

A New Asterinid Sea Star, *Disasterina akajimaensis* (Echinodermata: Asteroidea) from the Ryukyu Islands, Japan, with Notes on the Genus *Disasterina*

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A new asterinid, *Disasterina akajimaensis* sp. nov., is described from a specimen collected at Akajima Island, the Ryukyu Islands, Japan. It is clearly distinguishable from its five congeners by the following diagnostic characters: body relatively low and flat, uncalcified interradial areas conspicuous on ventral interradial areas, papulae numerous in center of disc, abactinal plates mostly lacking spinelets, inferomarginal plates with 2–4 spinelets, actinolateral plates with 1 spine, oral plates with 4–5 oral spines and no suboral spine, adambulacral plates with 1–3 furrows and 1 subambulacral spine. This is the first report of this genus from Japanese waters. Notes on the genus *Disasterina* and a tabular summary of the characters of the currently known species are also given.

Key Words: Asterinidae, *Disasterina*, new species, Japan.

Introduction

The genus *Disasterina* Perrier, 1875 of the family Asterinidae was established for *Disasterina abnormalis* Perrier, 1875 as a relative of *Asterina* Nardo, 1834, but distinguished from the latter by thick integument covering the body and by the abactinal plates being loosely imbricated, leaving papular spaces. The uncalcified skin distal to each pair of oral plates in the type species is also characteristic for *Disasterina*, but it varies among species; for example, *D. longispina* (H. L. Clark, 1938), originally considered as a species of the separate genus *Manasterina* H. L. Clark, 1938, has no uncalcified skin (H. L. Clark 1938; O'Loughlin and Waters 2004). In the latest revision of the genera of Asterinidae, O'Loughlin and Waters (2004) revised *Disasterina*, which thus currently has five valid species (see also A. M. Clark 1993; O'Loughlin 2009; Mah 2010). All of the species are distributed in the Indo-West Pacific region (Döderlein 1888; Koehler 1910; H. L. Clark 1916, 1938; Livingstone 1933; Mortensen 1933; A. M. Clark and Rowe 1971; Liao 1980). No species of *Disasterina* has ever before been found in Japanese waters.

In this study we collected one specimen of *Disasterina* from the intertidal zone of Akajima Island in the Ryukyu Islands of southwestern Japan. This specimen is described here as the holotype of a new species. It has been deposited in the National Museum of Nature and Science, Tokyo (NSMT). Terminology follows the glossary and illustrations of A. M. Clark and Downey (1992).

Genus *Disasterina* Perrier, 1875

[New Japanese name: Numeri-itomaki-hitode-zoku]
(Table 1; Fig. 1)

Disasterina Perrier, 1875: 289 [reprinted in 1876: 209–210]; Livingstone 1933: 5–7; H. L. Clark 1946: 138; Spencer and Wright 1966: U69; A. M. Clark 1993: 218; Liao and A. M. Clark 1995: 131–132; Rowe and Gates 1995: 35; O'Loughlin and Waters 2004: 19–20.
Habroporina H. L. Clark, 1921: 34. Synonymized by A. A. Livingstone (1933).
Manasterina H. L. Clark, 1938: 157–158; H. L. Clark 1946: 139; A. M. Clark 1993: 220; Rowe and Gates 1995: 36. Synonymized by O'Loughlin and Waters (2004).
Type species: *Disasterina abnormalis* Perrier, 1875 (by monotypy).

Comparative material. *Disasterina ceylanica* Döderlein, 1888: 1 alcohol specimen, Naturhistorisches Museum Basel (NMB), réf. 2, probably one of the syntypes; Trincomali, Ceylon, collected by Paul Sarasin and Fritz Sarasin; R/r=20/8 mm. *Disasterina odontacantha* Liao, 1980: 1 dry specimen, NSMT E-4218; Ambon Island, Indonesia, 0–16 m deep; R/r=11/6 mm.

Remarks. O'Loughlin and Waters (2004) included five species in *Disasterina*: *D. abnormalis* (type species), *D. odontacantha*, *D. ceylanica*, *D. longispina*, and *D. spinosa* Koehler, 1910. *Disasterina odontacantha* is clearly congeneric with *D. abnormalis*, sharing an uncalcified interradial

Table 1. Characteristics of the species of *Disasterina*. N: number of specimens recorded. R, r: body size (R, r) in mm. R in parentheses is shown without r. R/r: R/r ratio. Body: L=low and flat, H=high with median keel on rays. IUA: interradial uncalcified area, P=present, A=absent. ABS: number of abactinal spinelets. SMS: number of superomarginal spinelets. IMS: number of inferomarginal spinelets. ALS: number of actinolateral spines. OS: number of oral spines. SOS: number of suboral spines. FS: number of furrow spines. SAS: number of subambulacral spines. Numbers in parentheses for ABS and IMS are observed for only several particular plates. Asterisks (*) indicate type locality.

