

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

Michael Dadole Ubagan and Sook Shin*

Department of Animal Biotechnology & Resource, College of Science and Technology, Marine Biological Resource Institute, Sahmyook University, Seoul 01795, Republic of Korea

*Corresponding author

Sook Shin

Tel. 02-3399-1717

E-mail. shins@syu.ac.kr

Received: 5 August 2021

Revised: 3 September 2021

Revision accepted: 6 September 2021

Abstract: *Henricia* specimen was collected from the East Sea of Korea using fishing nets. The specimen was identified as *Henricia hayashii* (Djakonov 1961), belonging to the family Echinasteridae of the order Spinulosida. This species can be distinguished from other *Henricia* species by slender arms ($R/r = 7.4$), constricted arm base, six to thirty-five slender spinelets, open-meshed, reticulated abactinal skeleton comprising semi-triangular, rod-like form, and small ossicles present inside the papular areas. This species superficially resembles *H. reniessa* in terms of its body size but differs in the shape and arrangement of the abactinal and actinal plates. To date, two genera of Echinasteridae, *Aleutihenricia* and *Henricia*, including a total of 14 species, have been reported in Korea. Herein, the morphological characteristics of *H. hayashii* are described, and photographs are provided.

Keywords: morphology, taxonomy, *Henricia hayashii*, East Sea, Korea

INTRODUCTION

The genus *Henricia* Gray, 1840 is a species-rich genus comprising 95 species worldwide (Wakita *et al.* 2019; Ubagan *et al.* 2020). Due to the lack of a stable phylogenetic definition, many species have been described and assigned to *Henricia* based only on traditional diagnosis (Fisher 1911; Hayashi 1940; Djakonov 1950; Madsen 1987; Clark and Downey 1992; Clark and Jewett 2010). The number of *Henricia* species has increased, especially in the northwestern part of the Pacific; however, high diversity within the genus has persisted. Recently, three new species, *H. epiphysialis* from the East Sea of Korea (Ubagan *et al.* 2020), and *H. margarethae* and *H. fragilis* from the deep-sea of Sagami Bay and Ogasawara of Japan (Kobayashi *et al.* 2021), have been added to the genus *Henricia*. Species from the surrounding regions of the northwestern Pacific, Japan have contrib-

uted to defining useful diagnostic characters of the genus *Henricia*. In particular, two distinguishing characteristics (i.e., the width of adambulacral plates, the ratio of two measurements in ambulacral plates to the length of interradius) are useful for differentiating other related species of genus *Henricia* (Wakita *et al.* 2019). However, these morphological characteristics could be plastic to some degree, and the ossicle shape and spine number may vary with the size of the animal (Madsen 1987). One approach to reducing the complications of species diagnosis is to focus on regional fauna in taxonomic revisions (Eernisse *et al.* 2010).

MATERIALS AND METHODS

The *Henricia* specimen was collected from waters near Jukbyeon, Korea (37°02'20.2"N, 129°25'49.58"E), using

fishing nets on May 24, 2013. This specimen was 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 specimen 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 (2020).

SYSTEMATIC ACCOUNT

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

Henricia hayashii (Djakonov 1961)

그물애기불가사리 (신칭) (Fig. 1A-K)

Henricia hayashii (Djakonov 1961), pp. 22, 23, pl. 2, fig. 8, pl. 13, figs. 54, 55; Chichvarkhin & Chichvarkhina, 2017a: p. 208, fig. 4A; 2017b: p. 26, fig. H. Chichvarkhin *et al.* 2019: p. 20, fig. 8A-N; Mah, 2021: 369111.

Material examined. One specimen: Jukbyeon (37°02' 20.2"N, 129°25'49.58"E), 24 May 2013, MERBK-A-1259, fishing net, Shin, S. and Lee, T.

Description. Arms five, long, slender, gradually tapering to tips (Fig. 1A, B). Abactinal paxillae clustered, containing six to thirty-five slender spinelets, forming slightly curved series around the papular area, and not covered with skin (Fig. 1C). Denuded abactinal spines, slender, bearing seven to 11 pointed apical thorns (Fig. 1J). Papular areas irregular shape, wider than abactinal plate areas, containing two to six papulae in each area (Fig. 1H). Abactinal skeleton open-meshed, reticulated, comprising semi-triangular, rod-like form, small ossicles present inside papular areas (Fig. 1G). Madreporite situated near center of disk, circular in form, slightly 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. Superomar-

ginal plates bearing nine to 12 spines, reaching tip of arm. Inferomarginal plates reniform in shape, compact, and larger than surrounding plates, bearing more than 30 spinelets. Ventrolateral plates rounded cross shape, compact, bearing 13 to 16 spines, reaching one-half length of arm (Fig. 1I). Adambulacral armature comprising 14 to 18 bluntly tip spinelets; inner spines being longer, larger than outer spines, and arranged in two or three transverse or zigzag rows (Fig. 1D, K). Oral plate bearing two bluntly tip spines (Fig. 1E). Furrow spine single, situated deeply on furrow edge, densely covered with adambulacral spines (Fig. 1D).

