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Short communication

First Record of Indo-West Pacific Spider Crab, *Naxioides robillardi* (Decapoda: Epialtidae) from Korean Waters

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ABSTRACT

An epialtid spider crab, *Naxioides robillardi* (Miers, 1882), is known as widely distributed in Indo-West Pacific region include Japanese waters. Four specimens of epialtid crabs were collected from adjacent waters of Jejudo Island and identified as *N. robillardi*. This species can be grouped into two forms such as *N. robillardi* form typical and *N. robillardi* form *mammillata* according to morphological features of carapace, gastric spine, and chela. Morphological characters of all Korean specimens well agree with the form *mammillata* in general. In this paper, morphological diagnosis and illustrations of newly collected *N. robillardi* are provided. DNA barcode sequence of *COI* region is also determined for the first time.

Keywords: spider crab, new record, Epialtidae, *Naxioides*, *COI*, Korean fauna

INTRODUCTION

Members of the superfamily Majoidea Samouelle, 1819 are called spider crabs or decorator crabs because of their slender legs and camouflage behavior (Wicksten, 1993; Poore, 2004). Among them, the family Epialtidae MacLeay, 1838 is one of the most diverse groups, currently comprising 452 species in 89 genera (Davie et al., 2015) in the world; however, only 16 species have been recorded from Korean waters so far (Kim, 1973; Lee et al., 2014; Ko and Lee, 2015; Yang et al., 2015; National Institute of Biological Resources, 2019). During a continuous faunal study of Korean crabs, four epialtid specimens were collected, using otter trawl and the fish traps of local fishermen, from off the coast of Jejudo Island in Korea and identified as *Naxioides robillardi*. One of the epialtid crabs, *N. robillardi* (Miers, 1882), is widely distributed in the Indo-West Pacific region from the eastern coast of Africa to Australia (Tasman Sea including Norfolk Islands) and Japan (Pacific coast and East China Sea) (Poupin, 1995; Lee et al., 2017; Devi et al., 2019) (Fig. 1). This species usually inhabits hard bottom habitats between 30 and 260 m depth (Poupin, 1995).

Integrative taxonomic studies using morphological and molecular data have been widely conducted to distinguish the boundaries of species among various animal phyla (Park and Kim, 2017; Tyagi et al., 2019; Soong et al., 2020). In particular, the mitochondrial cytochrome *c* oxidase subunit I (*COI*) gene has been used as a useful taxonomic marker in most animal phyla, including Decapod species (Hebert et al., 2003; Cabezas et al., 2008; Bilgin et al., 2015; Negri and Mantelatto, 2017; Ng et al., 2018). However, to date, none of the *COI* gene data of *Naxioides* species have been published in public databases such as GenBank (Sayers et al., 2020) or Barcode of Life Data System (Ratnasingham and Hebert, 2007). Therefore, the *COI* gene sequence of *N. robillardi* was determined for the first time and presented with a morphological diagnosis and illustrations.

A stereomicroscope (M205C; Leica, Wetzlar, Germany) was used to observe the microscopic parts. Drawing and photographs were obtained using a drawing tube attached to a stereomicroscope and a digital SLR camera (D810; Nikon, Tokyo, Japan), respectively. Measurements were taken using a digital slide caliper to the nearest 0.1 mm. Postpseudorostal carapace length (pcl) was measured in the midline from

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Table 1. Pairwise percent genetic distance (p-distance) between six epialtid species based on partial sequences of *COI* gene

