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Newly recorded sea star *Henricia oculata* (Asteroidea: Spinulosida: Echinasteridae) in the East Sea, Korea

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Abstract: *Henricia* specimens were collected using fishing nets from the East Sea of Korea. The specimens were identified as *Henricia oculata* Pennant, 1777, belonging to the family Echinasteridae of the order Spinulosida. This species can be distinguished from other *Henricia* species by broad arms (R/r = 4–4.1), rough skin, a thick arm base, three to nine minute delicate abactinal spines, and inferomarginal plates reniform in shape. This species superficially resembles *H. pachyderma* in its body size and wide papular areas but differs mainly in the number of papulae and abactinal spines, and the shape and arrangement of the inferomarginal plates. To date, two genera of Echinasteridae, *Aleutihenricia* and *Henricia*, with a total of 13 species, have been reported in Korea. The morphological characteristics of *H. oculata* are described, and photographs are provided.

Keywords: distribution, Echinasteridae, *Henricia oculata*, East Sea, Korea

INTRODUCTION

The family Echinasteridae is currently populated by eight genera, of which two genera, *Aleutihenricia* and *Henricia*, are present in the Korean fauna. *Henricia* is the most diverse of the echinasterid genera and includes 94 described species. Although *Henricia* species are well distributed worldwide, the complexity of the morphological characteristics in several of the recognized species has been poorly described. Historically, the taxonomy of *Henricia* has been based on traditional morphology, using the main diagnostic characteristics from the abactinal and actinal morphological characteristics (i.e., the shape and number of abactinal and actinal spines, the shape of abactinal and actinal skeletons, and the number of adambulacral spines). Previous taxonomic research performed on *Henricia* species in the western Pacific (Fisher 1911; Djakonov 1940; Hayashi 1940) was a major contribution to the classification of this group of species. In the classification of *Henricia* species, individual species cannot be correctly separated based on only one characteristic. Moreover, only a set of individual characteristics that can reliably separate species has been used for *Henricia* identification (Bratova and Paskerova 2017). Currently, 11 *Henricia* species have been recorded in Korea (Ubagan and Shin 2019a, b, c, 2020): *H. anomala* Hayashi, 1973; *H. elachys* Clark & Jewett, 2010; *H. leviuscula* Stimpson, 1857; *H. nipponica* Uchida, 1928; *H. ohshimai* Hayashi, 1935; *H. pachyderma* Hayashi, 1940; *H. pacifica* Hayashi, 1940; *H. perforata* (O.F. Müller, 1776); *H. regularis* Hayashi, 1940; *H. reniossa* Hayashi, 1940; and *H. sanguinolenta* (O.F. Müller, 1776). Most *Henricia* species are distributed in the East Sea of Korea.

MATERIALS AND METHODS

The *Henricia* specimens were collected from waters near Namae and Shinnam, Korea, using fishing nets on March 3, 2014, and September 12, 2014, respectively. The collected specimens were preserved in 95% ethanol, and the following morphological characteristics were examined: the size of the disk, upper and proximal portions of the arms, number of abactinal spines, shape of the abactinal and actinal skeleton, and number of adambulacral spines. The morphological features of the specimens were photographed 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 were those used by Ubagan and Shin (2019a).

SYSTEMATIC ACCOUNT

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

***Henricia oculata* Pennant, 1777**
거친애기불가사리 (신칭) (Fig. 1A–K)

Henricia oculata Pennant, 1777: Madsen, 1987: pp. 254–257, figs. 44–45; Clark and Downey, 1992: p. 393, pls. 93e, 95f–g, figs. 60q–r; Jewett et al., 2012: p. 160, fig. 9d; Mah, 2020: 123970.

Material examined. One specimen: Namae, 3 March 2014, MERBK-A-1257; one specimen: Shinnam, 12 September 2014, MERBK-A-1258, fishing net, Shin, S. and Lee, T.

