence of the tridentate hooded hooks. *Pseudopolydora* cf. *kempi*, which has been known to have a wide geographical distribution, is characterized by a prostomium incised anteriorly, the presence of the occipital antenna, and two rows of black spots on the dorsal side. In this paper, photographs of scanning electron microscopy for characteristic features of each species are presented.

Keywords: Polychaeta, Spionidae, *Malacoceros*, *Pseudopolydora*, key to species, taxonomy, Korea

INTRODUCTION

The family Spionidae Grube, 1850 is one of the largest taxa of polychaetous annelids commonly found in various environments from intertidal to deep sea (Blake and Kudenov, 1978; Meißner and Götting, 2015; Radashevsky, 2015; Abe et al., 2016). The members of the family have generally elongate body with a pair of palps on the anterior end and dorsal branchiae separated or fused to the postchaetal lamellae in various degrees (Fauchald, 1977; Blake, 1996). Currently, this family comprises more than 40 genera (Meißner et al., 2014).

The genus *Malacoceros* Quatrefages, 1843 is a small group containing 16 recognized species up to date (Delgado-Blas and Díaz-Díaz, 2013; Meißner and Götting, 2015; Read and Fauchald, 2019). The members of this genus clearly differ from other spionids by a prostomium with front-lateral or lateral horns and the branchiae present from chaetiger 1 to the end of the body (Blake and Kudenov, 1978; Blake, 1996; Delgado-Blas and Díaz-Díaz, 2010, 2013). In East Asia, one *Malacoceros* species, *Malacoceros indicus* (Fauvel, 1928), have been previously reported from Japan, China, and the Philippines (Imajima, 1991; Liu, 2008; Meißner and Götting, 2015), but none from Korea.

The genus *Pseudopolydora* Czerniavsky, 1881 is a group comprising about 20 species, predominantly found from intertidal to subtidal zone in various habitats and mainly reported from the western Pacific (Radashevsky and Migotto, 2009; Walker, 2011; Abe et al., 2016). This genus is defined by the absence of the notochaetae on chaetiger 1, the branchiae present on the posterior to chaetiger 5, and having two types of modified spines in the notopodium on chaetiger 5 (Blake and Kudenov, 1978; Blake, 1996; Radashevsky and Hsieh, 2000; Delgado-Blas, 2008; Radashevsky and Migotto, 2009; Walker, 2011). Only two species, *Pseudopolydora antennata* (Claparede, 1869) and *Pseudopolydora paucibranchiata* (Okuda, 1937), have been previously reported in Korean waters (Paik, 1982, 1989).

In this paper, we newly report two spionid species, *Malacoceros reductus* Blake & Kudenov, 1978 and *Pseudopolydora* cf. *kempi* (Southern, 1921), from Korean waters with detailed descriptions and illustrations. The genus *Malacoceros* is first recorded in Korean fauna by the report of *M. reductus* in the present study.

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MATERIALS AND METHODS

Samples were collected from muddy sand habitats of intertidal or subtidal zone in Korean waters. Specimens were extracted using sieves with pore size of 500 μm. After extraction, they were initially fixed with 5% formaldehyde-seawater solution and then transferred to 85% ethanol. Characteristics of these specimens were observed with appendages dissected in a petri dish using dissection forceps, surgical knives, and needles under stereomicroscope (SMZ1500; Olympus, Tokyo, Japan). Dissected specimens were mounted onto temporary slides using glycerol or permanent slides using polyvinyl lactophenol solution. Methyl green staining was strongly recommended for observation of most characters by means of light microscopy. Specimens had to be transferred into water first and then dipped into a methyl green solution. The staining faded completely when specimens were returned to alcohol. Staining with Shirlastain A was also helpful for the observation under the light microscope and could be applied in either ethanol or water. Drawings were made with a stereomicroscope and light microscope (LABOPHOT-2; Nikon, Tokyo, Japan) with aids of drawing tubes. Specimens for scanning electron microscopy (SEM) were dehydrated with a t-BuOH freeze dryer (VFD-21S; Vacuum Device, Ibaraki, Japan). They were mounted on stubs and coated with gold-palladium. Observations were conducted using a scanning electron microscope (SU3500; Hitachi, Tokyo, Japan). The materials examined in this study are deposited at Chosun University and the National Institute of Biological Resources (NIBR) in Korea.