Species	N	R, r (mm)	R/r	Body	IUA	ABS	SMS	IMS	ALS	OS	SOS	FS	SAS	Geographical distribution	References
<i>D. abnormalis</i> Perrier, 1875	25	R=19–30 r=8–15 (R<38)	2–2.5	L	P	0	0	1–5	1	4–6	1	2–5	1	New Caledonia*; Great Barrier Reef; Torres Strait; Indonesia; NW Australia	Perrier (1875), H. L. Clark (1921), Livingstone (1933), Jangoux (1978, 1986), O’Loughlin and Waters (2004)
<i>D. ceylanica</i> Döderlein, 1888	3	R=14–32 r=7–10.5	2–3.1	H	A	0	0	4–5	1	9	2	4–5	2	Ceylon*	Döderlein (1888), present study
<i>D. longispina</i> (H. L. Clark, 1938)	4	R=24 r=12	2.0	H	A	0–1 (2–5)	0	2–4	1	5	1	3–4	1	W Australia*	H. L. Clark (1938), O’Loughlin and Waters (2004)
<i>D. odontacantha</i> Liao, 1980	16	R=11–20 r=6–9 (R=9–25)	1.8–2.2	L	P	1–2	1	4–5 (3, 6)	1	3–4	0	3–4	1	Paracel [Xisha] Is.*; Indonesia; Fiji; Guam	Liao (1980), Liao and A. M. Clark (1995), Fujita and Marsh (2004), O’Loughlin and Waters (2004)
<i>D. spinosa</i> Koehler, 1910	1	R=14 r=5	2.8	H	A	1–3	3–4	1–2	2	7–8	3	5	3	Andaman Is.*	Koehler (1910)
<i>D. akajimaensis</i> sp. nov.	1	R=16.9 r=8.1	2.1	L	P	0 (2–5)	0	2–4	1	4–5	0	1–3	1	Ryukyu Is.*	present study

