

琉球大学学術リポジトリ

沖縄島沿岸のサンゴ礁から得られた3種のウニ類について

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Three regular sea urchins (Echinodermata: Echinoidea) from coral reefs at Okinawajima Island, the Ryukyu Islands, Southwestern Japan

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Abstract. Morphological features of three regular echinoids from coral reef at Okinawajima Island, *Lissodiadema lorioli* Mortensen, 1909, *Centrostephanus asteriscus asteriscus* A. Agassiz & H.L. Clark, 1907, and *Microcyphus excentricus* Mortensen, 1940, are reported. This is the first morphological examination of *L. lorioli* and *C. a. asteriscus* from Japan, while the discovery of *M. excentricus* represents the first record after the original description.

Introduction

Echinoids, generally known as sea urchins, are one of the most common marine invertebrates in coastal environments. Their species diversity is the highest in the Indo-Pacific region (Mortensen 1951; Shigei 1974). Japan is located at north end of this region, and is known to have exceedingly rich fauna characterized by an abundance of endemic species (Shigei 1974, 1989). In the Ryukyu Islands, southwestern Japan, since the first faunal research of echinoids by Döderlein (1885), 154 species belonging to 36 families have been recorded (Yoshiwara 1901; Shigei 1981, 1987; Hayashibara & Shigei 1995; Mochizuki et al. 2005, 2008). The echinoid fauna mainly consists of tropical species, including more than 15% of the extant species of the world (Shigei 1981). Recent faunal works in the Ryukyu Islands have mainly focused on shallow coral reef environments (Hayashibara & Shigei 1995; Mochizuki et al. 2005, 2008). New findings from even relatively accessible environments may imply further discovery of unknown echinoid diversity from other understudied environments (e.g. deep water, submarine caves, etc.) in the Ryukyu Islands.

In the present paper, we report three regular echinoids recently discovered from the coasts of Okinawajima Island, central Ryukyu Islands. *Lissodiadema lorioli* Mortensen, 1909, and *Centrostephanus asteriscus asteriscus* A. Agassiz

& H.L. Clark, 1907, have already been recorded from Japan (Shigei 1986, 1989; Hayashibara & Shigei 1995). The present study examines and diagnoses the two species based on the specimens collected from Japan for the first time. This paper also records *Microcyphus excentricus* Mortensen, 1940, from Japan for the first time. This also represents the second distributional record of the species.

All specimens examined in this study were deposited in the Ryukyu University Museum, Fujukan, University of the Ryukyus, Okinawa, Japan (RUMF); the Biological Institute on Kuroshio, Kochi, Japan (BIK); and the University Museum, the University of Tokyo, Japan (UMUTZ). Terminology follows that of Smith & Kroh (2011).

Results and discussion

Family Diadematidae Peters, 1855

Genus *Lissodiadema* Mortensen, 1903

Lissodiadema lorioli Mortensen, 1903

Japanese name: Subetoge-Gangaze (named by Shigei, 1974)

(Fig. 1, 4A)

Lissodiadema lorioli Mortensen, 1903: 393; 1940a: 329, pl. XXXV, figs 7–9, pl. LXIX, fig. 3; Clark & Rowe, 1971: 152; Rowe & Gates, 1995: 228. Paulay, 2003: 575.

Diadematidae gen. sp. - Hayashibara & Shigei, 1995: 22, fig. 2.

Materials examined. RUMF-ZE-00461, off Cape Maeda, Okinawajima Island, Ryukyu Islands, Japan, depth unknown (probably shallower than 10 m), 24 March 2003, night, SCUBA diving, coll. M. Obuchi. RUMF-ZE-00509, bared specimen, off Mizugama coast, Okinawajima Island, Ryukyu Islands, 5 m deep, 5 October 2012, night,

