First report of *Cryptoplax propior* Is. and Iw. Taki, 1930 (Polyplacophora: Cryptoplacidae) in Korea

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ABSTRACT

We report the first occurrence of the chiton *Cryptoplax propior* Is. and Iw. Taki, 1930, a species of Polyplacophora newly reported for the Korean molluscan fauna. Two specimens of *C. propior* were obtained during faunal surveys from two localities on both the north and south coasts of Jeju Island, off the southern coast of Korea. Although reference has been made to *C. propior* in several faunal and taxonomic studies, little is known about the ecology of this species, and only a few specimens have been collected since it was first described in 1930. Scanning Electron Microscopy (SEM) revealed the characteristics of *C. propior*: the granular rows on the median and tail valves, and the short, thick blunt spicules on the perinotum. Due to the present study, the distribution range of *C. propior* now extends from south-central Japan to Jeju Island, southwestern Korea.

Additional Keywords: Jeju Island

INTRODUCTION

Located in the northern East China Sea, Jeju Island has a warm humid temperate climate with an average yearly temperature of 16°C (Korean Meteorological Administration, 2013). The ocean around the island is a complex region, where three major water masses from the north and northwest are mixed. The warm Tsushima current washes the southern coastal area of the island, giving this area somewhat warmer winter sea surface temperatures than the rest of the country, ranging from 14-16 °C (Limpanont et al., 2010, 2011). During the summer, the sea surface temperature in Jeju often reaches a maximum temperature of 28 °C (Global Sea Temperature, 2013). Since Jeju Island is part of the Warm Temperate Northwest Pacific Province (Spalding et al., 2007), there is a strong affinity with the fauna of southern Japan and eastern China, and also northeast Taiwan (Noseworthy et al., 2007). Furthermore, many warmer water species of the Indo-West Pacific region also occur in Jeju Island. For the past 12 years surveys have been conducted to enumerate the mollusk fauna, with special attention to its biodiversity, biogeography, and ecology. According to Noseworthy et al. (2007), there are 1,072 mollusk species in Jeju Island, and 755 species are exclusively distributed in marine environments. Due to the extensive surveys, several species newly reported for the island fauna have been reported (Noseworthy and Choi, 2010; Noseworthy et al., 2012).

Currently, 12 species of Polyplacophora are known to occur in Jeju Island (Min et al., 2004; Noseworthy et al., 2007), and several other specimens which may represent new species records have been obtained. *Cryptoplax* occurs mainly in the warm Indo-West Pacific region as well as in cooler regions further south, such as South Africa, Tasmania, and Western Australia (Malacos.com, 2006).

In Japan four species of *Cryptoplax* have been reported (Saito, 2000), but only *C. japonica* Pilsbry, 1895 has been identified in Korea. This species ranges from Sakhalin Island southward to the southern Korean peninsula and Jeju Island. Here we report the occurrence of *Cryptoplax*

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propior Is. and Iw. Taki, 1930, a species newly reported for the Korean molluscan fauna.

MATERIALS AND METHODS

Two chiton specimens were obtained by SCUBA diving in the autumn of 2012 at Munseom, a small island about one kilometer south of Seogwipo harbor on the south coast of Jeju Island, and at Bukcheon-ri on the north coast (Figure 1). Both specimens were obtained at a depth of 5 m. These specimens were identified as belonging to Cryptoplacidae but did not resemble any members of this family found in the Korean fauna literature (for instance, Kwon et al., 1993, 2001; Min et al, 2004). An examination of the Polyplacophora in Saito (2000) and other Japanese literature revealed that it was a specimen of *Cryptoplax propior* Is and Iw. Taki, 1930. The species has not been previously reported from the Korean Peninsula.

The specimens were measured, examined with a stereo microscope, then fixed in 70% ethanol. They were compared with the original description of *C. propior* and with specimens of *C. japonica*, which most closely resembles *C. propior*. Valves and girdle were dissected from one of the specimens for further study, and a scanning electron microscope (JSM-6700F, JEOL Korea Ltd.) was used for the examination of each valve and the perinotum spicules. The material is stored at the School of Marine Biomedical Science, Jeju National University (#L145S1005).