SYSTEMATIC ACCOUNTS

Order Spinoida Grube, 1850
Family Spionidae Grube, 1850
[1]*Genus *Malacoceros* Quatrefages, 1843

[2]****Malacoceros reductus*** **Blake & Kudenov, 1978 (Figs. 1, 2)**
Malacoceros reductus Blake and Kudenov, 1978: 197, fig. 13.

Material examined. Korea: 50 specimens, Yeosu-si: Samsan-myeon, Deokchon-ri, 34°1′11″N, 127°18′16″E, 27 May 2017; 10 specimens, Jeollanam-do: Wando-gun, Cheongsan-myeon, Ji-ri, 34°11′40″N, 126°51′40″E, 22 Aug 2017, cat on NIBRIV0000834647. All examined specimens were incomplete and collected from muddy sand of subtidal zones.
Description. All specimens incomplete, up to 20.0 mm long and 2.0 mm wide. Colour of alcohol fixed specimens whitish-brown without any pigmentation.

Prostomium bell-shaped with distinct lateral horns, with medial weak incision anteriorly; prostomium posteriorly extended into low indistinct caruncle at end of chaetiger 1. Two pairs of black eyes arranged trapezoidally, anterior pair crescent-shaped, and posterior pair rounded. Occipital antenna absent. Peristomium moderately developed, forming low lateral wings partially encompassing prostomium posteriorly. Nuchal organs not unambiguously discernable. Dorsal crests absent, but transverse ciliary bands across dorsum present in well-preserved specimens (Fig. 1A).

Chaetiger 1 reduced, with small elongate notopodial lamellae and smaller rounded neuropodial lamellae. Dorsal branchiae present from chaetiger 1 to end of fragment, elongate, almost fused, distally free from notopodial postchaetal lamellae on anterior chaetigers, and basally fused on posterior chaetigers; first branchiae distinctly shorter than succeeding branchiae; longest branchiae on chaetigers 4−10, branchiae decreasing in length after about chaetiger 10 to end of fragment. Interparapodial lateral pouches absent (Figs. 1A−D, 2A).

Parapodia on chaetiger 1 small, and positioned more dorsally than on following chaetigers. Notopodial postchaetal lamellae elongate, becoming subtriangluar and shorter on posterior chaetigers; neuropodial postchaetal lamellae rounded on anterior chaetigers, then becoming more flattened on posterior chaetigers (Fig. 1A−D).

Chaetae in anterior and middle chaetigers capillaries with fine granulations or without granulations, arranged in 2 rows. Hooks in neuropodia from chaetiger 30, up to 7 in series, tidentate with two small blunt teeth above ball-shape main fang. Ventral sabre chaetae from chaetiger 30, up to 3 in inferior position (Figs. 1E−G, 2B).

Pygidium not observed in fragmented specimens from Korean waters.
Methyl green staining pattern: Inconspicuous. Anterior part of prostomium, peristomium intensively stained; margins of postchaetal lamellae and branchiae of anterior and middle chaetigers intensively stained.
Remarks. Korean materials of the present study are well agreed with the original description of the species based on the following diagnostic characteristics: (1) a prostomium with lateral horns (not latero-frontal horns), (2) the presence of the caruncle, (3) a peristomium forming lateral wings, (4) the reduction of chaetiger 1 prominent, (5) the branchiae almost fused to the notopodial lamellae on the anterior chaetigers and basally fused on the posterior chaetigers, and (6) hooded hooks bluntly tridentate (Blake and Kudenov, 1978; Delgado-Blas and Díaz-Díaz, 2013).

However, the Korean materials of *M. reductus* have a mi-

Korean name: [1]*양손얼굴갯지렁이속 (신칭), [2]*짧은양손얼굴갯지렁이 (신칭)

