

## Two newly recorded sea stars of genus *Henricia* (Asteroidea: Spinulosida: Echinasteridae) from the East Sea, Korea

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### Contribution to Environmental Biology

- The description of the two *Henricia* species provides important information for understanding taxonomical insights of *Henricia* species in Korea.
- The results of this study make a valuable contribution to the research on the taxonomy and species diversity of Korean echinoderms.

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**Abstract:** Two newly recorded sea stars, *Henricia densispina* (Sladen, 1879) and *H. reniossa asiatica* Djakonov, 1958, collected from the East Sea of Korea using fishing nets, were described in this study. Morphologically, *H. densispina* is characterized by the shape (sub-triangular) similarity of the intermarginal plates to the superomarginal plates. *Henricia reniossa asiatica* Djakonov, 1958, has long and slender arms ( $R/r = 7.2-9.1$ ); clustered abactinal paxillae with 3-13 abactinal spinelets; a denuded abactinal skeleton made up of crescentic, elongated cross-shaped, the presence of small ossicles that divided the papular areas; and an adambulacral armature comprised of 14-17 spinelets. This study provides the first occurrence of *H. densispina* and *H. reniossa asiatica* in the Korean fauna and a detailed morphological description of these species' key characteristics is provided.

**Keywords:** biodiversity, echinoderms, morphology, sea stars, taxonomy

## 1. INTRODUCTION

The genus *Henricia* is a diverse group of sea stars found in various marine habitats worldwide (Blake 2010; Mah and Foltz 2011). These echinoderms are known for their striking coloration and unique morphology, with long, slender arms and abactinal paxillae (Mah *et al.* 2010). In Korea, *Henricia* species are commonly found along the rocky intertidal zone and have been subject to extensive taxonomic study in recent years. With 16 known species in the genus *Henricia*, represents a significant component in the marine fauna of Korea (Shin 2010; Ubagan *et al.* 2020; Ubagan *et al.*

2023).

Recent taxonomic studies of *Henricia* species in Korea have revealed previously unrecognized diversity within the genus, with new species described in recent years (Ubagan *et al.* 2020). These discoveries highlight the importance of continued taxonomic research in the region and the need for more comprehensive survey efforts to document the marine biodiversity of Korea. In this context, the present study contributes to our understanding of the diversity and distribution of *Henricia* species in Korea by shedding light on the morphological variation within *Henricia* species.

The Korean Peninsula is situated in a biogeographi-

cally complex region, with influences from the North Korea Cold Current and the Tsushima Warm Current in the southern part of the Japan/East Sea. These complex interactions between currents play a crucial role in shaping the hydrographic conditions and biodiversity patterns of the region (Hong and Cho 1983; Rebstock and Kang 2003). This unique location has resulted in a high diversity of marine habitats in Korean seas (Khim *et al.* 2021). Despite this richness, the biodiversity of many marine groups, including echinoderms, remains poorly understood. The limited survey efforts in many areas of Korea have hindered efforts to document and understand the diversity of sea stars in the region.

## 2. MATERIALS AND METHODS

Asteroid specimens were collected from the coastal waters of the East Sea (Daejin, Geojin and Uljin) of Korea, using a fishing net. The collected specimens were preserved in 95% ethanol, and the morphological characteristics were examined, such as the size of the disk, the upper and proximal portions of the arms, the number of abactinal spines, the shape of the abactinal and actinal skeletons, and the number of adambulacral spines. The morphological features of the specimens were photographed by using a scanning electron microscope (JSM-6510; JEOL Ltd., Tokyo, Japan), a stereomicroscope (Nikon SMZ1000; Nikon Co., Tokyo, Japan), and a digital camera (Nikon D7000). The abbreviations for the measurements followed those used by Ubagan *et al.* (2023).

## 3. SYSTEMATIC ACCOUNTS

Class Asteroidea de Blainville, 1830  
Order Spinulosida Perrier, 1884  
Family Echinasteridae Verrill, 1870  
Genus *Henricia* Gray, 1840

### *Henricia densispina* (Sladen, 1879)

삼각애기불가사리 (신칭) (Fig. 1A–K)

*Cribrella densispina* Sladen, 1879: 432.