As the Jeju Island material is separated from the original material in both space and time, it was deemed appropriate to redescribe the valves and girdle, the most distinctive features of this species. An examination of the morphology of the radula would have been useful but such a study could not be conducted because the specimens had been dried before being placed in ethanol. This created difficulties in extracting the radula and rendered it unusable. Radula studies can be done if more material becomes available in the future. The taxonomy used follows that of Sirenko (2006), and the descriptive nomenclature is based on that of Schwabe (2010).

An appendix to this work, by the same authors, **Appendix 1. A Catalogue of *Cryptoplax* Species,** is posted online at http://nautilus.shellmuseum.org.

SYSTEMATICS

Order Chitonida Thiele, 1909
Superfamily Cryptoplacoidea H. and A. Adams, 1858
Family Cryptoplacidae H. and A. Adams, 1858

Genus *Cryptoplax* Blainville, 1818

Type Species: *Cryptoplax larvaeformis* (Burrow, 1815), by subsequent designation.

Diagnosis: Mainly moderately-large to large vermiform chitons with reduced tegmentum and wide, rather fleshy girdle covered with spicules of varying shape and size.

Cryptoplax propior Is. and Iw. Taki, 1930

(Figures 1–19)

Type Locality: "Prov. Shima" (Shima Peninsula, now part of Mie Prefecture, southeastern Japan).

Material Examined: Jeju Island, Seogwipo-shi, Munseom (one specimen); Jeju Island, Bukcheon-ri (one specimen.)

Dimensions: Length, 22 mm, width, 7 mm (extended) (Munseom); Length, 8 mm, width, 4 mm (curled) (Bukcheon-ri.)