Description. Arms five, slightly broad arm base, gradually tapering to tips (Fig. 1A, B). Abactinal paxillae clustered, containing three to nine minute spinelets, more or less in a curved series around the papular area, and covered with rough skin (Fig. 1C). Papular areas wide, containing two to six papulae in an area (Fig. 1H). Abactinal skeleton open-meshed, reticulated, comprising rod-like, small ossicles present inside papular areas (Fig. 1G). Madreporite situated near center of disk, circular in form, not elevated, and bearing spines larger than abactinal spines (Fig. 1F). Actinal plates close-meshed, with narrow spaces of papular areas with one or two papulae larger than abactinal plates. Superomarginal, intermarginal, inferomarginal, and ventrolateral plates distinguishable. Superomarginal plates bearing five to nine spines, reaching tip of arm. Intermarginal plates formed longitudinally between inferomarginal and superomarginal plates, containing a wide area on actinal side, reaching three-quarters length of the arm. Inferomarginal plates reniform in shape, compact, bearing three to six spines, and larger than surrounding plates. Ventrolateral plates rounded cross shape, compact, bearing four to six spines, reaching one-half length of arm (Fig. 1I). Adambulacral armature comprising three to eight bluntly pointed spinelets; inner spine being longer and more spatulate than outer spines, and arranged in two transverse or zigzag rows (Fig. 1D, K). Oral plate bearing two slender, flat tip spines (Fig. 1E). Furrow spine single.

Size. R = 76–92 mm, r = 19–22 mm, R/r = 4–4.1.

Habitat. Hard substrates (rocks).

Color. Body color was light brown in alcohol.

Korea. East Sea (Namae, Shinnam).

Distribution. Korea (East Sea), Alaska (Akun Island, Kodiak Island), France, Ireland, Portugal, and the United Kingdom (British Isles, England, Scotland, Wales).

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

Remarks. *Henricia oculata* was first described as *Asterias oculata* by the British zoologist Thomas Pennant, 1777, and was later transferred under *Henricia*. Our specimen superficially resembled that of *H. pachyderma* in its size, wide papular areas, the conical shape of the abactinal spines, and flat-tipped adambulacral spines. It differs mainly from the similar *H. pachyderma* in the number of papulae (*H. oculata*: 2–6; *H. pachyderma*: 1–3), the number of abactinal spines (*H. oculata*: 3–9; *H. pachyderma*: 5–13), the shape of inferomarginal plates (*H. oculata*: reniform; *H. pachyderma*: transversely elongated), and the arrangement of inferomarginal plates series (*H. oculata*: compact; *H. pachyderma*: loose). In comparison with other *Henricia* species bearing broad arms, our morphological analysis showed that it differed from *H. perforata* in the shape of abactinal spines (*H. oculata*: conical; *H. perforata*: slender), the shape of inferomarginal plates (*H. oculata*: reniform; *H. perforata*: transversely elongated), and the arrangement of the series of inferomarginal plates (*H. oculata*: compact; *H. perforata*: loose) (Table 1). Our specimens *H. oculata* have slight morphological differences compared to the Atlantic *H. oculata*. Previously, *H. oculata* abactinal plates had