*Henricia densispina* Fisher, 1919: 436; Hayashi, 1940: 140; Djakonov, 1961: 20; Mah, 2023a: 369105.

**Material examined.** One specimen, Gyeongsangbuk-

do, Uljin-gun, Uljin-eup, Mangyang-ri (36°51'09.9" N 129°26'17.18"E), 24 May 2013, deposited in NIBR (NIBRHVBNIV0000000592).

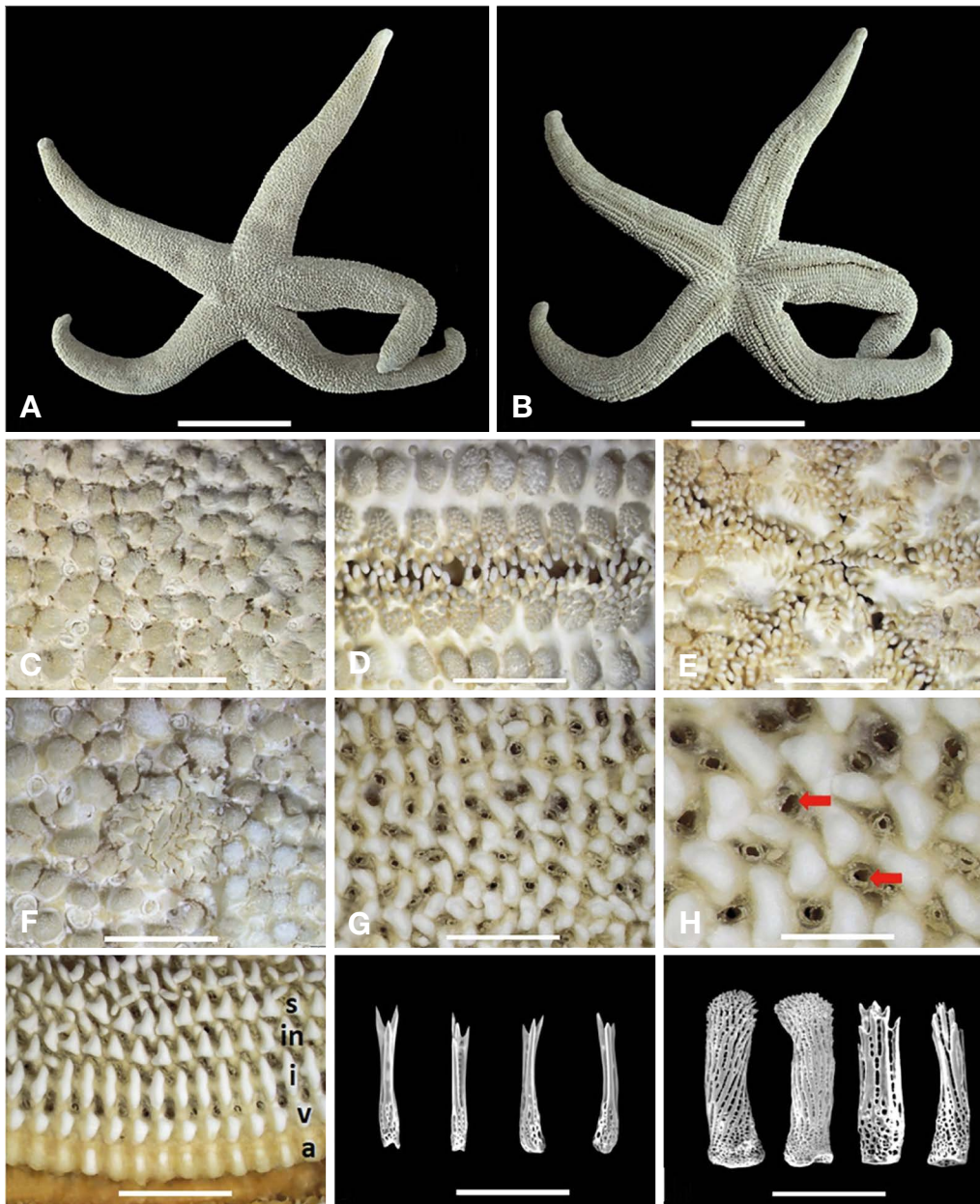
**Description.** Arms five, moderately long, gradually tapering to tips; disc small (Fig. 1A, B). Abactinal paxillae clustered, containing more than 25 abactinal spinellets with sharp apical tip (Fig. 1C). Denuded abactinal spines slender with three to four sharp apical tips (Fig. 1J). Papular areas narrow with irregular shapes, containing one or two, rarely three papulae in an area (Fig. 1C, H). Denuded abactinal skeleton closed meshed, imbricated, comprised of sub-triangular shaped with plate raised centrally (Fig. 1G). Madreporite sunken, situated near margin of disk, semi-circular in form, and bearing spines similar as adjacent spines (Fig. 1F). Denuded actinal skeleton showing four series of plates (superomarginal, intermarginal, inferomarginal, and ventrolateral) which diverging near arm tip, leaving intermarginal plates wide spaces. Superomarginal slightly larger than the intermarginal plates, forming sub-triangular plates slightly similar to the abactinal plates. Intermarginal plates similar form as superomarginal plates with smaller sizes, extending near tip of arm. Inferomarginal plates imbricated, elongated cross-shaped, reaching near tip of arm. Ventrolateral plates rounded cross-shaped showing smaller sizes to adjacent plates; narrow papular areas with one or two papulae (Fig. 1I). Adambulacral armature composed of 23–29, robust spinelets, inner two or three spatulate-shape, larger spines, arranged in transverse rows (Fig. 1D). Oral plate bearing two spatulate spines, four marginal spines, and six sub-oral spines (Fig. 1E). Furrow spine single, doubled distally.