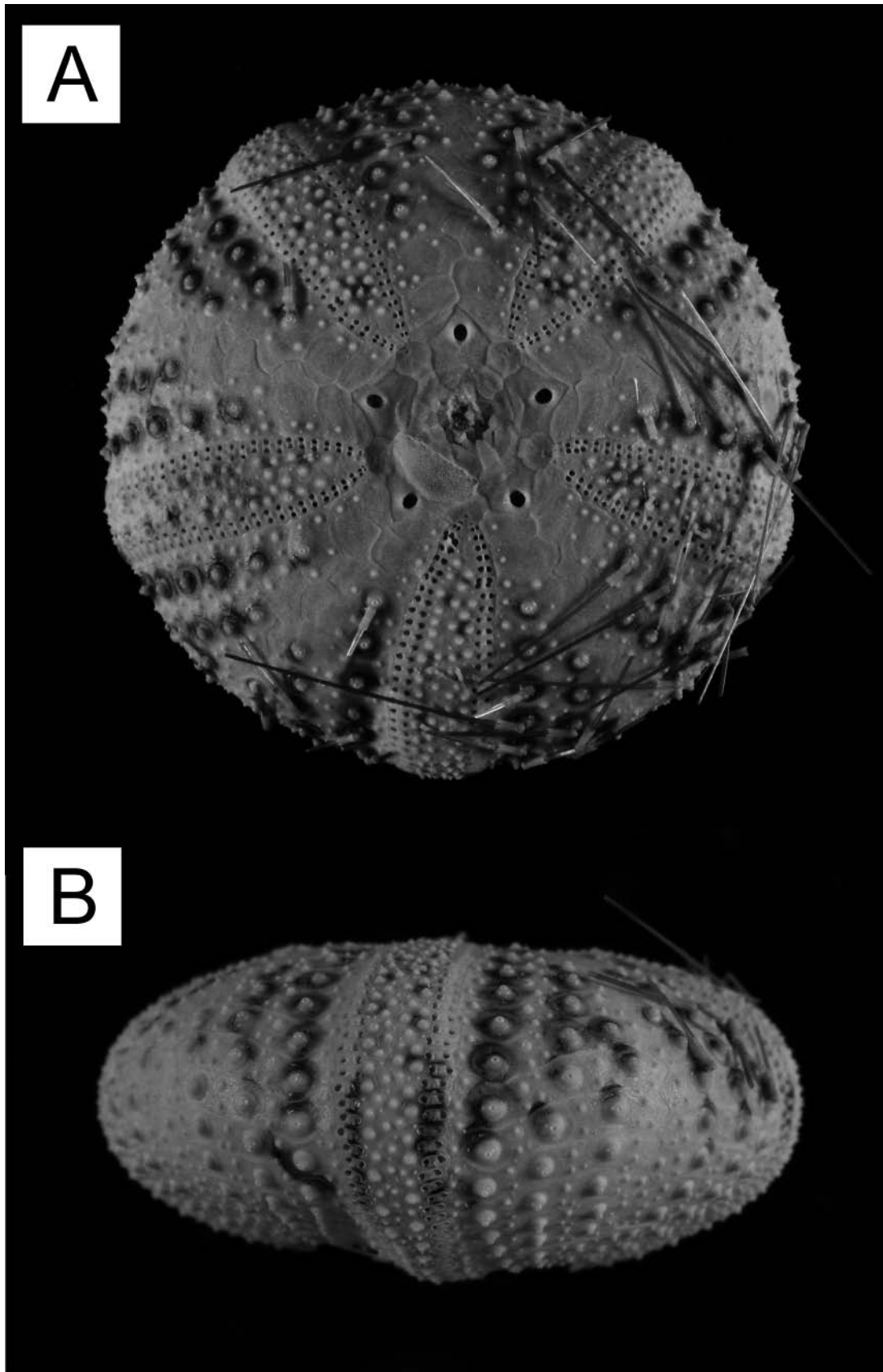


Fig.1. *Lissodiadema lorioli* (RUMF-ZE-00509, 30.0 × 13.0 mm). A, dorsal view; B, lateral view.

図 1. スベトゲガンガゼ (RUMF-ZE-00509, 30.0 × 13.0 mm). A, 背面; B, 側面.

SCUBA diving, coll. M. Obuchi.

Diagnosis. Small-sized species, with thinly hair-like, non-serrated spines. Tubercles without crenulation, crowded in ambulacra, aligned in three vertical series in each column of interambulacra.

Description. Test low, flattened above and below, up to 30 mm in width, 13 mm in height (Fig. 1). Each plate thin, integrated weakly.

Ambulacra consisted of 19–20 plates, about 1/3 of interambulacral width at ambitus. Pore-pairs uniserial, located along adradial sutures in adapical side, while located on center of plates in adoral side, crowded only at peristomial edge. Interporiferous area covered with numerous tubercles of same sizes in adapical side; primary tubercles distinguishable in adoral side, arranged in one vertical series in each column; tubercles perforated, non-crenulated.

