Asterodiscidid sea star, Asterodiscides elegans (Echinodermata, Asteroidea), newly recorded from Japanese waters

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Asterodiscidid sea star, *Asterodiscides elegans* (Echinodermata, Asteroidea), newly recorded from Japanese waters

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Abstract: We described the external features of the rarely encountered asterodiscidid sea star, *Asterodiscides elegans*, as well as its first recording in Japanese waters. The morphological characteristics of two specimens collected in 2020 from the coast of the Kii Peninsula, the middle part of Honshu Island (50 m depth), matched those previously described. This finding extends the northernmost range of this species in the North Pacific. We proposed a new Japanese name, Noichigo-nankai-hitode, for this species. Additionally, we compared the external features to those of documented pentagonal *Asterodiscides* species inhabiting the Indo-West Pacific Ocean.

Key words: starfish, asterodiscidid sea star, *Asterodiscides*, new to Japan, external features

Introduction

The asterodiscidid sea stars of the genus *Asterodiscides* comprise 18 known species that are distributed from the shallow continental shelf to the upper bathyal zone at depths of less than 800 m in the Indo-Pacific regions, of which the northern, southern, eastern, and western limits are southern Japan, Tasmania in Australia, the Hawaiian Islands, and Natal in South Africa, respectively (A. M. Clark, 1993; Mah, 2021). Two species of *Asterodiscides* have been recorded in Japanese waters. *Asterodiscides japonicus* Oguro in Imaoka *et al*., 1991, which is likely a junior synonym of *Asterodiscides grayi* Rowe, 1977 according to Lane & Rowe (2009), is found from Suruga Bay to southern Kyushu (Uyeno *et al*., 2020), the Ogasawara Islands (Arai *et al*., 2018), and the Oki Islands (Kohtsuka, 2010), and the more rarely encountered species, *Asterodiscides helonotus* (Fisher, 1913) has been observed in the Kii Peninsula and the Ashizuri-misaki Cape (Saba & Irimura, 2002; Nakachi, 2012).

This genus is characterized by a large, massive, stellate, or pentagonal body, covered with various conical, subspherical, or cylindrical tubercles. The most distinctive and unique features are the size and shape of its 3–4 superomarginal plates: the elongate, ovate, or square-shaped distalmost superomarginal plate is much larger than the others that are often indiscernible.

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Recently, we captured two specimens of the sea star belonging to this genus that had the unique morphological features mentioned above from the Kii Peninsula, the middle part of Honshu Island, Japan. Our detailed examination revealed their identity as *Asterodiscides elegans* (Gray, 1847), which has not been recorded in Japanese waters. The purpose of this paper was to present a new locality record and describe the external features of *A. elegans* found for the first time in Japanese waters. In addition, we discussed the differences in external features among short-armed *Asterodiscides* sea stars using photographs of the specimens deposited in the Australian Museum, Sydney, Australia (A. M. J.). The Japanese specimens examined in this study are deposited in the Osaka Museum of Natural History (OMNH). The following abbreviations are used herein: *R*, arm length, as measured from the center of the disc to the tip of the arm; *r*, disc radius, the distance from the center of the disc to the edge where two arms meet; and *R/r*, the ratio of arm length to disc radius.

Genus ***Asterodiscides*** A. M. Clark, 1974
[Japanese name: Nankai-hitode-zoku]

Asterodiscides elegans (Gray, 1847)
[New Japanese name: Noichigo-nankai-hitode]
(Fig. 1)

Asterodiscus elegans Gray, 1847: 75; 1866: 5; Sladen, 1889:

353; Fisher, 1919: 355; A. M. Clark in A. M. Clark & Rowe, 1971: 40.

Asterodiscides elegans: A. M. Clark, 1974: 435; 1993: 291; Rowe, 1977: 197; Walenkamp, 1990: 42, Liao & A. M. Clark, 1995: 112; Lane *et al*., 2000: 473; Antokhina & Britayev, 2012: 897.