**Size.** R = 72 mm, r = 14 mm, R/r = 5.1.

**Habitat.** Hard substrates (rocks).

**Distribution.** Korea (East Sea); China (Bohai Sea); Japan (Aomori Bay, Madara Island); Philippines; Russia (Tartar Strait, Kurile Island).

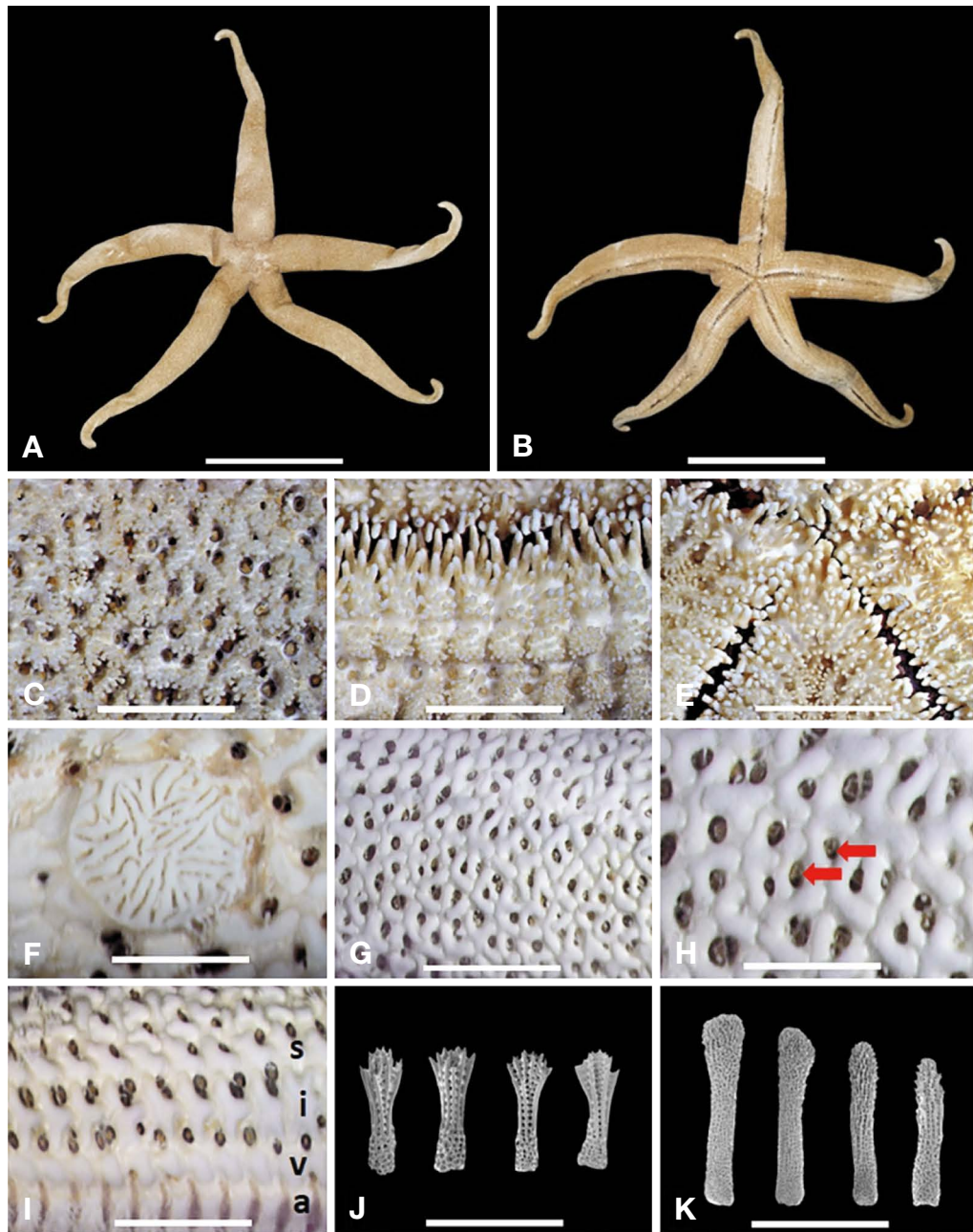
**Remarks.** *Henricia densispina* was first described by Sladen in 1879 and collected from the Korea Strait near Madara Island, Japan. This species was also recorded by Fisher in 1919 during the Philippine cruise of the Albatross. Hayashi (1940) declared in his examination that this species resembled *H. leviuscula leviuscula* and *H. leviuscula spiculifera* based on their structures of the abactinal skeleton, marginal plates, and sub-adambulacral spines. As we examined this species, we noticed that our specimen is closely related to *H. regularis* Hayashi (1940), in physical appearance. Moreover,