Interambulacra consisted of 17–18 plates. Primary tubercles perforated, non-crenulated, larger than ambulacral ones. Secondary tubercles almost same size as primary ones, except in adoral side. Three vertical series of large tubercles present in each column; outer one appearing from third plate from apical, middle one from fifth, and inner one from eighth; small tubercles scattered between them. Plates near apical without large tubercles; median area naked. Plates decreasing in height toward bottom.

No distinct pit or depression on test.

Apical system 8 mm in diameter, monocyclic but ocular plates II and III not separated from periproct by extended genital plate 2. No tubercles on ocular and genital plates. Genital pores relatively large. Edge of periproct covered with larger plates, some of which with minute tubercles. Anal cone distinct, enclosed basally by small plates, extended when alive.

Peristome 12.6 mm in diameter. Membrane thick, heavily covered with imbricate plates on which pedicellariae rarely present. Buccal plates without tubercles, neighboring each other; each pair well separated.

Spines hollow, not serrated but longitudinally furrowed, extremely thin, about 0.2 mm in diameter, 60 mm in length, twice as long as width of test. Spines on adoral side relatively thick, short, with blunt tips.

Tridentate and ophicephalous pedicellariae distinct, with long stalk and neck. No tooth on valve of tridentate.

Coloration (Fig. 4A). Bared test faintly light

brown. Body reddish brown with polished spines when alive.

Ecology. *Lissodiadema lorioli* is nocturnal, inhabiting crevices of coral reefs. This species seems to stay in the backs of such crevices during daytime. Small specimens (ca. less than 10 mm in test diameter) are often found under boulders on reef slopes.

Distribution. This species is known from shallow (<50 m deep) waters of Amboina, Indonesia (type locality), Great Barrier Reef (Rowe & Gates 1995), Guam (Paulay 2003) and the Ryukyu Islands (Hayashibara & Shigei 1995; present report).

Notes. General morphology of examined specimens agrees well with the original description of the type specimen (Mortensen 1903, 1940a). In particular, they shared the characters peculiar to the species, such as non-crenulated tubercles and three series of primary tubercles on each column of interambulacra.

Hayashibara & Shigei (1995) reported an unidentified specimen of family Diadematidae collected from the coast of Akajima Island, Kerama Islands, located west of Okinawajima Island. Judging from their description and figure, we identify their specimen as *Lissodiadema lorioli*. Although the records of this species are relatively few, records are widely dispersed in the West Pacific, including both coastal waters and oceanic islands, which implies a wide ranging distribution of the species.

Genus *Centrostephanus* Peters, 1855

Centrostephanus asteriscus asteriscus

A. Agassiz & H.L. Clark, 1907

Japanese name: Asunaro-Gangaze (named by Shigei, 1986)
(Fig. 2, 4B)

Centrostephanus asteriscus A. Agassiz & H.L.

Clark, 1907: 237; 1908: 119; Mortensen, 1940a: 311, pl. XXXVII, figs. 1–2, pl. LXXVI, figs. 5–9, 13, 19–21; Shigei, 1986: 63; 1989: 187.

Materials examined. RUMF-ZE-00461, off Mizugama coast, Okinawajima Island, Ryukyu Islands, 9.6 m in depth, 25 February 2005, night, SCUBA diving, coll. M. Obuchi. RUMF-ZE-00510, bared specimen, off Cape Maeda, Okinawajima Island, Ryukyu Islands, 17 m in depth, 7 August 2004, night, SCUBA diving, coll. M. Obuchi.