Material examined. OMNH-Iv 6914: R = 65.3 mm, r = 52.0 mm, R/r = 1.26; Pacific Ocean, off Sakai Port, Minabe-cho, Wakayama Prefecture, western coast of the Kii Peninsula, Japan (ca. 33º44′N, 135º20′E), 50 m depth; gill net; March 19, 2020; collected by Masuo Sakai. OMNH-Iv 6915: R = 71.6 mm, r = 51.8 mm, R/r = 1.38; likely the same locality and depth as above; gill net; January 30, 2020; collected by Yasuhiko Azuma.

Description. Massive body with pentagonal disc having five short arms (Fig. 1A). Disc swollen upward. Abactinal surface covered with numerous conical tubercles of various sizes (Fig. 1B). Tips of tubercles round or flat. Papulae

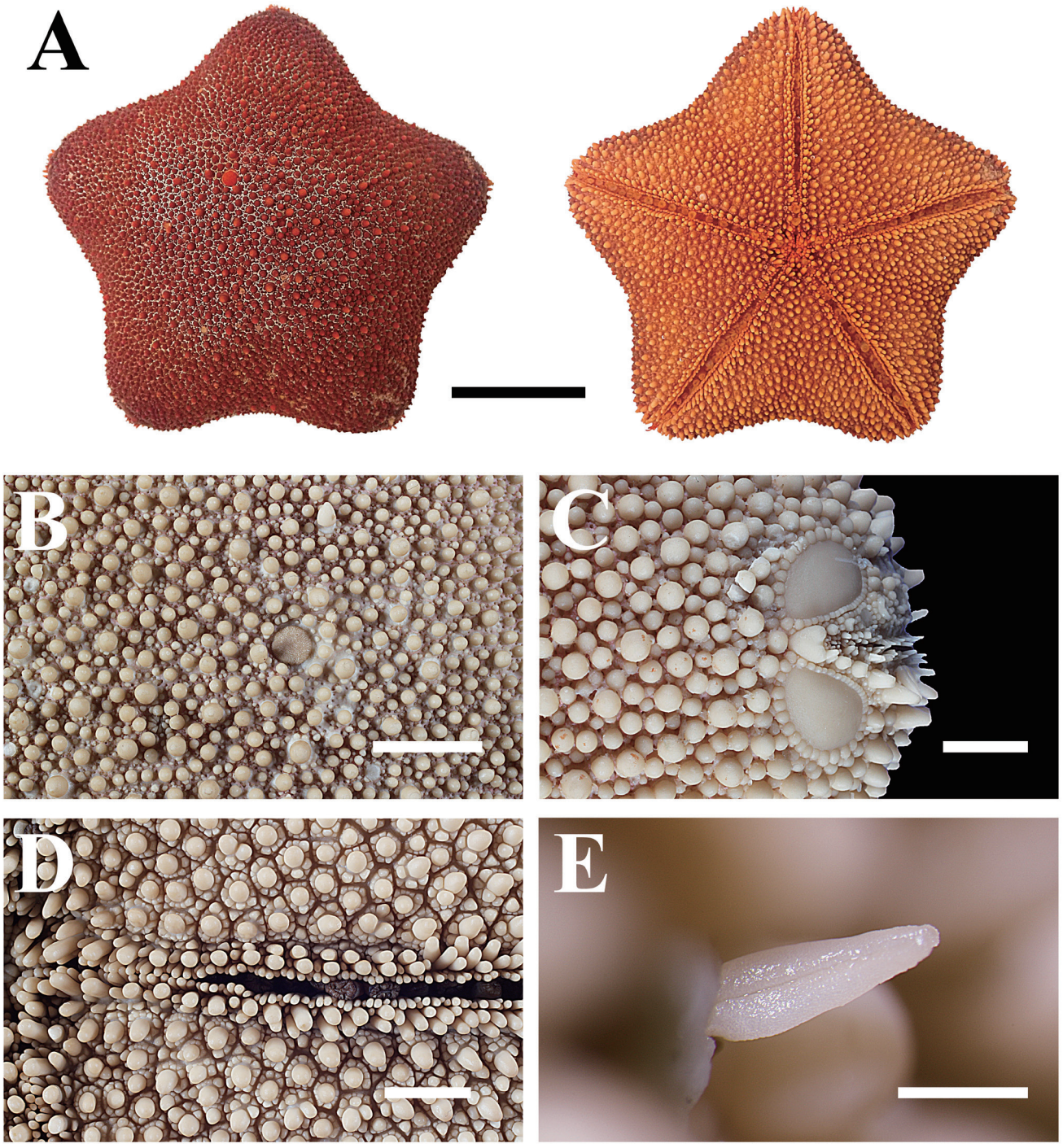

Fig. 1. *Asterodiscides elegans* from Japan (OMNH-Iv 6914). A: abactinal side (left) and actinal side (right), B: abactinal tubercles, C: distalmost superomarginal plates, D: actinal tubercles and adambulacral spines, E: pedicellaria. A: living individual, B–E: alcohol-preserved specimen. Scale bars: A = 40 mm; B = 10 mm; C, D = 5 mm; E = 1 mm.

emerging among tubercles.

Superomarginal and inferomarginal plates not evident apart from distalmost large ovate superomarginal plate of 7 mm in length and 4 mm in width (Fig. 1C). A pair of these distalmost superomarginal plates almost in contact with each other at proximal end. The second largest superomarginal plate, 3 mm in length and 2 mm in width, observed adjacent to distalmost plate of specimen OMNH-Iv 6915. All superomarginal plates slightly swollen having smooth surface; each plate completely surrounded with a single series of small granules.

A small heart-shaped terminal plate without spines or granules wedged into junction of distalmost superomarginal plates at each arm tip (Fig. 1C).

Single, distinct, nearly circular madreporite of 4 mm in diameter with numerous irregular grooves on surface located interradially, one-third of way from center of disc to margin.