No.	Species	Accession No. (voucher No.)	1	2	3	4	5	6	7	8	9	10	11	Reference
1	*Naxioides robillardi*	MT469874 (MABIK CR00247307)	–	0	0	21.5	18.4	18.6	17.7	17.7	17.7	20.9	20.5	Present study
2		MT469873 (MABIK CR00247306)	0	–	0	21.5	18.4	18.6	17.7	17.7	17.7	20.9	20.5	
3		MT469872 (MABIK CR00247305)	0	0	–	21.5	18.4	18.6	17.7	17.7	17.7	20.9	20.5	
4	*Menaethius monoceros*	EU682856 (unknown)	21.5	21.5	21.5	–	20.7	19.0	18.8	18.8	18.8	21.3	21.2	Hultgren and Stachowicz (2008)
5	*Epialtus bituberculatus*	KC695784 (CCDB 917)	18.4	18.4	18.4	20.7	–	7.8	17.1	17.1	17.1	21.1	20.9	Tamburus and Mantelatto (2016)
6	*Epialtus brasiliensis*	KC695786 (CCDB 2441)	18.6	18.6	18.6	19.0	7.8	–	17.3	17.3	17.3	20.5	20.3	
7	*Acanthonyx petiverii*	KC695774 (CCDB 1063)	17.7	17.7	17.7	18.8	17.1	17.3	–	0	0	14.1	13.9	
8		KC695773 (CCDB 3814)	17.7	17.7	17.7	18.8	17.1	17.3	0	–	0	14.1	13.9	
9		KC695769 (CCDB 2427)	17.7	17.7	17.7	18.8	17.1	17.3	0	0	–	14.1	13.9	
10	*Acanthonyx lunulatus*	JQ305884 (unknown)	20.9	20.9	20.9	21.3	21.1	20.5	14.1	14.1	14.1	–	0.4	Da Silva et al. (2011)
11		JQ305885 (unknown)	20.5	20.5	20.5	21.2	20.9	20.3	13.9	13.9	13.9	0.4	–	

CCBD: Crustacean Collection of the Department of Biology, FFCLRP, University of São Paulo; MABIK: National Marine Biodiversity Institute of Korea.