**Fig. 1.** *Henricia densispina* (Sladen, 1879). A. abactinal side; B. actinal side; C. abactinal paxillae; D. adambulacral spines; E. oral part; F. madreporite; G. abactinal skeleton; H. papulae (arrows); I. actinal skeleton: superomarginal plates (s); intermarginal plates (in); inferomarginal plates (i), ventrolateral plates (v), adambulacral plates (a); J. abactinal spines (SEM); and K. adambulacral spines (SEM). Scale bars: A, B = 2 cm, C-I = 1 mm, J = 100  $\mu$ m, K = 200  $\mu$ m (J, K, SEM images).

the analyses of the number and shape of the abactinal spines, the structure and shape of the abactinal and actinal plates, and the number of the adambulacral spines were all agreed upon in the descriptions of Fisher (1919) and Hayashi (1940). The similarity of the shape of the

intermarginal to the superomarginal was also noted by Hayashi (1940) as one of the key characters to separate this species from the species *H. regularis* and *H. exigua*, of which this particular key character is also possessed by our specimen. *Henricia densispina* is newly recorded



**Fig. 2.** *Henricia reniessa asiatica* Djakonov, 1958. A. abactinal side; B. actinal side; C. abactinal paxillae; D. adambulacral spines; E. oral part; F. madreporite; G. abactinal skeleton; H. papulae (arrows); I. actinal skeleton: superomarginal plates (s), inferomarginal plates (i); ventrolateral plates (v), adambulacral plates (a); J. abactinal spines (SEM); and K. adambulacral spines (SEM). Scale bars: A, B = 3 cm, C–I = 1 mm, J = 100  $\mu$ m, K = 500  $\mu$ m (J, K, SEM images).

in the Korean fauna.

***Henricia reniessa asiatica* Djakonov, 1958**  
 긴팔애기불가사리(신칭) (Fig. 2A–K)  
*Henricia reniessa asiatica* Djakonov, 1958: 303; Chich-

varkhin and Chichvarkhina, 2017a: 208; 2017b: 25.  
 Mah, 2023b: 369139.