Size. R = 82 mm, r = 11 mm, R/r = 7.4.

Habitat. Hard substrates (rocks).

Color. Body color was light brown in alcohol.

Distribution. Korea (East Sea), Russia (Vostok Bay).

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

Remarks. *Henricia hayashii* was first introduced by Russian zoologist, A. M. Djakonov in 1961. *H. hayashii* is similar to *H. reniessa* by its body size but differs in the shape and arrangement of the abactinal skeleton. Compared to other species with slender, tapering arms such as *H. leviuscula*, the primary differences are the following: 1) abactinal spines (*H. hayashii*: slender; *H. leviuscula*: granular and solid glassy tip); 2) abactinal skeleton (*H. hayashii*: open meshed, reticulated; *H. leviuscula*: closed meshed, imbricated). Thus, *H. hayashii* allowed for the establishment of different morphological characteristics compared to other species of *Henricia* with slender arms. Our specimen *H. hayashii* have slight differences compared to the holotype description from Djakonov (1961) in terms of the furrow spines: our specimen possess single furrow spine, while Djakonov's description includes double deep furrow spines. In addition, the size of our specimen is smaller (R = 82 mm) compared to the original specimen (R = 142 mm). However, this morphological difference does not make the specimens distinct from each other. Therefore, we consider that our specimen to be the same species as that described by Djakonov (1961). *H. hayashii* is newly reported in Korean fauna.

ACKNOWLEDGEMENTS

This study was supported by a grant from the National Institute of Biological Resources (NIBR), which was funded by the Ministry of Environment (MOE) of the Republic

