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# A newly recorded tropical sea urchin, *Lovenia elongata* (Echinoidea: Spatangoida: Loveniidae), from Ulleungdo Island, Korea

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**Contribution to Environmental Biology**

- The discovery of *Lovenia elongata* from Ulleungdo Island in Korea expands our understanding of the distribution and ecology of this species, which is an important component of sub- and tropical Indo-Pacific biodiversity ecosystems.
- The newly recorded *L. elongata* in Korea also provides a valuable baseline for future studies on the ecology and conservation of this species and its habitat.

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**Abstract:** *Lovenia elongata* is a member of the family Loveniidae and is one of the most common tropical echinoids. This species has a broad distribution range in the sub- and tropical regions of the Indo-Pacific Ocean, extending from the Mozambique to the Hawaiian Islands, and from southern Japan to northern Australia. It is commonly found in subtidal areas and on coral reefs within these regions. This species was for the first time recorded from the Ulleungdo Island, Korea. This species is characterized by a teardrop-shaped test that reaches up to 5 cm in length, with a deep groove at the front and tapered at the back end. The petaloid is not obvious, and the primary spines are long and banded. This study is the first to report the newly recorded *L. elongata* in Korea.

**Keywords:** Echinodermata, echinoids, spatangoids, heart urchin, taxonomy

## 1. INTRODUCTION

The order Spatangoida L. Agassiz, 1840, also known as heart shape-bodied sea urchins, is the most diverse extant group of echinoids (Stockley *et al.* 2005), consisting of 17 extant families (Kroh and Mooi 2022). Among them, family Loveniidae Lambert, 1905, also known as sea porcupines, is a member of irregular echinoids characterized by their secondary bilateral symmetry. Unlike most sea urchins, members of the Loveniidae exhibit different anterior-posterior ends, with the mouth and anus located ventrally and distally on an oval-shaped horizontal plane (Clark and Rowe 1971; Shigei 1986; Rowe and Gates 1995). The family currently includes five systematically recognized genera (Kroh and Mooi 2022).

*Lovenia elongata* (Gray 1845) is classified in the genus *Lovenia* Desor in Agassiz and Desor, 1847, along with nine congeners (Kroh and Mooi 2022). This species a common sea urchin in the sub- and tropical regions of the Indo-Pacific Ocean, ranging from the Mozambique to the Hawaiian Islands, and from southern Japan to northern Australia (Rowe and Gates 1995; Kroh and Mooi 2022). Within this region, it is commonly found in subtidal areas and on coral reefs (Clark and Rowe 1971; Rowe and Gates 1995). In this study, we discovered this species from Ulleungdo Island in Korea and provide a detailed redescription of its morphological