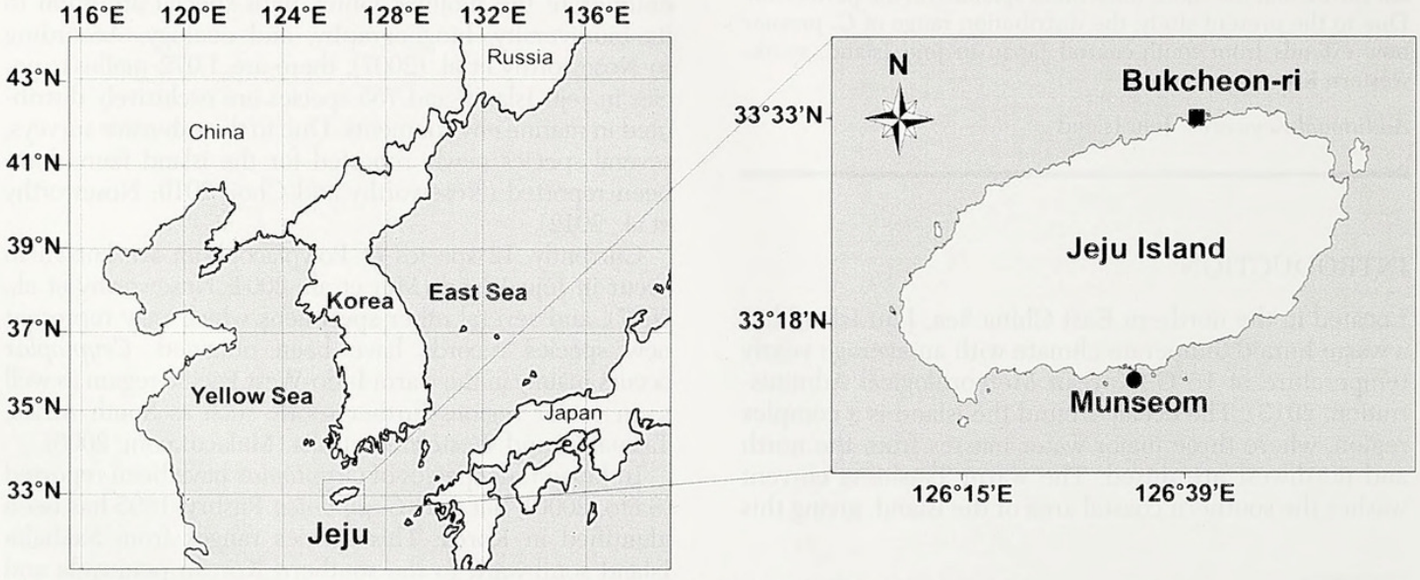
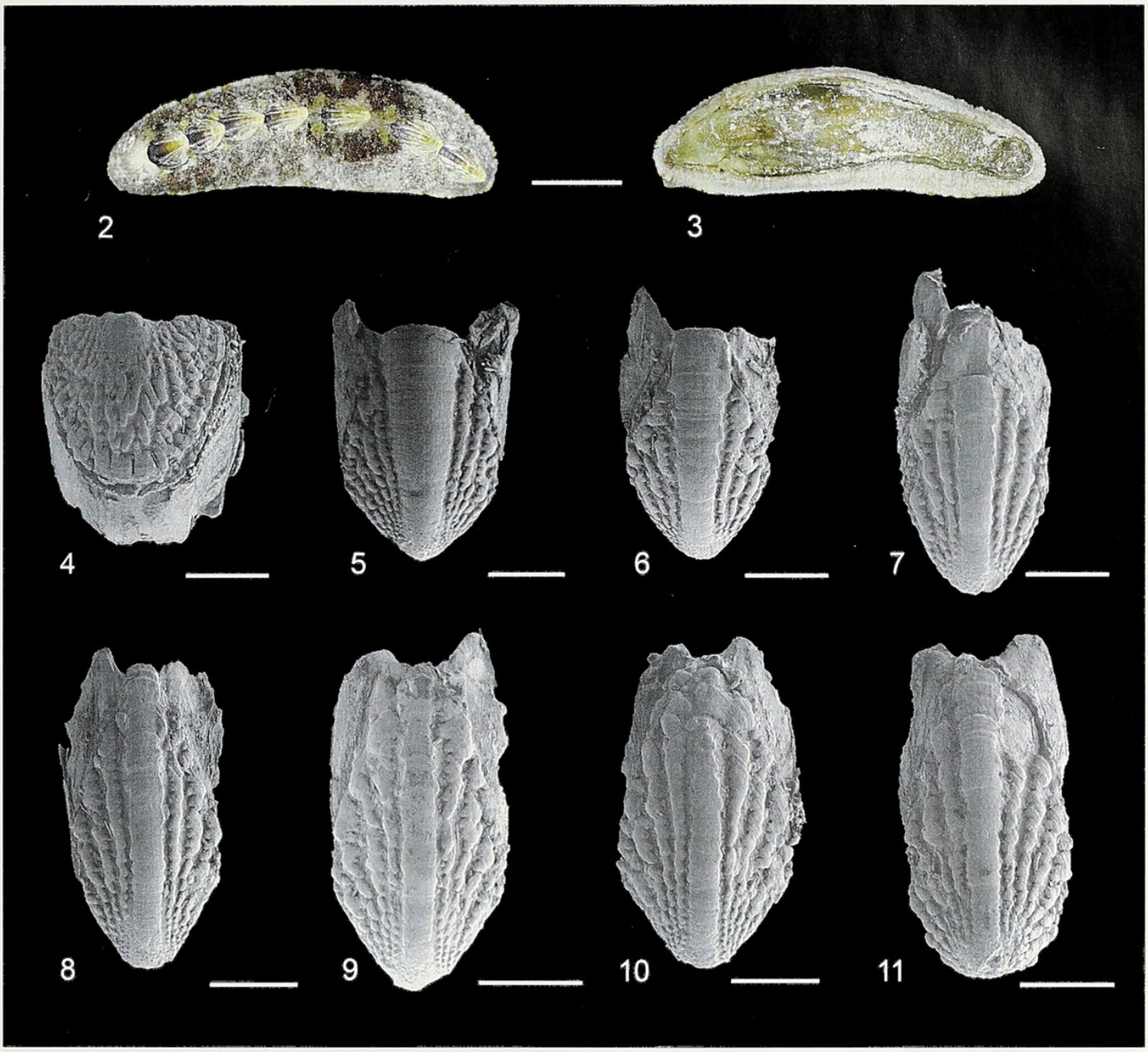


Figure 1. Sampling sites of specimens of *Cryptoplax propior*: ■: Bukcheon-ri; ●: Munseom



Figures 2–11. *Cryptoplax propior.* **2, 3.** Munseom, Jeju Island. **2.** Dorsal view. **3.** Ventral view. Scale bar = 1 cm. **4–11.** SEM view of ultrastructure of individual valves. **4.** Head valve. **5.** Second valve. **6-10.** Median valves. **11.** Tail valve. Scale bar = 1 cm.