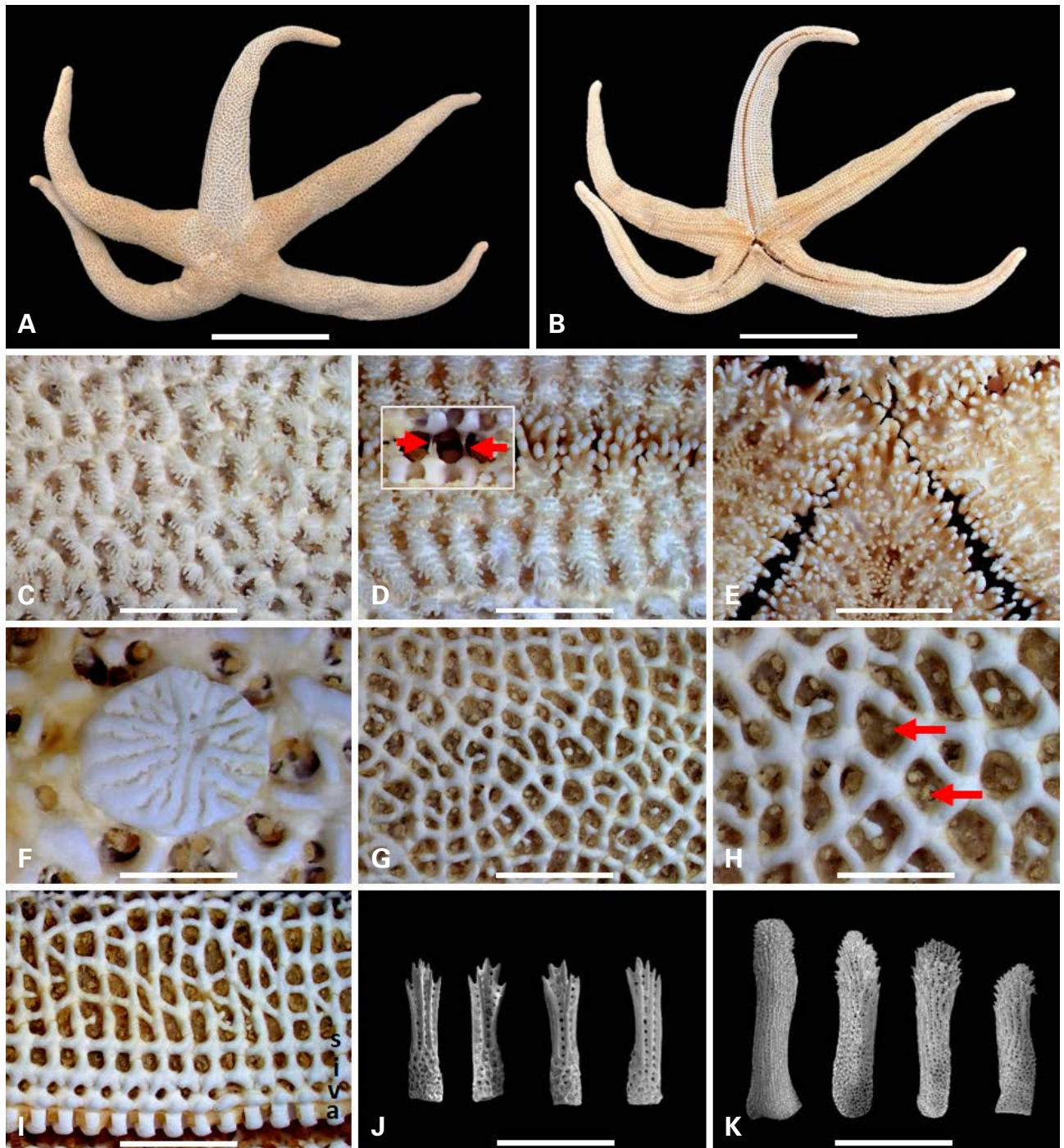


Fig. 1. *Henricia hayashii*. A. abactinal side; B. actinal side; C. abactinal paxillae; D. adambulacral spines, furrow spines (arrows); E. oral part; F. madreporite; G. abactinal skeleton; H. papulae (arrows); I. actinal skeleton: superomarginal plates (s), inferomarginal plates (i), ventrolateral plates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

of Korea (NIBR 202102203), and the project titled “Improvement of management strategies on marine disturbing

and harmful organisms (No. 20190518)” funded by the Ministry of Oceans and Fisheries, Korea.

REFERENCES

- Chichvarkhin A and O Chichvarkhina. 2017a. A new sea star species of the genus *Henricia* Gray, 1840 (Echinodermata, Asteroidea) from the northwestern Sea of Japan and description of a new subgenus. pp. 202–209. In: Life-Supporting Asia-Pacific Marine Ecosystems, Biodiversity and Their Functioning (Dautova TN, ed.). Qingdao-Vladivostok: Far Eastern Federal University. Vladivostok, Russia.
- Chichvarkhin A and O Chichvarkhina. 2017b. Sea stars of the genus *Henricia* Gray, 1840 (Echinodermata, Asteroidea) from the northwestern Sea of Japan. pp. 25–27. In: Scientific and Technological Developments of Research and Monitoring of Marine Biological Resources. Vladivostok, Russia.
- Chichvarkhin A, O Chichvarkhina and D Wakita. 2019. Sea stars of the genus *Henricia* Gray, 1840 (Echinodermata, Asteroidea) from Vostok Bay, Sea of Japan. PeerJ 7:e6585.
- Clark AM and ME Downey. 1992. Starfishes of the Atlantic. Chapman & Hall Identification Guides 3. Chapman & Hall. London. pp. 1–794.
- Clark RN and SC Jewett. 2010. A new genus and thirteen new species of sea stars (Asteroidea: Echinasteridae) from the Aleutian Island Archipelago. Zootaxa 2571:1–36.
- Djakonov AM. 1950. Keys to the fauna of the USSR. Sea Stars (Asteroids) of the USSR Seas. Zool. Inst. Acad. Sci. USSR (translated 1968 by Israel Program for Scientific Translations, Jerusalem). 34:1–183.
- Djakonov AM. 1961. Review of sea stars of the genus *Henricia* Gray from the northwestern parts of Pacific Ocean. Issledovaniya Delnevostochnykh morei SSSR 7:5–39.
- Eernisse DJ, MF Strathmann and RR Strathmann. 2010. *Henricia pumila* sp. nov.: A brooding seastar (Asteroidea) from the coastal northeastern Pacific. Zootaxa 2329:22–36.
- Fisher WK. 1911. Asteroidea of the North Pacific and adjacent waters. Part. 1. Phanerozoia and Spinulosa. Bull. U.S. Nat. Mus. 76:1–420.
- Hayashi R. 1940. Contributions to the classification of the sea-stars of Japan I. Spinulosa. J. Fac. Imp. Sci. Hokkaido Univ. 7:107–204.
- Kobayashi I, H Kohtsuka and T Fujita. 2021. Two new deep-sea species of the genus *Henricia* (Asteroidea: Spinulosida: Echinasteridae) from Japanese waters. Zootaxa 4903:89–104.
- Madsen FJ. 1987. The *Henricia sanguinolenta* complex (Echinodermata, Asteroidea) of the Norwegian Sea and adjacent waters. A re-evaluation, with notes on related species. Steenstrupia 13:201–268.
- Mah C. 2021. *Henricia hayashii* Djakonov, 1961. World Asteroidea database. World Register of Marine Species at <http://www.marinespecies.org/aphia.php?p=taxdetails&id=369111> accessed 01 January 2021.
- Ubagan MD, T Lee, P Kim and S Shin. 2020. A new species of the genus *Henricia* (Asteroidea, Spinulosida, Echinasteridae) from South Korea. ZooKeys 997:1–15.
- Ubagan MD and S Shin. 2020. Newly recorded sea star *Henricia oculata* (Asteroidea: Spinulosida: Echinasteridae) in the East Sea, Korea. Korean J. Environ. Biol. 38:563–566.
- Wakita D, T Fujita and H Kajihara. 2019. Molecular systematics and morphological analyses of the subgenus *Setihenricia* (Echinodermata: Asteroidea: *Henricia*) from Japan. Spec. Divers. 24:119–135.