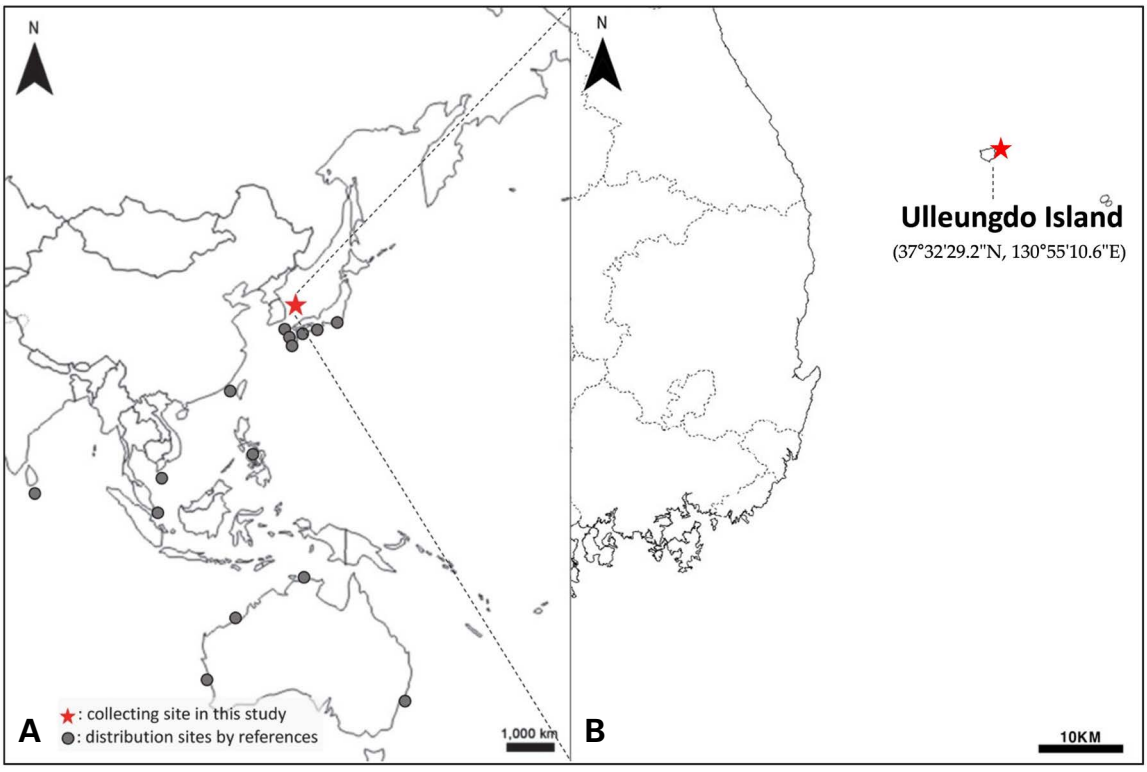


**Fig. 1.** Distribution of *Lovenia elongata* (Gray, 1845). The collection locality in this study is marked on the map with a star symbol (★), and distribution sites based on references are marked with a circle symbol (●).

characteristics, including high-resolution of photographs.

## 2. MATERIALS AND METHODS

Specimens of *Lovenia elongata* were collected on April 28, 2022 during the SCUBA diving survey of Ulleungdo Island, Korea (Fig. 1). After being photographed with a digital camera (G7Xmk2; Canon, Tokyo, Japan), the specimens were immediately preserved in an ethyl alcohol solution (>95%). The preserved specimens were stored at the National Institute of Biological Resources, Korea (NIBR). The test and spines of specimens were then imaged in high-resolution using a digital camera, and their detailed structures were observed with a stereo-microscope (SZ-61; Olympus, Tokyo, Japan). The specimens were identified using traditional taxonomic characters described by Gray (1845) and Shigei (1981a).

## 3. SYSTEMATIC ACCOUNTS

Phylum Echinodermata Klein, 1778
Subphylum Echinozoa Haeckel in Zittel, 1895
Class Echinoidea Schumacher, 1817
Subclass Euechinoidea Bronn, 1860
Infraclass Irregularia Latreille, 1825
Subterclass Atelostomata von Zittel, 1879
Order Spatangoida L. Agassiz, 1840
Suborder Brissidina Stockley, Smith, Littlewood, Lessios and MacKenzie-Dodds, 2005
Superfamily Spatangoidea Gray, 1825
Family Loveniidae Lambert, 1905

**Key to the genus of family Loveniidae in Korea**

1. Test not low. Labral plate wide and short. Paired sternal plates relatively large and fully tuberculate ·· ·····*Echinocardium*
– Test low. Labral plate narrow and elongated. Paired sternal plates narrow and triangular with tuberculation confined to posterior part only····· ***Lovenia***

Genus *Lovenia* Desor in L. Agassiz and Desor, 1847
참염통성게속(신칭)

*Lovenia* L. Agassiz and Desor, 1847: 10; Shigei, 1986: 157; Rowe and Gates, 1995: 230; Kroh and Mooi, 2022: 205266.

**Type species.** *Lovenia hystrix* Desor in L. Agassiz and Desor, 1847 (synonymized as *Lovenia elongata* (Gray, 1845).

***Lovenia elongata* (Gray, 1845) (Fig. 2)**
긴참염통성게(신칭)

*Spatangus elongata* Gray, 1845: 436.

*Lovenia hystrix* L. Agassiz and Desor, 1847: 11.

*Lovenia elongata* Gray, 1851: 131; A. Agassiz, 1872: 139; 1881: 175; Döderlein, 1885: 107; Meijere, 1904: 193; Döderlein, 1906: 265; Koehler, 1914: 111; H.L. Clark, 1917: 252; 1938: 439; Mortensen, 1948: 136; Utinomi, 1954: 355; Nishiyama, 1968: 397; A.M. Clark and Rowe, 1971: 164; Shigei, 1981a: 203; 1986: 157; Rowe and Gates, 1995: 230; Liu, 2008: 869; Kroh and Mooi, 2022: 214656.

*Lovenia camarota* H.L. Clark, 1917: 253.

**Material examined.** Two specimens, Ulleungdo Island: Ulleung-gun: Gyeongsangbuk-do, Korea (37° 32′29.2″N, 130°55′10.6″E) (Fig. 1B), 28 Apr. 2022, collected by Lee T. via SCUBA diving, a depth of 19.5 m, a water temperature of 15°C, moderate and coarse sand substrate, deposited in NIBR (NIBRIV0000901193).