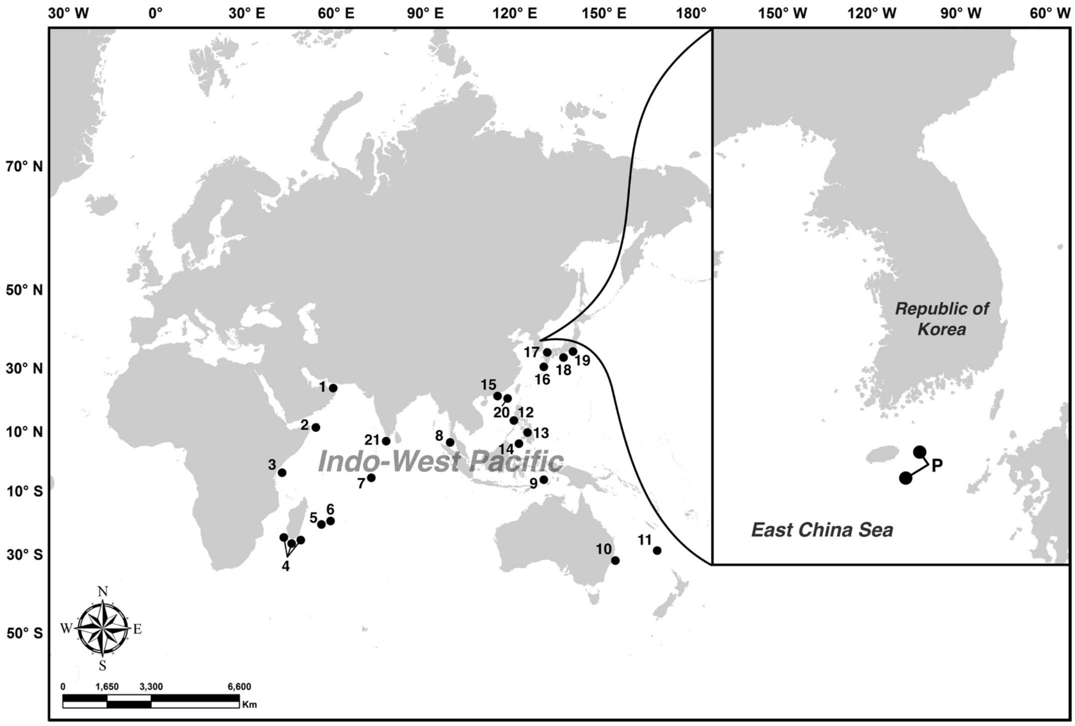

Fig. 1. Distribution of *Naxioides robillardi* (Miers, 1882) based on present study (P), Poupin (1995) (1–19), Lee et al. (2017) (20), and Devi et al. (2019) (21). Gulf of Oman (1, Off Muscat), East Africa (2, Somalia; 3, East of Mombassa), Madagascar (4, Morombé), Réunion (5), Mauritius (6, type locality), Salomon (7), Indonesia (8, North of Sumatra; 9), Australia (10, East of Wooli; 11, Norfolk Island), Philippines (12, 13, Bohol Island; 14, Sulu Archipelago), Hong Kong (15), Japan (16, Kagoshima; 17, East of Tsushima Island; 18, Off Kiinagashima; 19, Off Jogashima Island, Sagami Bay), South China Sea (20, northwest of Dongsha Island), India (21, off Muttom coast).

the base of the pseudorostral sinus to its posterior border. Carapace width (cw) was defined as the widest part of the carapace, excluding spines. Genomic DNA was extracted from the pereiopod of each specimen using a DNeasy Blood and Tissue Kit (Qiagen, Hilden, Germany) according to the manufacturer's instructions. The *COI* gene was PCR-amplified with a universal primer set of LCO1490 and HCO2198 (Folmer et al., 1994). General amplification conditions were as follows: initial denaturation at 95°C for 5 min, followed by 40 cycles of denaturation at 95°C for 20 s, annealing at 50°C for 20 s, and elongation at 72°C for 5 min. After the cycles, the reaction proceeded through a final elongation step at 72°C for 7 min and was stored at 4°C until displacement. To estimate genetic distance and demonstrate the utility of the obtained sequences, eight *COI* sequences of five epialtid species were mined from GenBank (Sayers et al., 2020) (Table 1). Sequence editing and alignment methods described by Kim et al. (2020) were used. The genetic distance was calculated using p-distance model by MEGA X (Stecher et al., 2020). All voucher specimens were housed at the National Marine Biodiversity Institute of Korea (MABIK) and the National Institute of Biological Resources (NIBR). The newly obtained *COI* sequences were registered in GenBank (Sayers et al., 2020) (Table 1).

SYSTEMATIC ACCOUNTS

Superfamily Majoidea Samouelle, 1819
Family Epialtidae MacLeay, 1838
Subfamily Pisinae Dana, 1851
[1]*Genus *Naxioides* A. Milne-Edwards, 1865

[2]***Naxioides robillardi* (Miers, 1882) (Figs. 2, 3)**

Naxia (*Naxioides*) *robillardi* Miers, 1882: 339, Pl. 20, fig. 1 (type locality: Mauritius).
Hyastenus elegans Miers, 1886: 58, Pl. 6, fig. 3; Serène and Lohavanijaya, 1973: 52.
Naxia mammillata Ortmann, 1893: 56, Pl. 3 fig. 7 (type locality: Kagoshima, Japan).

Korean name: [1]*긴가시뿔게속 (신칭), [2]*긴가시뿔게 (신칭)