Description: Tegmentum strongly reduced. Anterior four valves slightly overlapping; posterior four valves more widely separated (Figure 2). Color golden-brown; grooves between granulose rows somewhat lighter. Head valve rounded with moderately straight posterior margin, and possessing several indistinct granulated radial ridges and growth lines (Figure 4). Second valve round with wide, smooth jugum, tapering posteriorly, with low, longitudinal, lightly-beaded ridges. Apophyses moderately long, well-developed, with rather wide, shallow jugal lamina (Figure 5). Third to seventh valves (Figures 6–10) with about eight well-defined, slightly radiating, rather granulose rows on pleurolateral areas; jugum distinct, nearly parallel-sided. Valves narrow with slightly-beaked posterior ends; apophyses and jugal laminae similar to those of second valve but with narrower laminae. Tail valve (Figure 11) possesses posteriorly-terminal mucro directed backwards, apex overhanging terminal margin; antemucronal area exhibiting well-developed jugum. Radiating granular rows, apophyses, and jugal laminae similar to those of other valves. Length, height, and jugum length of valves provided in Table 1. Perinotum with dense, short, rather blunt spicules of unequal size, light purplish-brown mottled with grayish-tan, with light tan base. Girdle fringe grayish-white with irregular, indistinct reddish-brown areas, possessing rather short, rounded spicules (Figure 2). Foot grayish-brown with posterior area somewhat pointed (Figure 3), hyponotum light tan.

Table 1. *Cryptoplax propior.* Length, height, and jugum length of individual valves, from anterior to posterior (Munseom specimen). Measurements in mm.

Valve	Shell length	Shell height	Jugum length
1	2.179	2.003	–
2	2.325	2.981	0.873
3	1.916	2.768	0.547
4	1.755	3.289	0.423
5	1.843	3.445	0.395
6	1.766	3.263	0.314
7	1.864	3.263	0.324
8	1.710	3.248	0.410

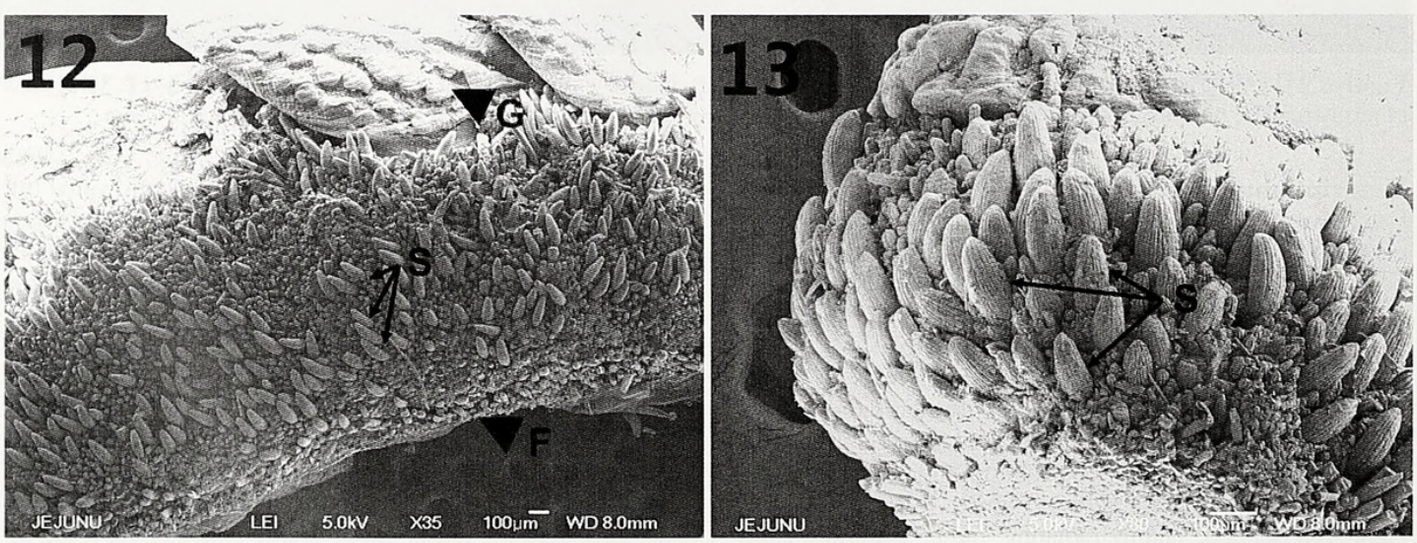
Remarks: The shape of the second, smaller specimen is more uniform, with parallel sides. The valves are similar in morphology to the dissected specimen, but are somewhat closer, suggesting a subadult specimen. However, there is no clear division between the head valve and the perinotum, the head valve appearing to blend into the orange-brown perinotum, which has dense, short, blunt spicules, somewhat coarser at both ends. The distinct girdle fringe has longer and coarser spicules which are whitish with small orange-brown patches. The foot, somewhat narrow and yellowish-white, is in the center of the ventral area, the hypnotum being a light grayish-tan.