**Material examined.** Two specimens, Gangwon-do, Goseong-gun, Hyeonnae-myeon, Daejin-ri, Daejin,



Korea (38°29'55.5"N 128°25'57.5"E), 26 Aug. 2013; three specimens, Goseong-gun, Geojin-eup, Geojin-ri, Geojin, Korea (38°27'2.06"N 128°28'22.5"E), 21 Dec. 2014; three specimens, Gangwon-do, Goseong-gun, Geojin-eup, Geojin-ri, Geojin, Korea (38°26'50.7"N 128°27'59.2"E), 27 Nov. 2015, deposited in NIBR (NIBRHVBNIV0000000591).

**Description.** Arms five, long, slender, subcylindrical, tapering to tips; disc small (Fig. 2A, B). Abactinal paxillae clustered, containing more than three to 13 abactinal spinelets with multiple, uneven apical tip (Fig. 2C, J). Papular areas narrow with irregular shapes, containing one to three papulae in an area (Fig. 2C, H). Denuded abactinal skeleton closed meshed, imbricated, comprised of crescentic, elongated cross-shaped, with some small ossicles dividing the papular areas (Fig. 2G). Madreporite sunken, situated near margin of disk, semi-circular in form, and bearing spines similar as adjacent spines (Fig. 2F). Denuded actinal skeleton showing four series of plates (superomarginal, intermarginal, inferomarginal, and ventrolateral) which slightly diverging near arm base, leaving intermarginal plates spaces. Superomarginal slightly smaller than the inferomarginal plates, forming reniform plates, reaching near tip of arm. Intermarginal plates similar form as superomarginal plates, present near basal arm. Inferomarginal plates imbricated, elongated cross-shaped, reaching tip of arm. Ventrolateral plates rounded cross-shaped showing similar size to adjacent plates; narrow papular areas with one or two papulae (Fig. 2I). Adambulacral armature comprised of 14–17 spinelets, inner two or three spatulate-shape, larger spines, arranged in transverse rows (Fig. 2D). Oral plate bearing two stout tip spines, three marginal spines, and six or seven sub-oral spines (Fig. 2E). Furrow spine single.

**Size.** R = 101–116 mm, r = 11–16 mm, R/r = 7.2–9.1.

**Habitat.** Hard substrates (rocks).

**Distribution.** Korea (East Sea); Russia (Dzhigit Bay, Tatar Strait, Sea of Japan).

**Remarks.** In 1958, a Russian taxonomist named A.M. Djakonov published the first description of a sea star species called *Henricia reniossa asiatica*. This description was later reviewed by Chichvarkhin in 2019. We collected some long-armed specimens from the East Sea and analyzed them in detail. Our analysis involved comparing our specimen to other slender-armed *Henricia* species, *Henricia reniossa reniossa* Hayashi (1940). The results suggest four key differences be-

tween our specimen and *H. reniossa reniossa*: 1) our specimen had a longer arm-to-disc ratio (R/r = 7.2–9.1) compared to *H. reniossa reniossa* (R/r = 5.5); 2) our specimen had 3–13 abactinal spines, while *H. reniossa reniossa* had 15–60 or more; 3) the shape of abactinal plates (our specimen: the crescent shape abactinal plates were not uniformly arranged, with small ossicles in the concave side of the abactinal plates; *H. reniossa reniossa*: the crescent shape of abactinal plates were uniformly arranged, without small ossicles in the concave side of the abactinal plates); and 4) adambulacral spines (our specimen: 14–17; *H. reniossa reniossa* has 15–25). The comparison of our specimen with the holotype of *H. reniossa asiatica* described by Djakonov in 1958 revealed close similarities in most traits, validating its identification as the same species. However, minor variations were observed in the number of abactinal spines although these differences were not substantial enough to warrant the recognition of a distinct species. *Henricia reniossa asiatica* is first reported in the Korean fauna.

## CRedit authorship contribution statement

**MD Ubagan:** Conceptualization, Data curation, Methodology, Investigation, Visualization, Writing-Original draft, Writing-Review & editing. **S Shin:** Resources, Project administration, Funding acquisition, Supervision, Writing-Review & editing.

## Declaration of Competing Interest

The authors declare no conflicts of interest.

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