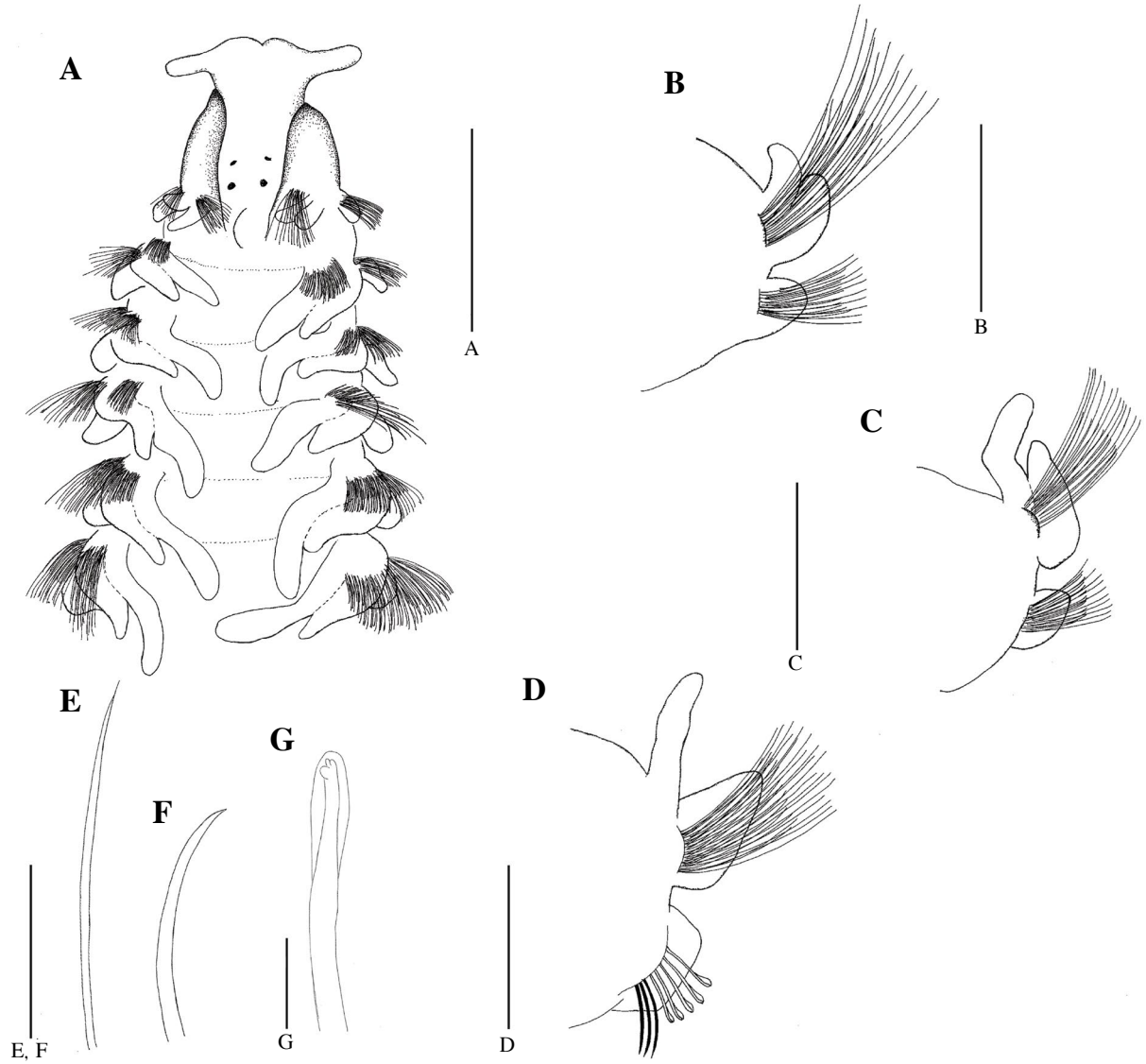

Fig. 1. *Malacoceros reductus* Blake & Kudenov, 1978. A, Anterior end with six chaetigers, dorsal view; B, Anterior view of chaetiger 1; C, Anterior view of chaetiger 2; D, Anterior view of chaetiger 38; E, Capillary chaeta; F, Ventral sabre chaeta; G, Neuropodial hooded hook. Scale bars: A=0.5 mm, B–D=0.3 mm, E, F=0.1 mm, G=0.03 mm.

nor difference from the original description of Australian materials in the first appearances of hooded hooks and ventral sabre chaetae: both hooded hooks and ventral sabre chaetae are present from chaetiger 30 in the Korean materials while from chaetiger 20 in the original description (Blake and Kudenov, 1978; Delgado-Blas and Díaz-Díaz, 2013). The first appearances of the hooded hooks and the ventral sabre chaetae in *Malacoceros* worms are usually known to be varied according to the specimen sizes (Delgado-Blas and Díaz-Díaz, 2013; Meißner and Götting, 2015). So, this difference is regarded as a variation, while the only anterior fragments of individuals were collected from the present study.

