

New record of a sea star of genus *Solaster* (Asteroidea: Valvatida: Solasteridae) from the East Sea, Korea

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Abstract: Asteroid specimens were collected using fishing nets from the East Sea, Korea. The specimens were identified as *Solaster paxillatus* Sladen, 1889, belonging to the family Solasteridae of the order Valvatida. This species can be distinguished from three other Korean *Solaster* species by having 10 arms; subambulacral spines comprising four or five near base of arm, six or seven in middle part, and five or six in distal part of arm; furrow spines comprising four or five near basal part and three or four in distal part of arm; and suboral spines comprising more than ten spinules. The morphological characteristics of this species were described with illustrations. *Solaster paxillatus* is first reported in marine fauna of Korea.

Keywords: *Solaster paxillatus*, Solasteridae, Valvatida, East Sea, Korea

INTRODUCTION

The family Solasteridae Viguer, 1878 comprises nine accepted genera (*Crossaster* Müller & Troschel, 1840; *Heterozonias* Fisher, 1910; *Laetmaster* Fisher, 1908; *Lophaster* Verrill, 1878; *Paralophaster* Fisher, 1940; *Rhipidaster* Sladen, 1889; *Seriaster* Jangoux, 1984; *Solaster* Forbes, 1839 and *Xenorias* Fisher, 1913), with 23 *Solaster* species (Mah 2019). Solasteridae is considered as a boreal family occurring in shallow to moderately deep waters (Downey 1971). Many solasterid species are multi-armed, with the enlarged central disc, but some have only five arms and have orange body color (Lambert 2000). Abactinal ossicles of solasterids are metapaxillae and they can be quite varied in a single specimen. The marginal series are paxilliform in most genera, and somewhat inconspicuous. Superomarginals are commonly quite small, but almost always at least slightly enlarged relative to adjacent abactinals (Fisher 1911). With the newly recorded species, *Solaster paxillatus*,

in Korea, four species have been reported in Korean fauna. A key for Korean *Solaster* species was provided.

MATERIALS AND METHODS

Solaster specimens were collected using fishing nets from 8 Oct. 2009 to 10 Apr. 2019 from the East Sea (Daejin, Geojin, Mulchi, Donghae Daejin, Chogok) of Korea. The collected specimens were preserved in 95% ethanol, and morphological characteristics, such as the size of the disk, upper and proximal portions of the arms, number of abactinal spines, number of subambulacral spines, number of furrow spines, and number of oral and suboral spines were examined. We observed the external features of the specimens using a stereomicroscope. For observing the internal structures of the specimens such as the spines and the skeletal plates, sodium hypochlorite (5.25% solution) was applied carefully to dissolve the skin covering (Shin 2010). After

complete removal of the skin, the skeletal parts and spines were washed with sufficient amounts of water and observed again using the stereo-microscope. The morphological features of the specimens were photographed using a scanning electron microscope (JSM-6510; JEOL Ltd., Tokyo Japan), stereomicroscope (Nikon SMZ1000; Nikon Co., Tokyo, Japan), and digital camera (Nikon D7000). Abbreviations for measurements follow Ubagan and Shin, 2019.

SYSTEMATIC ACCOUNTS

Class Asteroidea de Blainville, 1830
 Superorder Valvatacea Blake, 1987
 Order Valvatida Perrier, 1884
 Family Solasteridae Viguiier, 1878
 Genus *Solaster* Forbes, 1839

Key to the species of genus *Solaster* in Korea

1. Arms 10 or more in number; paxillae on abactinal surface moderately large, not crowded; furrow spines three or more in proximal and distal portion of arm 2
- Arms eight in number; paxillae on abactinal surface small, closely crowded; furrow spines two in proximal and one in distal portion of arm *Solaster endeca*
2. Abactinal plates reticulated by three or more irregular plates; oral spines less than 10 in number, different from actinal spines 3
- Abactinal plates imbricated by three to five irregular plates; oral spines more than 10 in number, similar from actinal spines *Solaster uchidai*
3. Inferomarginal plates bearing 20–25 spinules; ventro-interbrachial area narrow, crowded with paxillae comprising five to 12 web spinules; suboral spines comprising three or four spinules *Solaster dawsoni*
- Inferomarginal plates bearing more than 30 spinules; ventro-interbrachial area wide, crowded with paxillae comprising seven to 18 web spinules; suboral spines comprising more than 10 spinules *Solaster paxillatus*

¹*Solaster paxillatus* Sladen, 1889

주황햇님불가사리 (신칭) (Figs. 1A–K, 2A–D)

Solaster paxillatus Sladen, 1889: p. 452, pl. 71, figs. 1–3, pl.