Both specimens compare quite well with the original description and valve illustrations (Figures 14–17). The short, rather blunt spicules exhibit weak, vertical striations, as also mentioned in the description (Figure 18). However, the holotype (Figure 19) is larger with the extended length estimated at 33 mm, and has an elongate-oval shape with roundly-pointed extremities. Although the anterior of the dissected specimen is narrower, gradually widening to the posterior end, the shape of this specimen may be an artefact of preservation. Also, the tail valve of the Korean specimens is somewhat less pointed (Fig, 17). The color is somewhat different, the girdle of the holotype being reddish brown, while the dissected specimen has a purplish tinge and the second specimen is orange-brown. Additionally, the original description mentions a unicolored girdle, while the girdles of both Jeju specimens exhibit some mottling. Coloration in chiton species, often in the girdle, can be quite variable. Of the two specimens obtained, the smaller one resembles more closely the specimen figured in Saito (2000); however, the head valve in the illustration is more prominent.

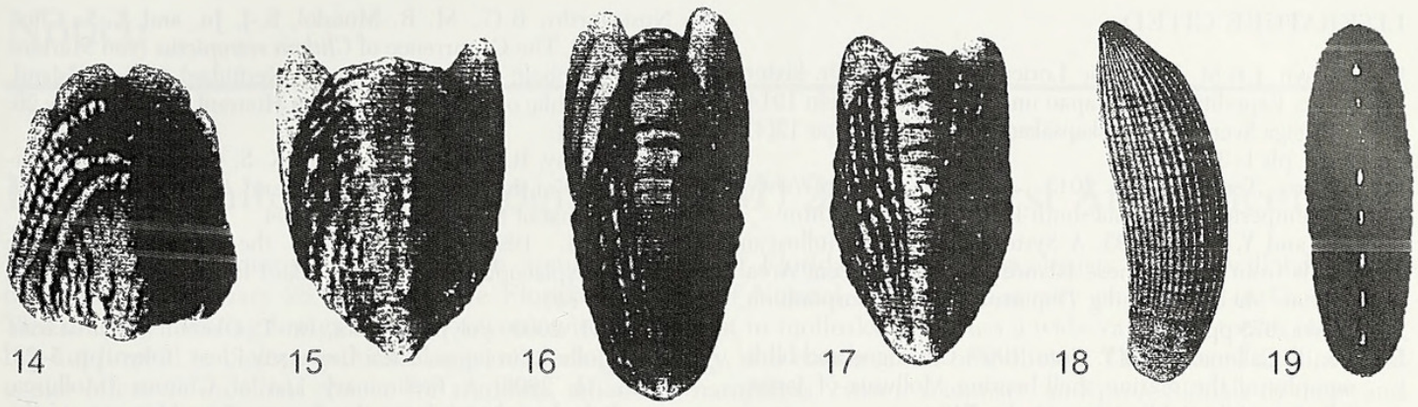
Distribution: South-central Japan to Jeju Island, southwestern South Korea.