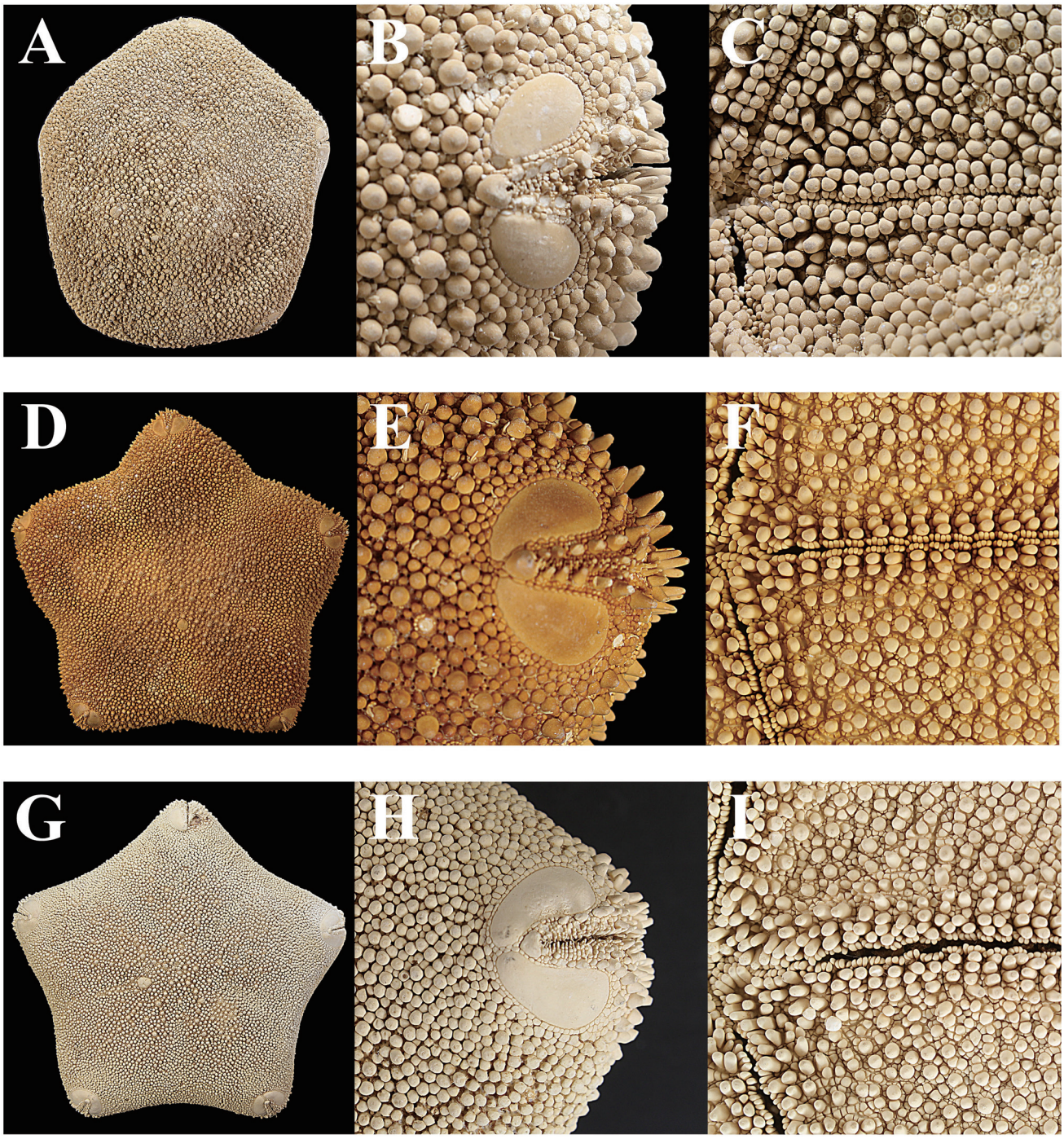

Fig. 2. Pentagonal *Asterodiscides* sea stars deposited in the Australian Museum. *A. elegans belli*, A. M. J. 9734, paratype, R = 65 mm, r = 60 mm, R/r = 1.1, abactinal side (A), distalmost superomarginal plates (B), actinal tubercles and adambulacral spines (C); *A. macroplax*, A. M. J. 16334, paratype, R = 70 mm, r = 54 mm, R/r = 1.3, abactinal side (D), distalmost superomarginal plates (E), actinal tubercles and adambulacral spines (F); *A. multispinus*, A. M. J. 16862, paratype, R = 74 mm, r = 55 mm, R/r = 1.3, abactinal side (G), distalmost superomarginal plates (H), actinal tubercles and adambulacral spines (I). All the photos were provided by Dr. Laetitia Gunton and Dr. Stephen Keable, Australian Museum.

Minute anus concealed by tiny pyramidal spines at center of disc.

Actinal plate with a single prominent central conical tubercle surrounded by smaller polygonal prism-shaped tubercles numbering approximately 10; several actinal plates equipped with 1–3 tubercles in addition to the longest central tubercle (Fig. 1D).

Mouth plate furnished with 5–6 square or triangular prism-shaped marginal spines; apical spine the largest and most robust. Three conical suboral spines; outermost spine the longest, approaching size of central tubercle of actinal plate.

Adambulacral plate having 4 (occasionally 5), long, mostly clavate furrow spines; 2 or 3 middle spines longer than others. Behind furrow series, 2 rod-shaped subambulacral spines: an inner spine facing ambulacral groove and an outer spine. Subambulacral spines of specimen OMNH-Iv 6914 irregularly arranged, lacking an outer spine or having a shorter outer spine at proximal 3–5 and several distal adambulacral plates, and occasionally having 2 inner spines at adambulacral plates of middle part of arm (Fig. 1D). Tube feet biserial and equipped with large suckers.

No pedicellaria, except for a single one on abactinal plate of OMNH-Iv 6914; minute straight pedicellaria with a length of 2 mm (Fig. 1E).

Live body color: cherry red tubercles on white abactinal plates and tangerine actinally (Fig. 1A).