Malacoceros reductus is distinguished from the previously reported *Malacoceros* species in East Asia, *M. indicus*, in having a prostomium with lateral horns instead of latero-frontal, the reduction of chaetiger 1 instead of being developed moderately, and the branchiae almost fused to the notopodial lamellae on the anterior chaetigers instead of being fused basally (Blake and Kudenov, 1978; Imajima, 1991; Williams, 2007; Delgado-Blas and Díaz-Díaz, 2013; Meißner and Götting, 2015).

Habitat. In this study, the materials were collected from the subtidal region (47 m depth).

Distribution. Australia (type locality), Korea.

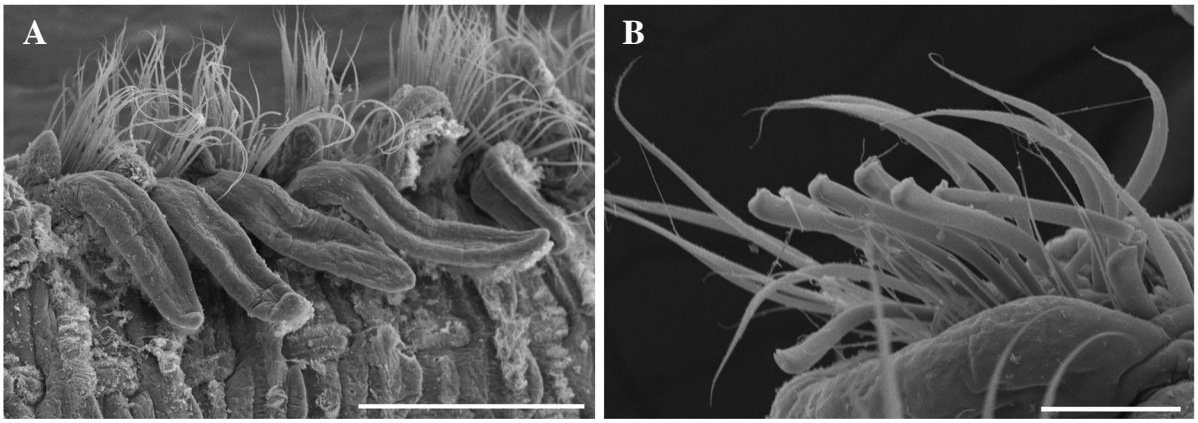

Fig. 2. Scanning electron microscopy photographs of *Malacoceros reductus* Blake & Kudenov, 1978. A, Middle chaetigers, dorsal view; B, Capillaries and neuropodial hooded hooks. Scale bars: A=0.4 mm, B=0.05 mm.

Genus *Pseudopolydora* Czerniavsky, 1881

[1]***Pseudopolydora* cf. *kempi* (Southern, 1921) (Figs. 3, 4)**

Polydora (*Carazzia*) *kempi* Southern, 1921: 636, fig. 20.

Pseudopolydora kempi: Blake and Woodwick, 1975: 118; Blake and Kudenov, 1978: 268; Light, 1978: 157, fig. 158; Zhou et al., 2010: 8; Hiebert et al., 2015: 218.

Pseudopolydora cf. *kempi japonica*: Radashevsky and Hsieh, 2000: 221, fig. 3.

Pseudopolydora cf. *kempi*: Sato-Okoshi, 2000: 448 in part; Abe et al., 2016: 658, fig. 2.

Material examined. Korea: 10 spcimens, Jeju-do: Jeju-si, Yongdam 2-dong, 33°31′10″N, 126°29′24″E, 28 Apr 2011; 25 specimens, Jeollabuk-do: Buan-gun, Jinseo-myeon, Jinseo-ri, 35°58′62″N, 126°60′43″E, 14 Aug 2014; 8 specimens, Jeollanam-do: Jindo-gun, Imhoe-myeon, Namdong-ri, 34°21′37″N, 126°9′25″E, 30 Mar 2018; 5 specimens, Jeollabuk-do: Buan-gun, Byeonsan-myeon, Gyeokpo-ri, 35°38′05″N, 126°28′03″E, 14 May 2018; 1 specimen, Jeollanam-do: Jindo-gun, Jodo-myeon, Chang-yu-ri, 34°18′20″N, 126°1′50″E, 25 Oct 2018, cat on NIBRIV0000825770.