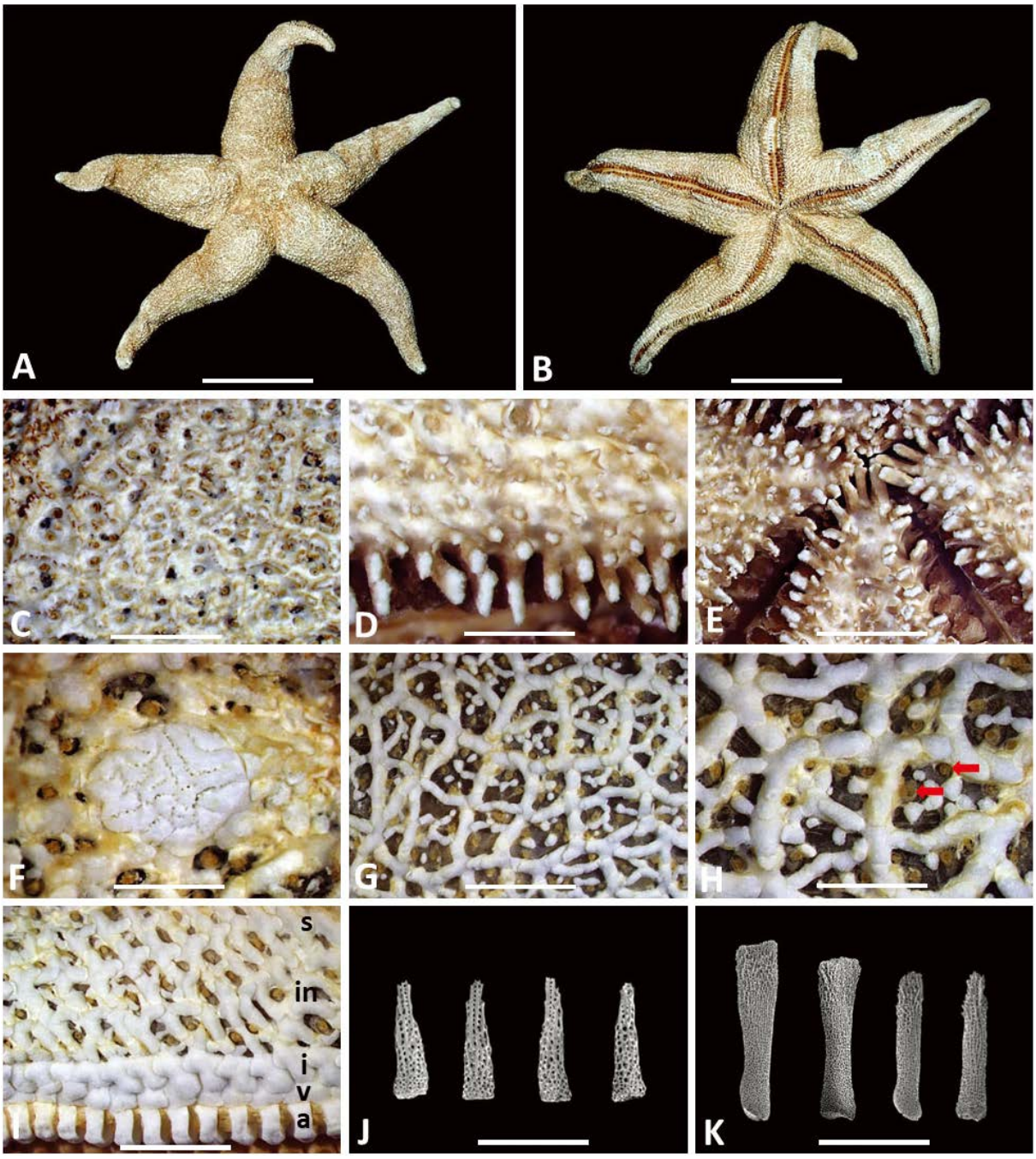

Fig. 1. *Henricia oculata*. A. abactinal side; B. actinal side; C. abactinal paxillae; D, K. adambulacral spines; E. oral part; F. madreporite; G. abactinal skeleton; H. papulae (arrows); I. actinal skeleton: superomarginal plates (s), intermarginal plates (in), inferomarginal plates (i), ventrolateral plates (v), adambulacral plates (a); and J. abactinal spines. Scale bars: A, B = 1 cm, C–I = 1 mm, J = 100 μm, K = 500 μm (J, K, SEM images).

been crowded with abactinal spines (up to 25 in numbers) in multiple rows (Madsen 1987), but our specimens possessed lesser number of abactinal spines (three to nine). However, differences in the number of abactinal spines alone cannot be regarded as a stable character for *Henricia* species identification (Bratova and Paskerova 2017).

Table 1. Comparison of morphological characteristics between *H. oculata* and related *Henricia* species reported in Korea

Characteristics	*H. oculata* (This study)	*H. pachyderma* (Shin 2010)	*H. perforata* (Ubagan and Shin 2020)
Range of R/r (Max R)	4.0–4.1	4.4–4.5	4.1–4.5
Number of abactinal papula(e)	2–6	1–3	2–7
Number of abactinal spines	3–9	5–13	2–6
Shape of abactinal spines	conical	conical	slender
Shape of inferomarginal plates	reniform shape	transversely elongated	transversely elongated
Arrangement of inferomarginal plates series	compact	loose	loose
Number of adambulacral spines	3–8	4–6	5–7
Pattern of adambulacral furrow + near ventrolateral plate	1 long, spatulate + 2–3 slender, stout + 4–8 shorter	1 flat tip + 2–3 slightly shorter, stout + 4–6 shorter	1 long, slender, pointed tip + 2–3 slightly shorter, pointed tips + 4–7 shorter

Morphological data derived from the present study, Shin (2010), and Ubagan and Shin (2020).

Therefore, we consider that Korean *H. oculata* is the same species as the Atlantic *H. oculata*. *H. oculata* is reported for the first time in the Korean fauna.

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