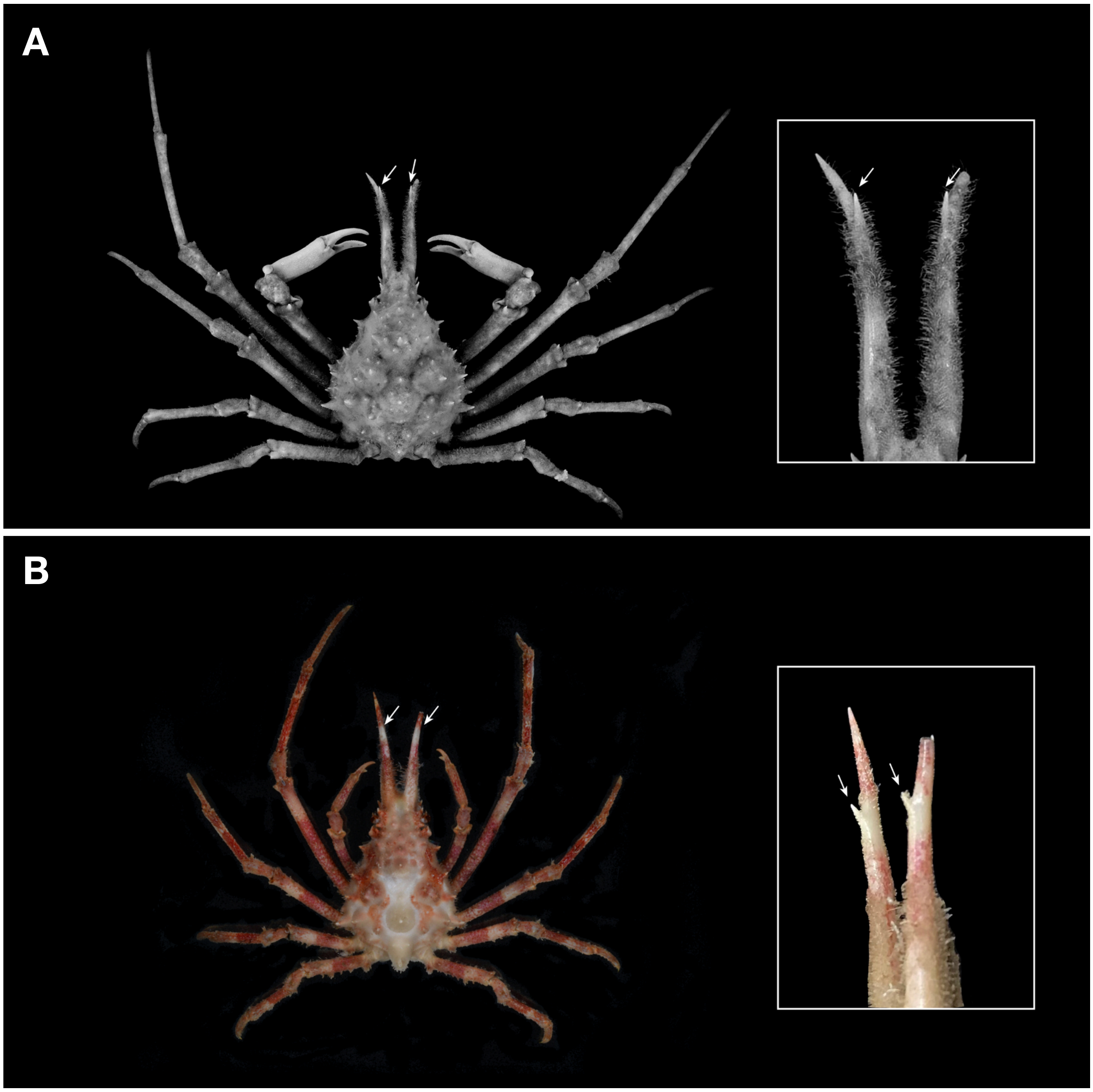

Fig. 2. *Naxioides robillardi* (Miers, 1882). A, Male (pcl 75.5 mm) (NIBRIV0000865951); B, Male (pcl 29.1 mm) (MABIK CR00247305); arrows indicate accessory spine on pseudorostrum. pcl, postpseudorostal carapace length.

Naxioides mamillata: Rathbun, 1911: 253; Sakai, 1938: 268, Pl. 27, fig. 1; 1965: 78, Pl. 35, fig. 1; 1976: 217, Pl. 75, figs. 1, 2; Serène and Lohavanijaya, 1973: 52, figs. 98–103, Pl. 9C–D.

Naxioides robillardi: Griffin, 1974: 21; Griffin and Tranter, 1986: 169 (key), 171; Poupin, 1995: 86, figs. 7, 8a, b, 9a, b; Richer de Forges and Ng, 2013: 479 (list); Lee et al., 2017: 4, fig. 13A; Devi et al., 2019: 399, figs. 2, 3.