Description. Body flattened anteriorly and cylindrical posteriorly, up to 20.0 mm long and 2.0 mm wide in complete specimens. Dorsal black spots paired, present on chaetigers 3–12. Lateral transverse black bands present on chaetigers 2–12. Pigmentations faded after fixation in some individuals. Body light tan in alcohol. (Figs. 3A, B, 4A).

Prostomium bifid anteriorly, extending posteriorly to middle of chaetiger 3 as a low caruncle; nuchal organs ciliary bands on sides of caruncle. Occipital antenna present on caruncle; black spot on caruncle behind occipital antenna. Four black eyes arranged trapezoidally. Palps as long as 20 segments, with longitudinal groove lined with fine cilia (Figs. 3A, B, 4A).

Chaetiger 1 with short notopodial postchaetal lamellae and well developed neuropodia; winged capillary neurochaetae present and notochaetae absent. Notochaetae arranged in 3 rows on chaetigers 3–10 (except chaetiger 5); anterior row with short and broadly winged chaetae; median row with slender and narrowly limbate chaetae; and posterior row with markedly elongate, slender, and slightly limbate chaetae (Figs. 3A–F, 4B, C).

Chaetiger 5 same in size as chaetigers 4 and 6, with 5 dorsal superior winged capillaries, 2 kinds of notopodial modified spines arranged in a double J-shaped series, and about 20 ventral winged capillaries; spines in anterior row (outer) pennoned with curved, pointed tips, and about 22 in series; spines in posterior row (inner) simple, falcate, and about 15 in series (Figs. 3A, B, 3G, H, 4C).

Hooks in neuropodia from chaetiger 8 to posterior end, not accompanied by capillaries; hooks bidentate, upper part of shaft with constriction, lower part of shaft bent at right angle (Figs. 3I, 4D).

Branchiae present on chaetigers 7–24, free from notopodial postchaetal lamellae. Transverse ciliary bands extending across dorsum between branchiae (Figs. 3A, B, 4A).

Pygidium large flaring disc in shape, with dorsal gap and without dorsolateral process (Fig. 3C).

Methyl green staining pattern: Anterior part of prostomium and peristomium intensively stained. Margins of branchiae and postchaetal lamellae also stain intensively. Scattered dots of chaetigers 5–13 most intensively stained ventrally. Some transverse ciliary bands between branchiae stained. Pygidium

Korean name: [1]*두점박이선녀얼굴갯지렁이 (신칭)