DISCUSSION

Van Belle (1983; see also Kaas and Van Belle, 1998) and others have placed Cryptoplax in the subfamily Cryptoplacinae within Acanthochitonidae, but Sirenko (2006; see also Schwabe, 2014) has more recently accepted the same grouping as a family, Cryptoplacidae. Chitons belonging to *C. propior* are apparently much smaller than other adult members of this genus, and previously reported only from Izu-Oshima Island, south of Tokyo, eastern Japan, and the type locality, the Shima Peninsula, in east-central Japan, (Is. and Iw. Taki, 1930). Although the species has been known for the Japanese fauna for more than 80 years, surprisingly little is known about its distribution, ecology, and life cycle. Is. Taki, in various studies on Japanese Polyplacophora, made reference to it (1938; 1961; 1962). Saito (2000) included an illustration of a curled specimen, and Higo and Goto (1993) and Higo et al. (1999) included it in their listing of the Japanese Polyplacophora. Kaas and Van Belle (1998) also included this species in their catalogue of



Figures 12–13. *Cryptoplax propior.* SEM views of girdle and valves. **12.** Median area. **13.** Posterior area. Abbreviations: **s:** spicules; **f:** girdle fringe; **g:** granular rows.



Figures 14–19. *Cryptoplax propior*. Original illustrations. **14.** Head valve. **15.** Second valve. **16.** Median valve. **17.** Tail valve. **18.** Girdle spicule. **19.** Holotype (dorsal view). No scale provided. (From Is. and Iw. Taki, 1930, Venus, The Japanese Journal of Malacology; used with permission.)

Recent chitons, as well as Saito in his discussion of the taxonomy of the genus *Cryptoplax* (Saito, 1994).

The original detailed description made no mention of the habitat of *C. propior* or the depth at which it was obtained; however, Saito (2000), stated that it is found "on the rhizoids of laminarian brown algae in the subtidal zone". Bergenhayn (1933) examined specimens from the intertidal zone at Misaki (Miura), Sagami Bay, which resembled those in the original description, but were smaller and could possibly be subadults. According to Bergenhayn, his specimens agreed in the morphology of the tegmentum and radula with the original description but the tegmentum color was yellowish-white instead of brown (Bergenhayn, 1933). Leloup (1940) commented on Bergenhayn's specimens but provided no new details. Saito (2006) mentioned *C. propior* in his list of chitons from the Sagami Sea and questioned Bergenhayn's record, asserting that this species is usually found in the subtidal zone among rhizoids of laminarian algae. However, Higo et al. (1999), while including the Misaki reference, listed the habitat of this species as "intertidal, rocks and gravel", suggesting a less-restricted habitat.

Saito (2006) also stated that *C. propior* closely resembles juvenile specimens of *C. japonica*. According to Saito (2000), one of the characteristics that separates the two species is the presence of 'radiating rows of granules" on pleurolateral areas of *C. propior*. In correspondence, he also stated that the morphology of the larger spicules on the perinotum is an important feature in separating *C. propior* from *C. japonica*; these spicules are "very short, thick and rather blunt at the tip", while those of *C. japonica* are long, slender, and pointed (Saito, pers. comm.).

SEM photos of the median and posterior areas of the perinotum of the Jeju specimens (Figures 12, 13) show spicules that resemble Saito's diagnosis, as well as the radiating rows of granules on the valves (Figure 12). Furthermore, SEM photos of *C. propior* provided by Saito compare well with those of specimens from Jeju Island (Saito, pers. comm.). In contrast, Hong et al. (1999), in their description of *Cryptoplax japonica*, mention the larger perinotum spicules as being slightly curved, smooth, and sharply pointed at the tip, differing from the short, thick, blunt, often striated spicules of the specimens in this study. An examination of the valves and girdle spicules of juvenile and subadult specimens of *Cryptoplax* specimens obtained from the east coast of the island, revealed a coarser sculpture of fewer radiating granular ribs and long, slender, pointed spicules characteristic of *C. japonica*, thus confirming the presence of two distinct species on the island.

CONCLUSION

Cryptoplax propior has both a restricted distribution and habitat in Japan. It has now been obtained from two widely-separated localities in Jeju Island, and may have a wider distribution there. This species and *C. japonica* are the northernmost representatives of the genus *Cryptoplax*, with a relatively restricted range, being reported from the northwestern Pacific, mainly from Korea and Japan.

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