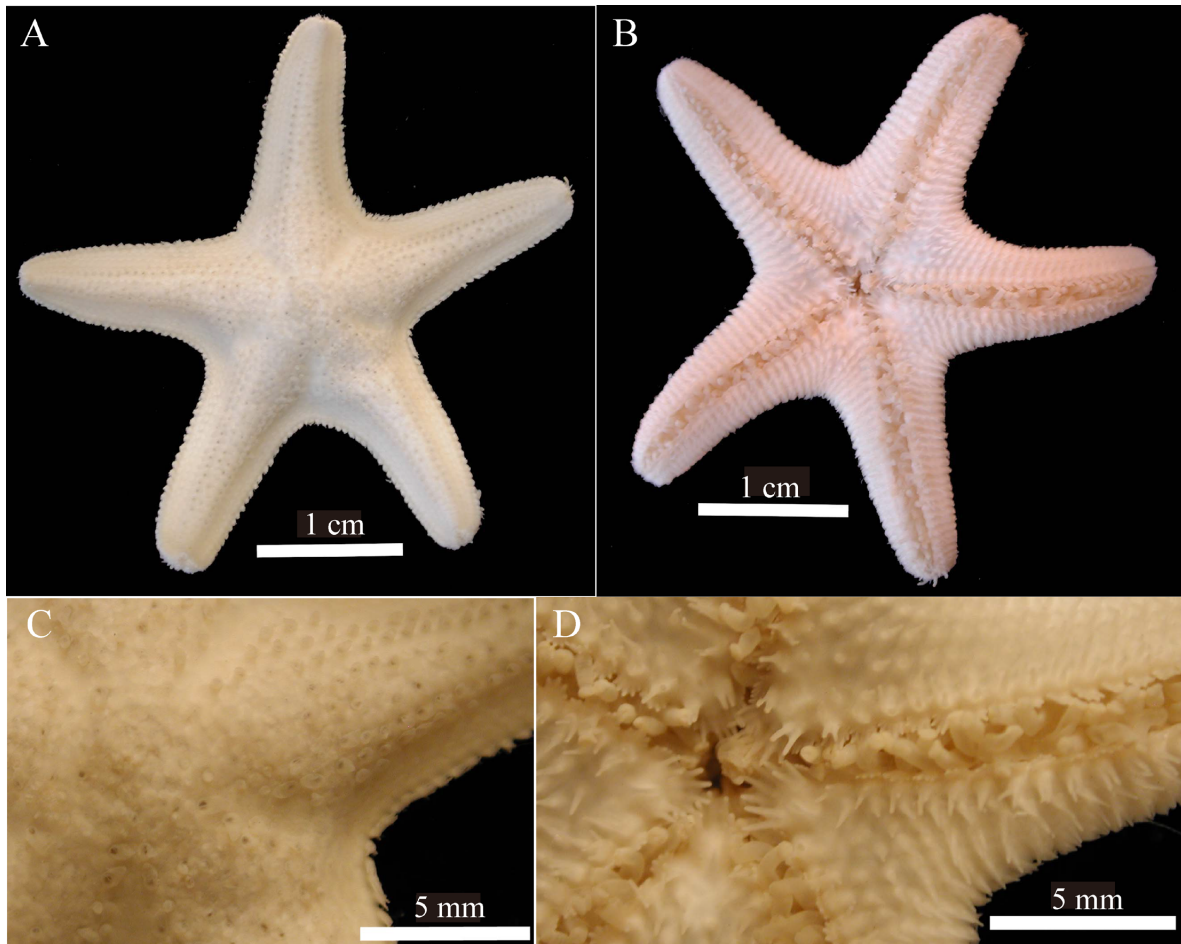


Fig. 1. *Disasterina ceylanica* Döderlein, 1888, syntype (NMB réf. 2). A, Abactinal view; B, actinal view; C, disk and proximal part of arm, abactinal view; D, mouth, oral plate pairs, and adambulacral furrows.

area just distal to each oral plate pair, a single spinelet per actinolateral plate, and a single spinelet per subambulacral plate (Table 1). The other three species are quite different, and their generic attribution is doubtful.

Apparently without examining specimens, but relying only on Döderlein's (1888) original description, Livingstone (1933) transferred *Disasterina ceylanica* to his new genus *Tegulaster* on the basis of having mid-radial abactinal plates forming a keel, but O'Loughlin and Waters (2004) re-assigned the species to *Disasterina*. We have re-examined one specimen of *D. ceylanica* (Fig. 1), probably one of the syntypes (Jangoux 1985: 21 called this specimen "holotype" without lectotype designation) although the measured body size ($R/r=20/8$ mm) does not exactly match that of any of the three syntypes ($R/r=32/10.5$, $25/10$, $14/7$ mm) mentioned in the original description (Döderlein 1888: 825). We compared this specimen with the list of differences between *Disasterina* and *Tegulaster* given by O'Loughlin and Waters (2004: 20), and some of its features suggest that this species should indeed be referred to *Tegulaster*. The body is not thin, but has a relatively thick disc and a mid-radial keel on the arms; the abactinal plates are fairly contiguous, with only small papular spaces, most of the abactinal plates being arranged longitudinally on the arms; the superomarginal plates are in distinct series; and the body is covered by

a smooth integument. While the form and pattern of spinelets are similar in these two genera (O'Loughlin and Waters 2004), in this specimen of *D. ceylanica* only some plates on the central disc and around the periphery of the madreporite have spinelets, the actinal plates each have one large spine, the adambulacral plates have four to five webbed furrow spines and two subambulacral spines, and the oral plates have nine webbed furrow spines, the two or three innermost ones being larger than the rest, and two suboral spines.

Based on a single specimen, *Disasterina longispina* was originally described in the monotypic genus *Manasterina* by H. L. Clark (1938), distinguished in particular by its size, the openly meshed abactinal plates, the single spinelet per abactinal plate and long, slender spinelets near the arm tips, and the absence of uncalcified interradial areas. Following their examination of three additional specimens from Western Australia, however, O'Loughlin and Waters (2004) recognized no generic value in such differences and synonymized *Manasterina* with *Disasterina*. In light of several characteristics similar to those of *D. ceylanica*, in our view there remains a question as to whether *Manasterina longispina* should be referred to *Disasterina* or *Tegulaster*.