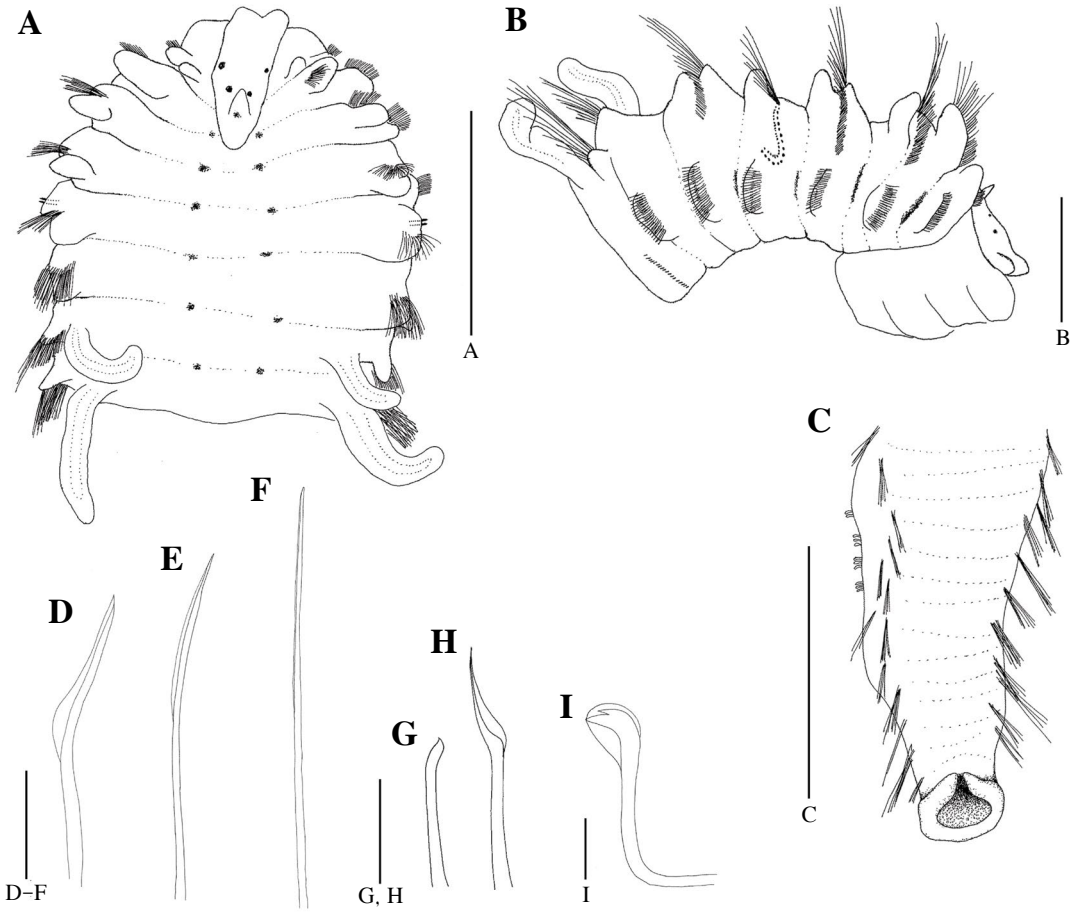

Fig. 3. *Pseudopolydora* cf. *kempi* (Southern, 1921). A, Anterior end with eight chaetigers, dorsal view; B, Anterior end with eight chaetigers, lateral view; C, Posterior end; D, Anterior row with short and broadly winged chaetae; E, Median row with slender and narrowly limbate chaetae; F, Posterior row with markedly elongate slender slightly limbate chaetae; G, Inner falcate spine of chaetiger 5; H, Outer pennoned spine of chaetiger 5; I, Hooded hook. Scale bars: A=1.0 mm, B=0.5 mm, C=2.0 mm, D–F=0.05 mm, G, H=0.6 mm, I=0.03 mm.

completely deep blue after staining.

Remarks. *Pseudopolydora kempi* was originally recorded from brackish waters in India and consequently reported from many countries including Japan, Mozambique, USA, Australia, Canada, Taiwan, and China (Southern, 1921; Day, 1967; Banse, 1972; Blake and Woodwick, 1975; Blake and Kudenov, 1978; Light, 1978; Radashevsky and Hsieh, 2000; Sato-Okoshi, 2000 in part; Zhou et al., 2010; Abe et al., 2016). The original description of *Pseudopolydora kempi* was very brief and based on the incomplete specimens only. There is no type material existing in this species (Radashevsky and Hsieh, 2000). Owing to these, some debates including the state of regional populations have been existed in this species, especially in East Asia. Radashevsky and Hsieh (2000) described the Taiwanese population of the species as *Pseudopolydora* cf. *kempi japonica* with remarks on inadequacy of the original description, while Sato-Okoshi (2000) regarded the Japanese population as *P.* cf. *kempi* because of having variation of the caruncle length. Recently, Abe et al. (2016) mentioned that the pigmentation pattern on body is a diagnostic morphological character in the taxonomy of *Pseudopolydora* species, with providing a description of *P.* cf. *kempi* based on the Japanese materials.

The specimens examined in the present study are well agreed with most of the previous descriptions of the species, especially with the description based on the Japanese materials by Abe et al. (2016), in the following diagnostic characteristics: (1) a prostomium bilobed anteriorly, (2) the presence of the occipital antenna, (3) the caruncle extending to the middle of chaetiger 3, (4) segment 5 less modified, similar to chaetigers 4 and 6 in size and shape, and (5) the presence of two rows of black spots on the dorsal side (Blake and Kudenov, 1978; Light, 1978; Radashevsky and Hsieh, 2000; Zhou et al., 2010; Abe et al., 2016).