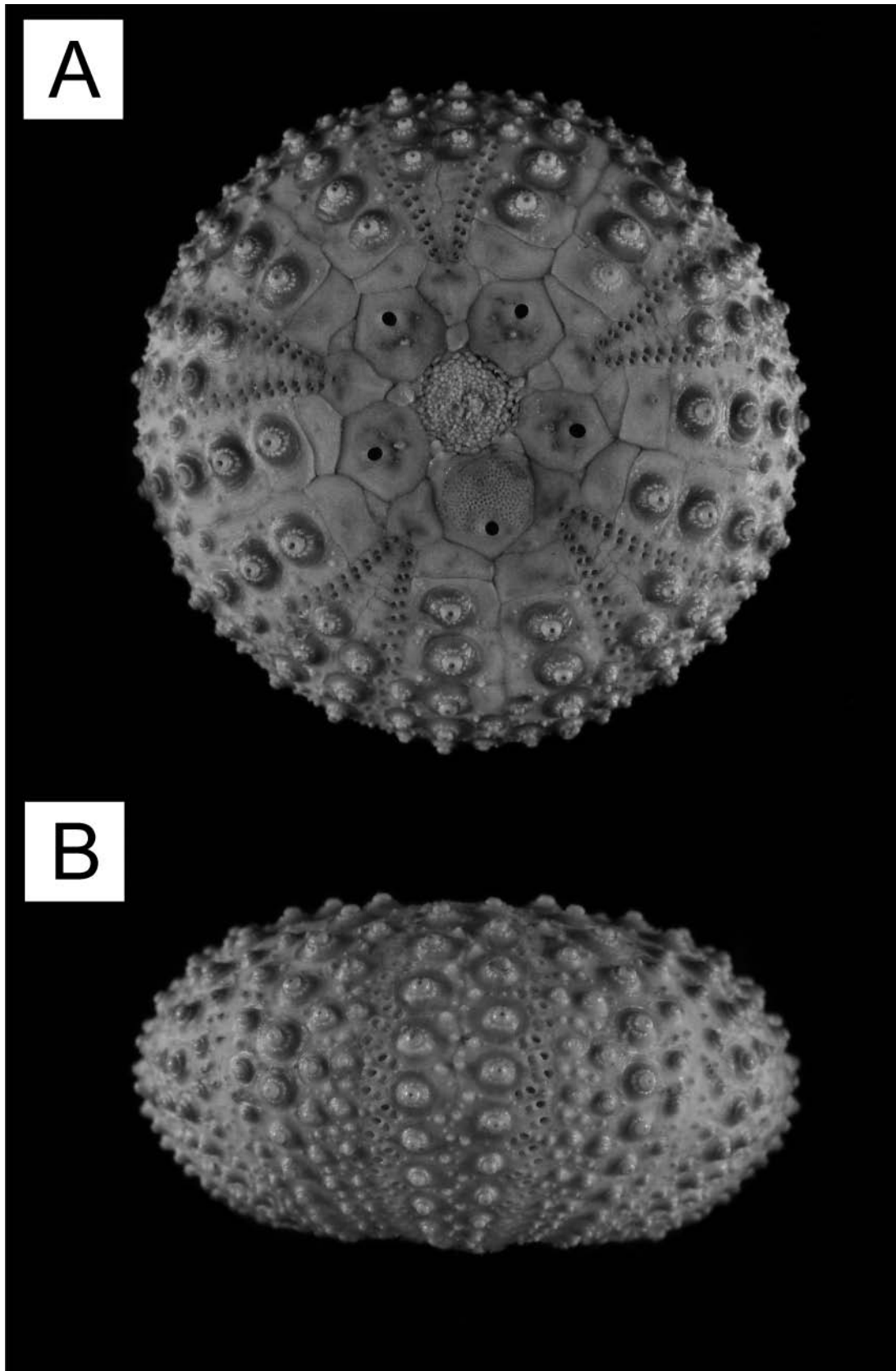


Fig.2. *Centrostephanus asteriscus asteriscus* (RUMF-ZE-00510, 21.3 × 10.3 mm). A, dorsal view; B, lateral view.
図2. アスナログンガゼ (RUMF-ZE-00510, 21.3 × 10.3 mm). A, 背面; B, 側面.

Comparative materials. *Centrostephanus asteriscus asteriscus*. UMUTZ-Ecn-SC10-02, Shinkurose, Hachijojima Island, 160–230 m in depth, 26 November 1974, dredge. UMUTZ-Ecn-SC10-03, Seto, Anijima Island, Ogasawara (Bonin) Islands, 20 m in depth, collected date unknown.

Diagnosis. Small to medium-sized species, with one white star-shaped mark on naked apical. Anal cone not projecting, unlike in other diadematid species. Spines banded, with dark red. Tubercles arranged in one vertical series in each column of ambulacra, four series in interambulacra.

Description. Test low, flattened above and below, up to 25 mm in width, 15 mm in height (Fig. 2).