Disasterina spinosa was considered to be a valid species by Livingstone (1933), but not referable to *Disasterina*; it

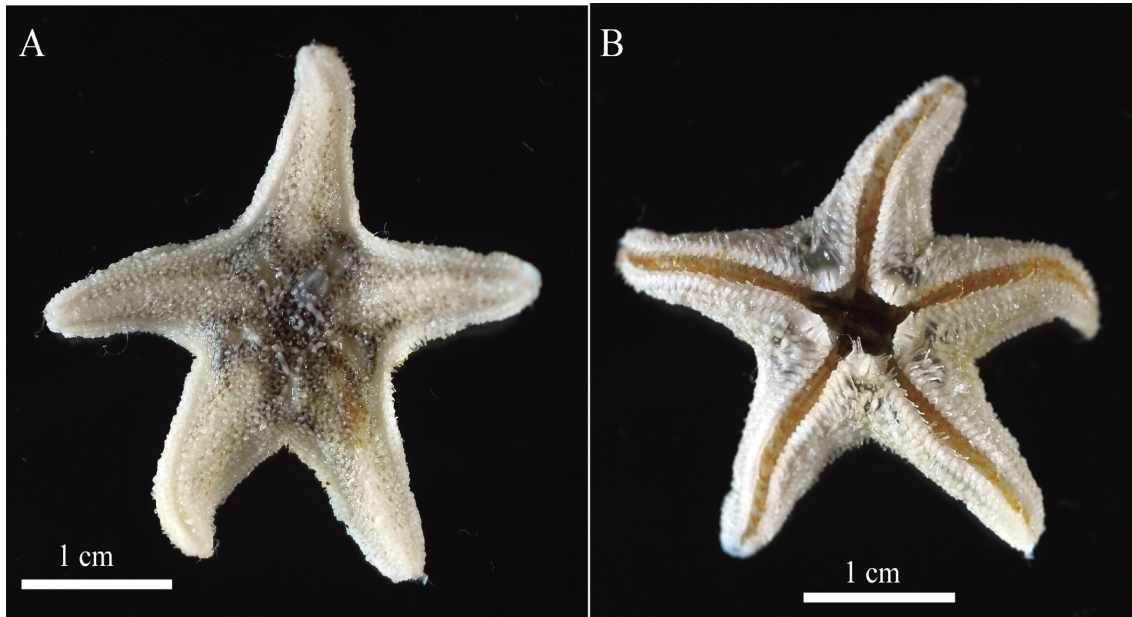


Fig. 2. *Disasterina akajimaensis* sp. nov., holotype (NSMT E-6758). A, Abactinal view; B, actinal view.

has, however, been retained in *Disasterina* by O'Loughlin and Waters (2004). These latter authors noted that the long, sacciform spinelets on the abactinal plates are the most distinctive characteristic of this species, but also that this characteristic has no generic value. Several other characteristics of *D. spinosa* are similar to those of *D. ceylanica*, though suggesting that this species may also be better referred to *Tegulaster* than to *Disasterina*.

The descriptions of these three species were based on only one or a few specimens, and more material is required to clarify their generic status.

O'Loughlin and Waters (2004) removed *D. leptacantha* Livingstone, 1933 (see also O'Loughlin 2009) and *D. prae-signis* Livingstone, 1933 (with its junior synonym *D. spinulifera* H. L. Clark, 1938) from *Disasterina* to *Tegulaster*. The generic status of *D. ceylanica*, *D. longispina*, and *D. spinosa* needs further consideration especially in relation to these species of *Tegulaster*. In addition to morphological evidence, molecular phylogenetic studies may be effective in resolving the generic status of the species of *Disasterina*.

Another synonymized genus, *Habroporina*, was established by H. L. Clark (1921) monotypically for *Habroporina pulchella* H. L. Clark, 1921. He did not mention the presence of interradial uncalcified areas in this species, but his photographs (H. L. Clark, 1921: pl. 24 fig. 3, pl. 26 fig. 5) clearly show them. Livingstone (1933), finding no differences between *H. pulchella* and *Disasterina abnormalis*, synonymized them.

***Disasterina akajimaensis* sp. nov.**

[New Japanese name: Akajima-numeri-itomaki-hitode]
(Table 1; Figs 2–6)