Material examined. Korea: 1 ♂, pcl 75.5 mm, cw 54.2 mm, Jeju-do, Jeju-si, Jocheon-eup, Bukchon-ri, Bukchon Harbor, 8 Aug 2015 (NIBRIV0000865951), EtOH fixed, coll. Park T from local fisherman's fish trap; 1 ♂, pcl 5.5 mm, cw 3.6 mm, The East China Sea, about 80 km southeast far from Seogwipo Port in Jeju-do (32°41′26.97″N, 127°11′36.75″E), 5 May 2019 (MABIK CR00247307), EtOH fixed, coll. Lee SH by otter trawl; 2 ♂♂, pcl 29.1, 18.5 mm, cw 17.1, 18.5 mm, Korea Strait, about 40 km east far from Seongsanpo Port in Jeju-do (33°31′44.84″N, 127°21′34.54″E), 6 May 2019 (MABIK CR00247305–6), EtOH fixed, coll. Lee SH by otter trawl.

Diagnosis. Carapace (Fig. 2A, B) elongate pyriform, covered with numerous, various spines and tomentum, regions well separated by grooves. Gastric region with three or four prominent spines longitudinally. Cardiac region slightly convex, with one prominent spine medially. Intestinal region with

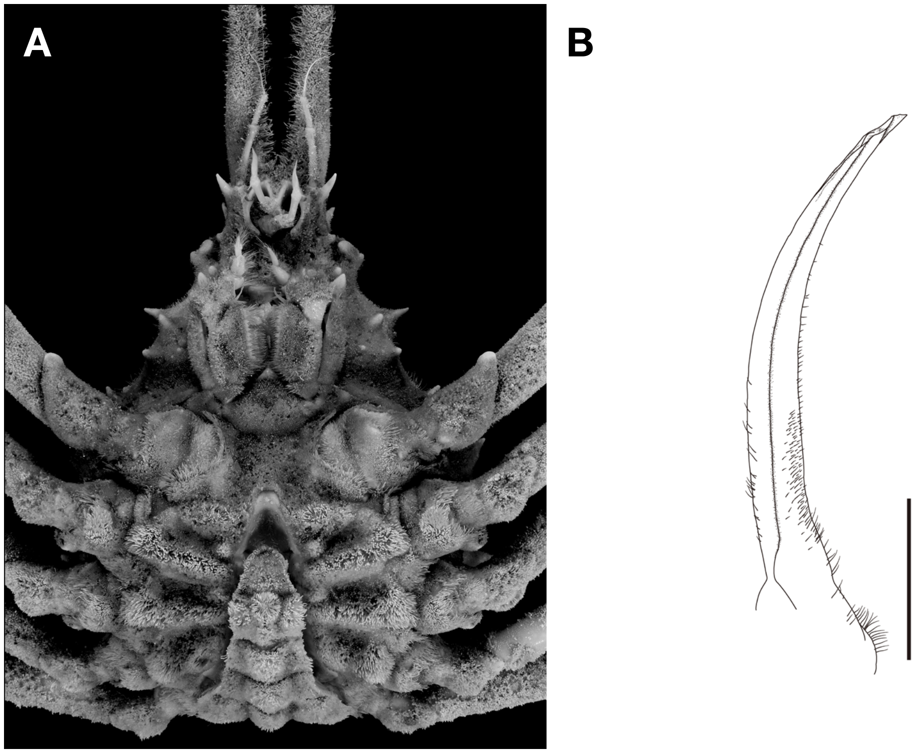

Fig. 3. *Naxioides robillardi* (Miers, 1882), male (pcl 75.5 mm) (NIBRIV0000865951). A, Ventral view; B, Left first gonopod, ventral view. pcl, postpseudorostal carapace length. Scale bar: B=5 mm.

three spines. Branchial region rounded, slightly convex. Pseudorostrum lyre-shaped, 0.8 times as long as pcl, covered with hooked setae, with one accessory spine on distal one fourth dorsally. Supraorbital eave transversely narrow. Preorbital angle with prominent spine anteriorly. Intercalated spine prominent. Postorbital lobe prominent, cupped. Hepatic margin with one long spine. Branchial margin with numerous spines, posterior one largest. Basal antennal article (Fig. 3A) with lateral margin, having one short proximal spine projecting laterally. Cheliped short, slender; finger 0.5 times as long as palm. Ambulatory legs slender, covered with tomentum. G1 (Fig. 3B) gently curved, tapering distally, with distinct longitudinal groove.