72, figs. 1–2; Fisher, 1911: p. 315, pl. 87, figs. 1–2, pl. 88, figs. 1–2, pl. 113, fig. 3; Hayashi, 1939: p. 303, pl. 24, figs. 5–6; Mah, 2019: 292727.

Material examined. One specimen, Donghae Daejin, 08 Oct. 2009; two specimens, Mulchi, 17 Oct. 2010; one specimen, Geojin, 29 Aug. 2014; one specimen, Chogok, 19 Dec. 2014; two specimens, Daejin, 19 Aug. 2015; one specimen, Daejin, 10 Apr. 2019.

Description. Arms 10 in number, long, slightly broad at base, tapering to tips; disk large, slightly elevated (Fig. 1A, B). Paxillae numerous, small, immersed in membrane, roundish (Figs. 1C, 2B) with small, slender 10–15 spinules (Fig. 2B). Abactinal skeleton irregularly reticulated with two or three lobed plates, covered by skin, situated midway between margin and center of disk. Papular areas containing five to ten or more papulae. Madreporite conspicuous with irregular striae, covered with some paxillae similar as abactinal paxillae (Fig. 1D). Marginal plates numerous, having two unequal series. Superomarginal plates smaller than inferomarginal plates, bearing 10 or more spinules slightly larger than adjacent abactinal paxillae. Inferomarginal plates large, numerous, forming paxilliform, bearing numerous spinules, inner part larger than outer end, forming two or three series, longer than superomarginal plates (Fig. 1F). Ventro-interbrachial area large, crowded with paxillae bearing seven to 18 web spinules (Fig. 2C), some paxillae forming fan-like shape and extending about one fourth length of arm (Fig. 1G). Furrow spines long, slender, comprising four to five near base of arm, and three to four in distal part of arm (Fig. 1H). Subambulacral spines comprising four to five near base of arm, six to seven in middle part, and five to six in distal part of arm (Fig. 1I–K). Oral plate broad, bearing nine or 10 bluntly pointed spines, inner three slightly longer and larger than subambulacral spines, middle spines larger than adjacent spines and forming elongated triangular shape. Suboral spines more than 10 in number, inner spines longer than outer spines (Figs. 1E, 2D).

Size. R = 145–225 mm, r = 46–70 mm, R/r = 3.1–3.2.

Distribution. Korea (East Sea), Japan (Honshu, south of Yeddo, Yokohama), Alaska (Kadiak Island).

Deposition. The collected specimens were deposited in the Marine Echinoderm Resource Bank of Korea (MERBK), Sahmyook University, Seoul, Korea.

Remarks. *Solaster paxillatus* had been first described by Sladen (1889) from south of Yeddo, Japan. The morphological characteristics of our specimens agree with the morphological description of Sladen (e.g. arm to disk ratio,