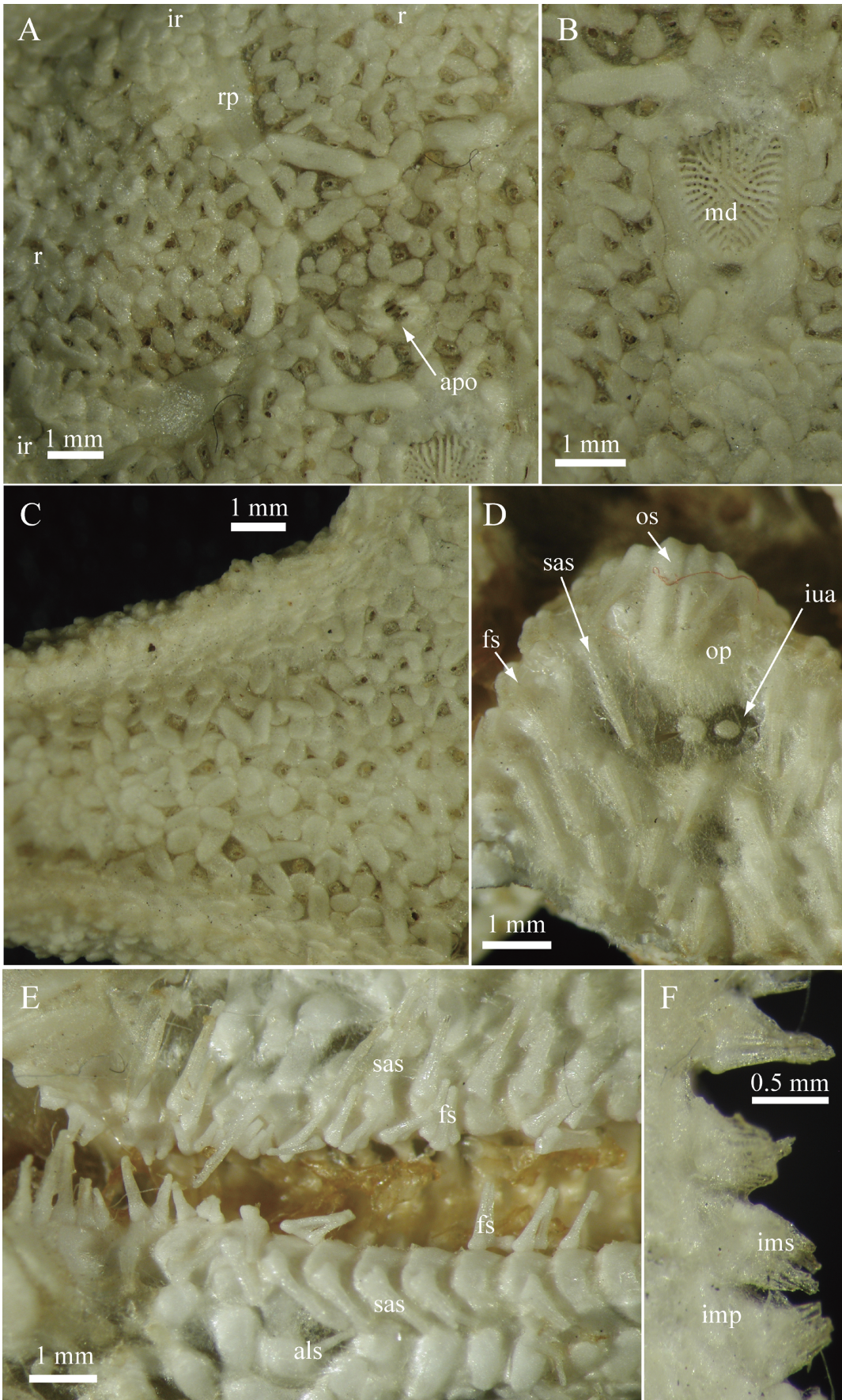
Disasterina odontacantha: Saba *et al.* 2008: 19–20. [Not *Disasterina odontacantha* Liao, 1980]

Material examined. Holotype: NSMT E-6758, Kushi-baru beach, Akajima Island, Ryukyu Islands (26°12.6'N, 127°16.6'E), intertidal, under rock, collected by M. Saba, on 19 November 2006. The specimen was directly preserved in 99% ethanol.

Description of holotype. Body thin, stellate with 5 tapering arms, slightly convex abactinally, flat actinally (Fig. 2). R/r = 16.9/8.1 mm = 2.1. Body entirely covered by smooth integument obscuring underlying skeletal plates in life, but plates visible after preservation in alcohol.