Distribution. This species has a wide range across East Africa, mouth of Gulf of Oman, the Indo-West Pacific, southeastern Australia, to Japan and Korea (Fig. 1).

RESULTS AND DISCUSSION

The species belonging to the genus *Naxioides* was recorded for the first time in Korean waters. The genus *Naxioides* can be distinguished from other epialtids based on the following characteristics: (1) the presence of pseudorostrum with an accessory spine on the dorsal surface and (2) the presence of an intercalated spine. Griffin (1974) synonymized *N. mammillata* Ortmann, 1893 with *N. robillardi*, and Poupin (1995) reviewed the *N. robillardi* group in detail. The characteristics of *N. robillardi* based on the reports of Griffin (1974) and Poupin (1995) are as follows: (1) the hepatic region has one prominent spine; (2) the cardiac region has one medial spine; (3) the pseudorostrum is 0.86 times as long as pcl; (4) the basal antennal article has a lateral margin with a short proximal spine, projecting laterally. However, Poupin (1995) recognized that *N. robillardi* is morphologically grouped into two forms (i.e., *N. robillardi* form typical and *N. robillardi* form *mammillata*), and their characteristics are as follows: (1) the posterior part of the carapace is slightly convex in form typical (vs. more convex in form *mammillata*); (2) the cw of form typical is narrower than form *mammillata* when they are of similar size; (3) the gastric spines are well developed in the typical form (vs. reduced in *mammillata*); and (4) the chela is more slender in form typical. Although these two forms are clearly distinct, the intermediate individuals were also reported by Poupin (1995).

According to Poupin (1995), the specimens from Mauritius, Madagascar, Reunion Island, southern Indonesia, and Australia were identified as form typical, and the specimens from northern Indonesia, Philippines, and Japan were identified as form *mammillata*. The specimen of Devi et al. (2019) collected from southern India appear to be form *mammillata* for the following reasons as a result of examining the illustration (Devi et al., 2019, fig. 2a): the posterior part of the carapace is convex, and the cw is wide. Following these records, form *mammillata* is distributed in the northern Indo-West Pacific, and present specimens were collected near the northern limit line of form *mammillata*.

The morphological features of present specimens agree with those of the form *mammillata sensu* Poupin (1995) in general. Poupin (1995) noted that the size and number of spines and spinules in the carapace vary with individual growth and that such variations are observed even among adult individuals. Specimens of various sizes (pcl 5.5–75.5 mm) were collected from Korean waters, and numerous small spinules were observed around the spines in the carapace of larger individual (Fig. 2A) and were not generally in small individuals (Fig. 2B), similar to Poupin's (1995) report.

A total of 658 bp of *COI* sequences were newly obtained from three *N. robillardi* in Korea, and all sequences were identical. To estimate interspecific genetic divergence among epialtid species, eight sequences of five epialtid species were mined from GenBank and compared (Table 1). Aligned sequences were 526 bp, and no deletions or insertions were detected. Intraspecific genetic divergences were lower than 0.4%. Interspecific genetic divergence between *N. robillardi* and other epialtid species ranged from 7.8% to 21.5% (Table 1). According to Hebert et al. (2003), the mean *COI* sequence divergence among crustacean pairs was 15.4%, and our result is comparable with the result of Hebert et al. (2003). Thus, the *COI* sequence information from this study can be useful for further integrative taxonomic studies of the epialtid species.

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CONFLICTS OF INTEREST

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

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