Etymology. The Japanese name for this genus is a combination of the words *nankai* (southern sea) representing the main distributional areas, *hitode* (sea star), and *zoku* (genus). The word *noichigo* included in the new Japanese specific name, means wild strawberry, reflecting the resemblance of the abactinal surface color and external appearance to the wild strawberry.

Remarks. The holotype of *Asterodiscides elegans* deposited in the British Museum has no locality data (Gray, 1847). Among the other 4 specimens at this museum, one was collected from the coast of Zamboangan in the southern Philippine Islands by the Challenger Expedition (Rowe, 1977). The localities from the Philippine Islands are supported by the specimens in the U. S. National Museum, which were sampled near Cabugan Grande Island by the Albatross Expedition (Fisher, 1919). The other 3 specimens in the British Museum were obtained in China; however, the detailed localities of these specimens are unknown because they were not collected through academic research but through trade in the mid-19th century. The credible information about this species from Chinese waters originated from the description of Liao & A. M. Clark (1995), which shown the occurrence from Hainan Island in the South China Sea (60–80 m depth). Other reports from the South China Sea were made by Lane *et al*. (2000) and Antokhina & Britayev (2012); the latter discovered this sea star on the southern coast of Vietnam (12–20 m depth). Given that the reliable data on the northern limit of localities identifies areas near Hainan Island, this study represents an extreme northern range extension of this sea star, which is greater than 1000 km north of its previously established area of southernmost China.

A closely related species, *Asterodiscides belli* Rowe, 1977 (Fig. 2A–C), located in the western and northeastern Indian Ocean, was considered a subspecies of *A. elegans* (Rowe, 1977) before being elevated from subspecies to species rank by Rowe (1985). The external features that separate these two species are the structure of pedicellariae, the number of tubercles on the actinal plates, and the number of furrow spines. *Asterodiscides elegans* has slender pedicellariae, 1–7 tubercles on the actinal plate, and 4–5 furrow spines, whereas *A. belli* has flask-shaped pedicellariae, 1–2 tubercles on the actinal plate, and 3–4 furrow spines. However, Walenkamp (1990) examined these features of specimens from the Indian Ocean and noted that they varied among individuals, suggesting that *A. elegans* and *A. belli* are conspecific with a wide range distribution in the Indo-West Pacific regions.

Based on the shape of the adult body, *Asterodiscides* sea stars are divided into two groups: pentagonal forms (R/r = 1.1–1.5) and stellate forms (R/r > 1.5) (Rowe, 1985). The former groups are composed of *Asterodiscides culcitulus* Rowe, 1977, *Asterodiscides macroplax* Rowe, 1985 (Fig. 2D–F), *Asterodiscides multispinus* Rowe, 1985 (Fig. 2G–I), and the *A. elegans* and *A. belli* mentioned above. Among these pentagonal species, *A. culcitulus*, which is distributed in western Australia, is clearly distinguished from the others by the extremely small distalmost superomarginal plates. The main differences between *A. macroplax* located from western to northwestern Australia and *A. multispinus* recorded in Queensland, northeastern Australia, are the number and arrangement of subambulacral spines. The former has only two spines (the inner and outer spines), whereas the latter generally has 3–4 (up to 6) spines across the width of the adambulacral plates (Marsh & Fromont, 2020). In contrast to the clear morphological differences among the species above, the differences in external features between *A. macroplax* and *A. elegans* are indistinct. The number of enlarged tubercles of each actinal plate overlaps between these two species, as *A. macroplax* usually has one, but can show up to 4 tubercles (Rowe, 1985), whereas *A. elegans* has one to seven (Rowe, 1977). The presence of abactinal interstitial granules of *A. macroplax* is an essential characteristic separating this species from *A. elegans* (Rowe, 1985); however, abactinal tiny tubercles and/or granules loosely surrounding the base of large tubercles can be recognized as interstitial granules.

More detailed studies including molecular assays are needed to establish the exact taxonomic position of the described *Asterodiscides* species, and to consider the synonymy of *A. elegans*, *A. belli*, and *A. macroplax*.

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