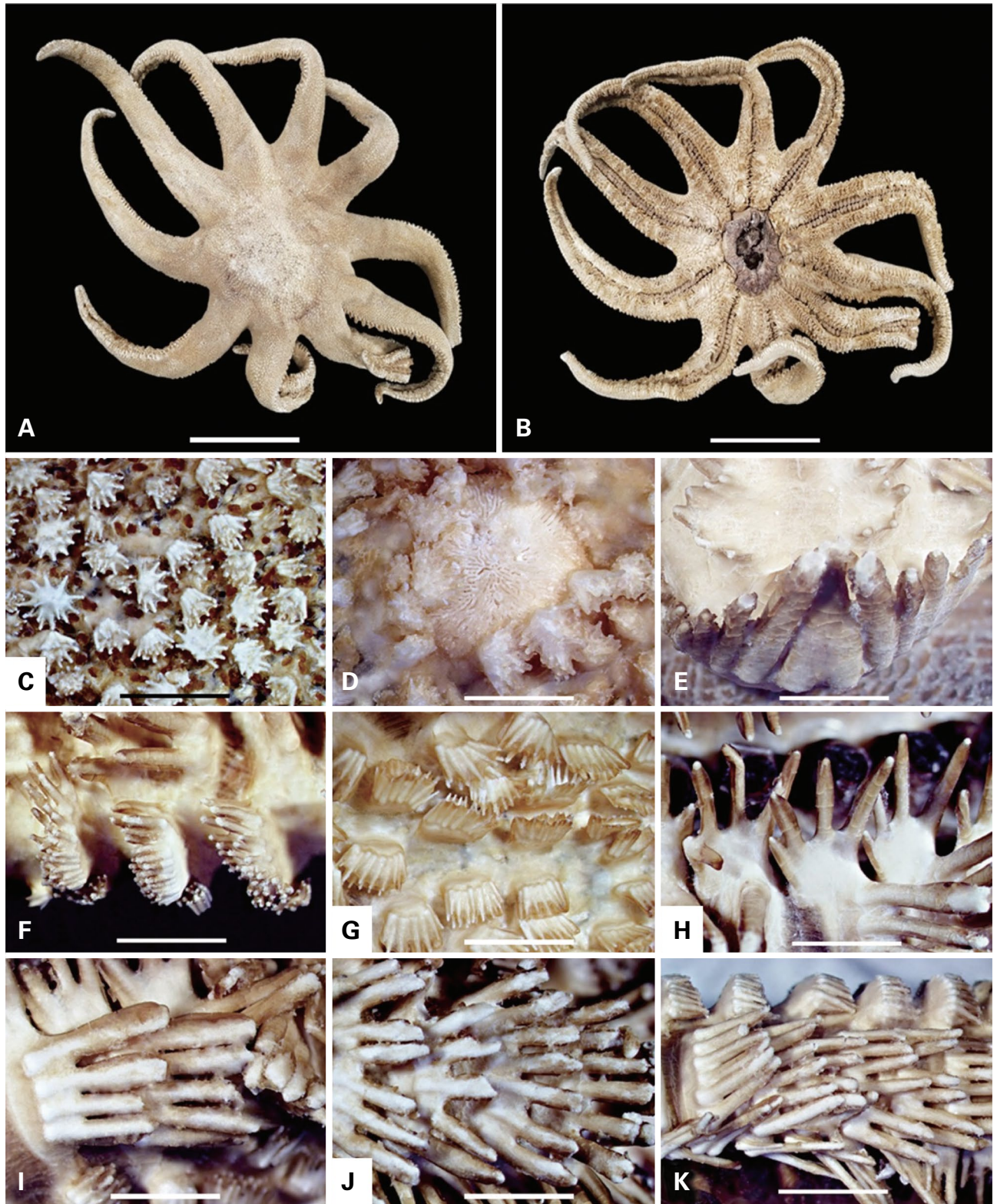


Fig. 1. *Solaster paxillatus*. A. abactinal side, B. actinal side, C. abactinal paxillae, D. madreporite, paxillae, E. oral spines, F. inferomarginal spines, G. ventro-interbrachial area, H. furrow spines (proximal part), I-K. subambulacral spines (I. proximal part, J. middle part, K. distal part). Scale bars: A, B = 3 cm, C-K = 1 mm.