**Description.** Test medium-sized, delicate, longer than wide, with conspicuous anterior notch (Fig. 2A). Frontal ambulacrum narrow, and slightly grooved. Posterior interambulacrum raised, and posterior end deeply grooved (Fig. 2A, E). Apical system located nearby center, slightly sunken, with four genital pores (Fig. 2F). Madreporite large. Periproct large, situated obliquely under roof of posterior end. Oral side slightly concave, near of posterior end raised. Peristome kidney-shaped. Labral plate narrow and elongated. Sternal plates not broad, appearing naked, posteriorly tuberculated. Anterior ambulacrum somewhat indented, with porepairs differentiated, paired petals, wide at internal fasciole, narrowing towards distal ends. Primary spines in antero-lateral part of aboral side very long with brown band, gently curved, directed posteriorly (Fig. 2G). Large primary tubercles 15 (specimen 1) and 18 (specimen 2) in antero-lateral interambulacrum, and about 22 (specimen 1) and 23 (specimen 2) in each postero-lateral interambulacrum. Periproct positioned at upper side of posterior invagination.

**Size.** Specimen 1: Length of test 27.5 mm, height 10.8 mm, width 24.7 mm; Specimen 2: Length of test 46.5 mm, height 17.9 mm, width 36.5 mm.

**Color.** The live specimen is covered with brown to reddish spines, and the denuded test is white.

**Distribution.** Korea (Ulleungdo Island), Japan (Sagami Bay, Oki Islands, southern Japan), Singapore, Vietnam, Philippine, North Australia, Indo-Pacific, Ceylon, Persian Gulf, Mozambique.

**Remarks.** Five species of *Lovenia* inhabit the waters adjacent to Korea, as well as southern Japan (Shigei 1981b; 1986) and South China Sea (Liu 2008): *L. elongata*, *L. gregalis* Alcock, 1893, *L. lata* Shigei, 1981, *L. subcarinata* Gray, 1951 and *L. triforis* Koehler, 1914. Among them, *L. elongata* is distinguished from the other four species by certain morphological characteristics: 1) four genital pores (compared to three in *L. triforis*); and 2) a deeply sunken posterior end of the test (in contrast to *L. gregalis*, *L. lata*, and *L. subcarinata*, which have slightly sunken or unsunken posterior ends, respectively). These two characters were important in identifying *Lovenia* species in previous taxonomic studies by Shigei (1981, 1986b) and Clark and Rowe (1971). Therefore, the unidentified *Lovenia* species in this study has been identified as *L. elongata*.

*Lovenia elongata* is a widely distributed tropical sea urchin, ranging from Mozambique in eastern Africa to the western Pacific (Rowe and Gates 1995; Kroh and Mooi 2022). Despite this broad distribution, no significant morphological variation has been reported within the species in any of its range. However, some morphological variation in the slope on the aboral side of the test has been observed in *L. elongata*, specifically in the height of the slope line on lateral view, this variation is not significant for species delimitation (Clark and Rowe 1971). Similar cases of non-significant morphological variation have been reported in other echinoid species, such as *Strongylocentrotus pallidus* (Sars 1871), as noted in a previous study that used both morphology and DNA barcoding by Lee and Shin (2011).

*Lovenia elongata* is a common tropical echinoid species. Our specimens were collected from Ulleungdo Island, which is affected by the East Korea Warm Current (EKWC), a major branch of the Tsushima Warm Current that flows into the East Sea (Pak *et al.* 2019). The EKMC has gradually extended its influence and

 


**Fig. 2.** *Lovenia elongata* (Gray, 1845). A, a test of aboral side; B, a test of oral side; C, a test of lateral side; D, periproct and posterior side; E, a test of anterior side; F, apical disks in aboral side; G, large primary spine; H, stinger in the large primary spine; I, small spine from ventro-lateral side; a, anterior; p, posterior. This sample (specimen 2: larger one) is stored at NIBR (NIBRIV0000901193).

causes strong temporal variability between 36°N and 40°N in the East Sea, from 1995 to the present (Pak *et al.* 2019). As the EKWC transports heat and salt northward, it affects not only the surface circulation and physical environment but also the deep circulation (Park 2007). Previously, the northernmost record of *L. elongata* was from the Oki Islands in central Japan, located at 34°14′43″N (Saitoh and Kanazawa 2012). Our collection from Ulleungdo Island, therefore, represents a new northern record and suggest that this island is exposed to a stronger influence from a branch of the Kuroshio Warm Current than before.

**CRediT authorship contribution statement**

J Lee: Investigation, Formal analysis, Writing-Original draft. T Lee: Investigation, Formal analysis, Resources, Supervision, Writing-Review & editing.

**Declaration of Competing Interest**

The authors declare no conflicts of interest.

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