Abactinal plates imbricated, irregular in shape (circular, triangular, oval, and slender), and variable in size, maximally 1.6 × 0.4 mm; unarmed, except 4 plates surrounding anal pore each having 2–5 short, sacciform spinelets (Figs 3A–C, 4A). Ten large and slender and about 25 small abactinal plates almost regularly arranged to surround pentagonal area at center of disc (Fig. 3A). In central pentagonal area, about 43 small abactinal plates arranged in mesh with papulae in spaces. Outside central pentagonal area, abactinal plates in interradial triangular part strongly imbricated (Fig. 3A); 10–12 large plates attached firmly to each other to form rigid area (Fig. 3A) internally connected with inter-

Fig. 3. *Disasterina akajimaensis* sp. nov., holotype (NSMT E-6758). A, Anal pore and a patch; B, madreporite; C, proximal part of arm, abactinal view; D, oral plate pair and interradial uncalcified area, some oral spines have been lost (see also Fig. 6 for oral plate pair and interradial uncalcified area at another interradius); E, proximal part of ambulacral furrow (oral plates seen at the lower-left corner are drawn in Fig. 6); F, inferomarginal spinelets, abactinal view. Abbreviations: als, actinolateral spine; apo, anal pore; fs, furrow spine; imp, inferomarginal plate; ims, inferomarginal spine; ir, interradial; iua, interradial uncalcified area; md, madreporite; op, oral plate; os, oral spine; r, radial; rp, rigid patch; sas, subambulacral spine.



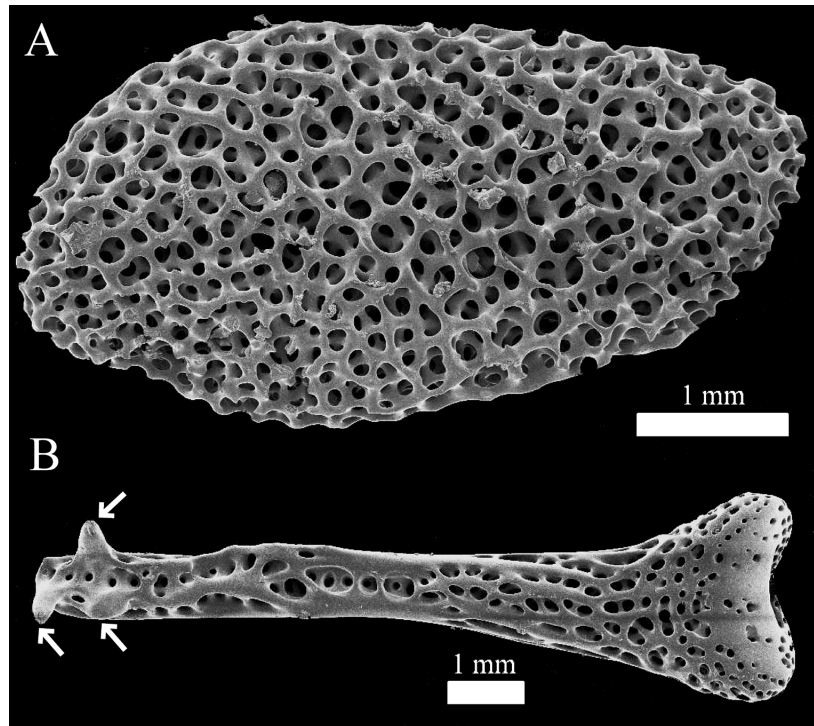


Fig. 4. *Disasterina akajimaensis* sp. nov., holotype (NSMT E-6758). A, Abactinal plate, outer view; B, actinolateral spine, with arrows indicating teeth.