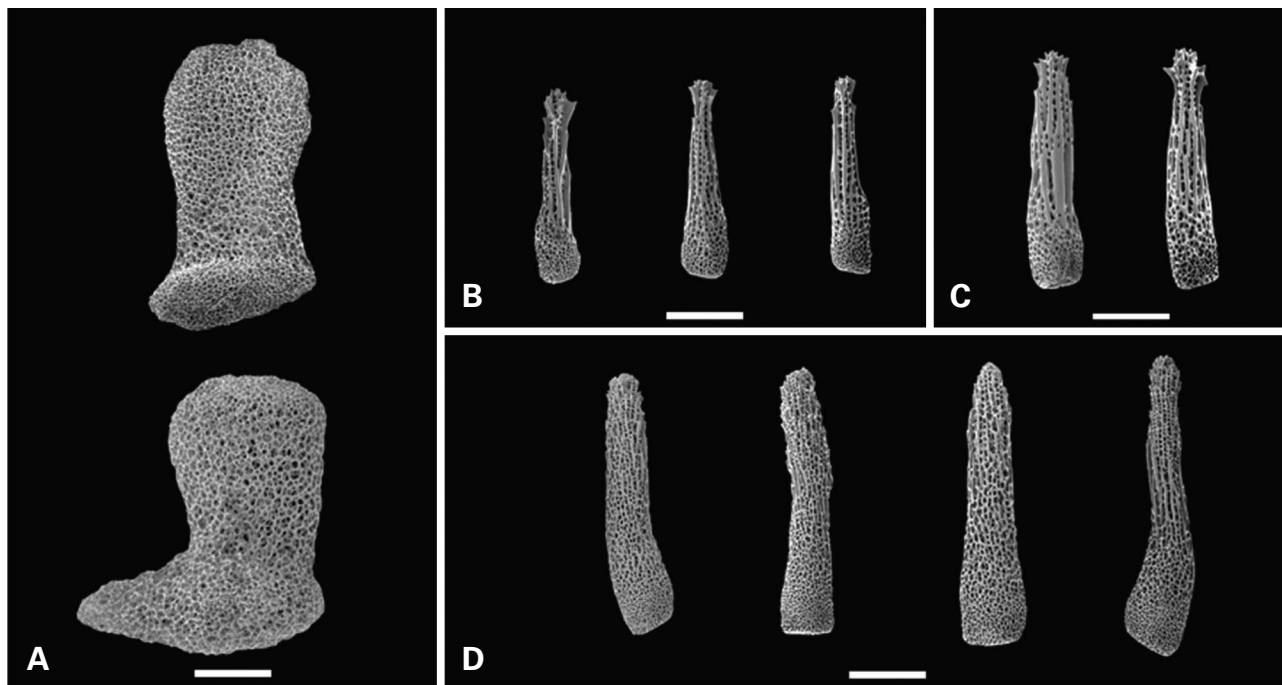


Fig. 2. *Solaster paxillatus*, paxillae and spines, SEM images. A. abactinal paxillae, B. abactinal spines, C. ventro-interbrachial spines, D. sub-oral spines. Scale bars: A, D = 500 μ m; B, C = 200 μ m.

Table 1. Comparison of morphological characteristics of *Solaster paxillatus* used in this study and original type material

Characters	<i>Solaster paxillatus</i> (this study)	<i>Solaster paxillatus</i> (Sladen, 1889)
Arms	10	9
Range of R/r	3.1–3.2	3–3.1
Shape of abactinal paxillae	Paxilliform with 10–15 spinules	Paxilliform with 10–12 spinules
Size of supermarginal plate	Small, slightly larger than neighboring paxillae of abactinal area	Small, slightly larger than neighboring paxillae of abactinal area
Number of spines in inferomarginal plate	30 or more skin-covered spinules	40–50 skin-covered spinules
Number of subambulacral spines	4–7	4 or 5
Number of oral spines	9 or 10	10
Number of furrow spines	4 or 5 in proximal part, 3 or 4 in distal part	4 or 5 in proximal part, 2 or 3 in distal part

disk size, shape of abactinal paxillae, size of supermarginal plates, and number of oral spines). Some slight differences such as the number of arms, number of subambulacral spines, and arrangement of furrow spines were observed (Table 1).

Our specimens can be distinguished from previously reported *Solaster* species in Korea such as *S. dawsoni* and *S. uchidai* by (1) the ventro-interbrachial area, *S. paxillatus* having wide ventro-interbrachial area with fan-shaped paxilliform (Fig. 1G), while *S. dawsoni* and *S. uchidai* has narrow ventro-interbrachial area; (2) the number of suboral spines, *S. paxillatus* has 11 or 12 spines, while *S. dawsoni* has three

or four, and *S. uchidai* containing one to five spines. The wide ventro-interbrachial area of *S. paxillatus* is nearly similar to *S. endeca*, but differs by the series of paxillae extending about middle of the arm in *S. endeca*, while in *S. paxillatus*, the series of paxillae just extending one fourth length of arm. *Solaster paxillatus* is first reported in Korean fauna.

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