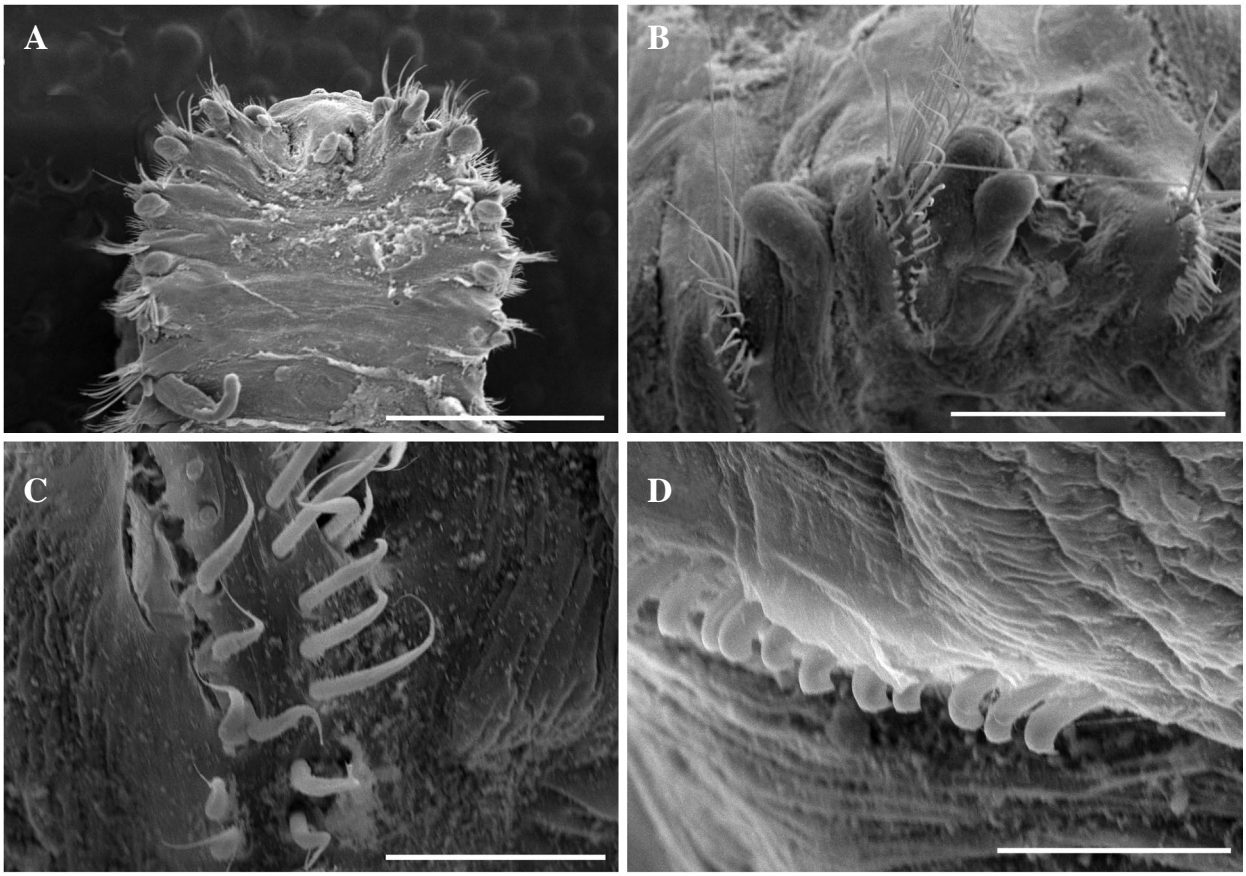

Fig. 4. Scanning electron microscopy photographs of *Pseudopolydora* cf. *kempi* (Southern, 1921). A, Anterior end, dorsal view; B, Chaetigers 4–6, lateral view; C, Chaetiger 5, lateral view; D, Hooded hooks. Scale bars: A = 1.0 mm, B = 0.3 mm, C, D = 0.05 mm.

Habitat. Mud sediments in bays and estuaries (Blake and Woodwick, 1975), sand bank (Blake and Kudenov, 1978), muddy habitats (Radashevsky and Hsieh, 2000), sand flat from intertidal to subtidal (Zhou et al., 2010), intertidal sand flat and mud flat (Abe et al., 2016). In this study, the materials were collected from the muddy sand from intertidal to 10 m depth.

Distribution. India (type locality), Australia, Canada, China, Japan, Korea, Mozambique, Taiwan, USA.

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CONFLICTS OF INTEREST

Seong Myeong Yoon, a contributing editor of the Animal Systematics, Evolution and Diversity, was not involved in the editorial evaluation or decision to publish this article. All remaining authors have declared no conflicts of interest.

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