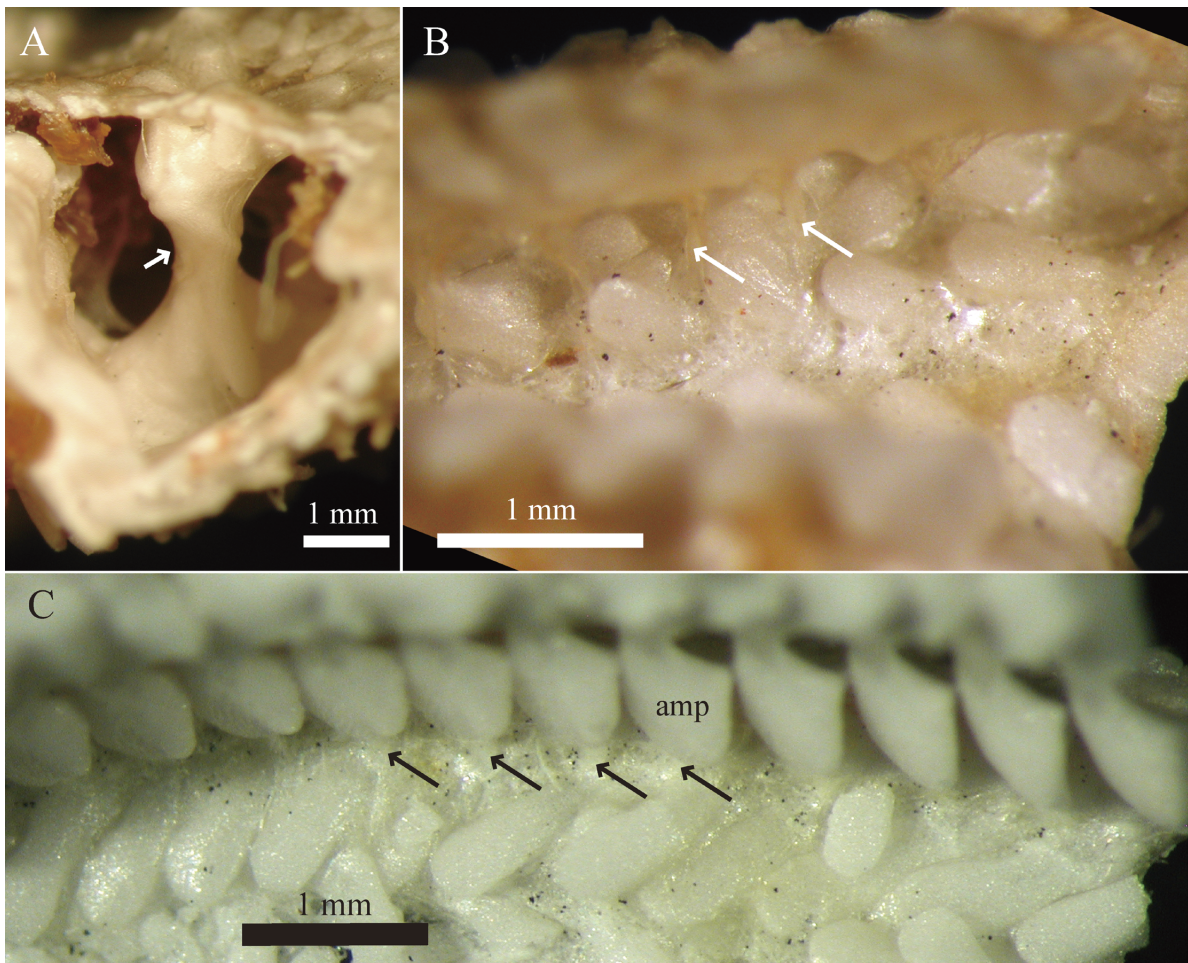


Fig. 5. *Disasterina akajimaensis* sp. nov., holotype (NSMT E-6758). A, Internal pillar (arrow); B, superactinal plates covered with soft tissue (arrows); C, superambulacral plates (arrows). Abbreviation: amp, ambulacral plate.

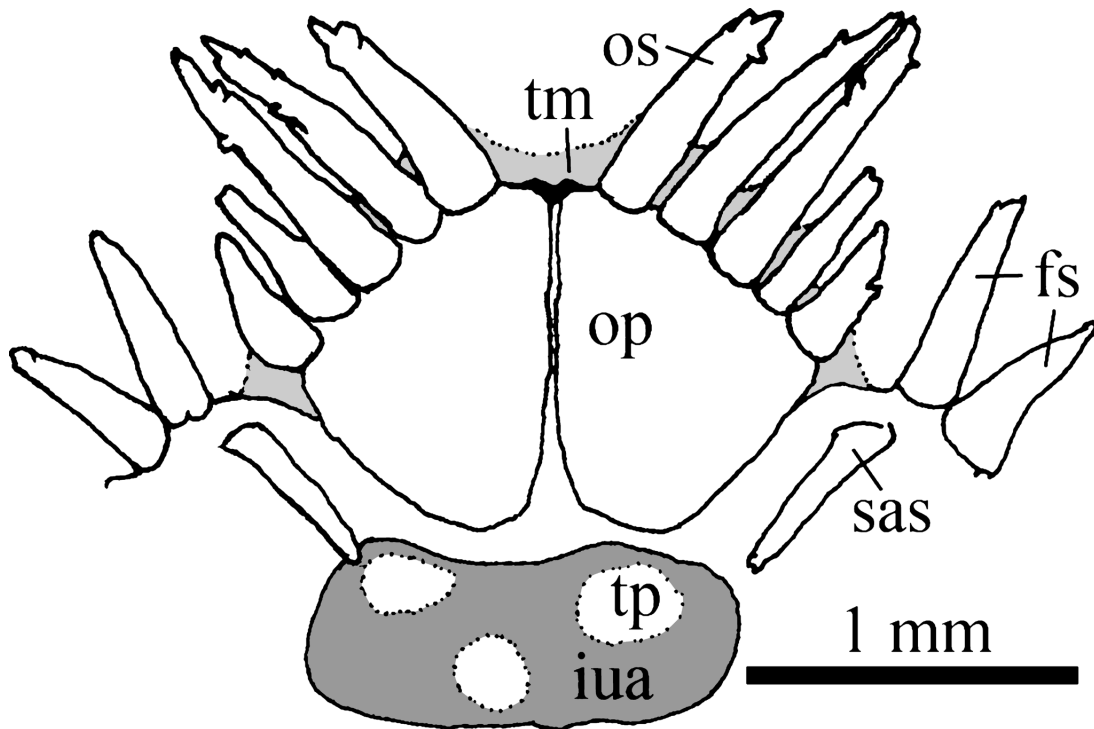


Fig. 6. *Disasterina akajimaensis* sp. nov., holotype (NSMT E-6758). Schematic view of oral plate pair and interradial uncalcified area. Abbreviations: fs, furrow spine; iua, interradial uncalcified area; op, oral plate; os, oral spine; sas, subambulacral spine; tm, thin membrane; tp, thin plate.

nal pillar (Fig. 5A). Abactinal plates in radial part contiguous or slightly imbricated, arranged irregularly in mesh with papulae in openings (Fig. 3A, C). Those just inside marginal plates strongly imbricated, smaller than those in inner part (Fig. 3C). Anal pore present at center of disc enclosed by above-mentioned plates with spinelets (Fig. 3A). Madreporite roundish pentagonal, situated just outside central pentagonal area, with about 16 sacciform spinelets on periphery (Fig. 3B).

Superomarginal plates minute, 5–7 in number, not forming distinct series. Inferomarginal plates 30–35 in number, arranged in series; spatulate, each bearing transverse distal fringe of 3 (rarely 2 or 4) webbed sacciform spinelets (Fig. 3F). Terminal plates roundish rectangular.

Papulae large, isolated, and present only on abactinal surface; numerous (42 in number) in central pentagonal area, sparse in radial part of ray (Fig. 3C).

On actinal surface, interradial uncalcified area present just distal to oral plate pair, covered with thin membrane in which 3 small, thin plates embedded (Figs 3D, 6).

Each oral plate bearing 4–5 oral spines; lacking suboral spines (Figs 3D, E, 6). Oral spines arranged closely in curved line; webbed basally by thin membrane; inner 3 spines longer than outer 1 or 2.

Adambulacral plates 33–35 in number, each with 3 (rarely 1 or 2) glassy furrow spines webbed by thin membrane, and 1 long, glassy subambulacral spine (Figs 3E, 6). Actinolateral plates roughly arranged in longitudinal rows; those of innermost two rows larger, each bearing long, sacciform actinolateral spine and innermost one extending just before terminal plate; outer rows unarmed, strongly imbricated (Fig.

3E). Most of oral spines, furrow and subambulacral spines, and actinolateral spines with 1–3 small transparent terminal teeth (Fig. 4B).

Superambulacral plates present irregularly, very small (Fig. 5C). Superactinal plates consisting of a single plate, present at internal margin, numerous interradially, becoming fewer distally (Fig. 5B).

Color in life uniformly light brown abactinally, whitish actinally (Fig. 2).

Remarks. This specimen was recorded as a young form of *D. odontacantha* in our preliminary report (Saba *et al.* 2008). The present new species is closely related to *D. odontacantha* as well as *D. abnormalis*, both of which share low and flat arms without a median keel, and a conspicuous interradial uncalcified area. It is closer to *D. odontacantha* but distinguishable by the absence of spinelets on most abactinal plates in contrast to the presence of the 1–2 spinelets, and by the 4 or 5 closely placed oral spines without any gap between them, in contrast to 3 or 4 more widely spaced spines. It is also distinguishable from *D. abnormalis* by the absence of a suboral spine on each oral plate in contrast to the presence of a long, sacciform one. The differences from the other species are shown in Table 1.

This is the first report of this genus from Japanese waters.

Distribution. Only from the type locality, Akajima, the Ryukyu Islands, Japan (present study).

Etymology. The specific epithet *akajimaensis* is derived from the island of Akajima, where the holotype was collected. New Japanese names given for this genus and species are Numeri-itomaki-hitode-zoku and Akajima-numeri-itomaki-hitode, respectively. Akajima is the locality, while

in Japanese “numeri” refers to the slimy nature of the body surface, an “itomaki” is a spool used in sewing with a shape that looks like asterinid sea stars, “hitode” are seastars, and “zoku” means genus.

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