Ambulacra consisted of 14–15 plates (when counted every three pore-pairs), about 2/3 of interambulacral width at ambitus. Pore-pairs uniserial near apical, forming arcs of three around ambitus, crowded near peristomal edge. Plates trigeminate; each small plates near apical unfused, with one pore-pair. Primary tubercles perforated, crenulated circumferentially, forming one vertical series in each column; areoles large, occupying about whole height of plates. Small, non-crenulated tubercles located along perradial sutures. In adoral side, one small tubercle located outside lower pore-pair of each plate. Unfused plates near apical naked, without tubercles.

Interambulacra consisted of 15–16 plates. Primary tubercles perforated, crenulated circumferentially, forming one vertical series in each column; areoles large as almost whole height of plates. Secondary tubercles perforated and crenulated, forming three vertical lines in each column; two located on each side of primary series; in adoral side, one besides adradial suture. Small non-crenulated tubercles scattered. One or 2 plates from apical naked, without tubercles.

No distinct pit or depression on test.

Apical system 8 mm in diameter, monocyclic with ocular plates separated from genital plates by small elongate plates located between them. Each genital plate with one tubercle above genital pore. Anal opening located centrally; anal cone not projecting when alive. Periproct covered with numerous minute plates; no distinct suranal plate. When alive, narrow and short white lines extended from anal opening toward each ambulacrum, forming conspicuous one star-shaped mark on apical membrane.

Peristome 10.5 mm in diameter. Membrane

thick, with small plates densely on which pedicellariae sometimes present; one plate located off each buccal notch. Buccal plates with several tubercles.

Spines hollow, distinctly verticillate with 10–16 spokes, twice as long as width of test, about 50 mm in length; no claviform spines.

Globiferous pedicellariae with gland on head. Tridentate pedicellariae without tooth. Triphyllous pedicellariae with small head and long stalk, up to 12 mm. Ophicephallus pedicellariae with or without glands on the stalk; ones without glands especially dense around mouth.

Coloration (Fig. 4B). Bared test faintly reddish with light green blotches on apical. Spines with dark red and gray bands. Body dark gray when alive. Conspicuous white star-shaped mark present on apical.

Ecology. This species has been observed on the outer slopes or drop-off walls of coral reefs, only at nighttime.

Distribution. This subspecies was known from Hawaii at depth of 25–463 m (type locality; A. Agassiz & H.L. Clark 1907). In Japanese waters, it has been collected from Hachijojima Island at depths of 160–230 m, and Ogasawara (Bonin) Islands at 20 m (Shigei, unpublished data). This report represents the first record from the Ryukyu Islands.

Notes. The specimens examined in this study agree with the original description of *C. asteriscus*, especially in the distinctly verticillate spines that are banded with dark red, and a star-shaped mark on the apical. The examined specimens were larger than the specimens studied in previous reports (up to 14 mm in test diameter; Mortensen 1940a). This suggests that this species can reach larger sizes than previously expected.

Mortensen (1939) described a “variety *malayanus*” for *C. asteriscus*. Since its taxonomic position has not been reconsidered after the original description, which is before 1961, it should be treated as a subspecific entity (ICZN 1999: Art. 45.6.4). *Centrostephanus asteriscus malayanus* Mortensen, 1939, is known from South China Sea and Indonesia, and distinguished from *C. a. asteriscus* by its greenish test and inconspicuous star mark on the apical membrane (Mortensen 1939, 1940a). Interestingly, contrary to the Ryukyu Islands being adjacent to South China Sea, the specimens from Okinawajima Island were morphologically identified as *C. a. asteriscus* from Hawaii, and not *C. a. malayanus*.

Shigei (1986, 1989) listed *C. asteriscus* in the Japanese echinoid fauna, although detail morphology of the specimens from Japan was not described. We were able to observe the specimens examined by Shigei in the University Museum, the University of Tokyo. These specimens were preserved in ethanol, with retained spines, and as such, taxonomically important skeletal morphology could not be observed. This implies that Shigei's record of *C. asteriscus* may be based on other specimens. However, what Shigei identified as *C. asteriscus* do indeed agree morphologically to the original description of *C. a. asteriscus*, as well as to the specimens from Okinawajima Island, especially in having a distinct star-shaped mark on the apical. Although the coloration of their tests, another taxonomically important character, cannot be reexamined, Shigei's (1986, 1989) records most probably represent *C. a. asteriscus* as well. The size of the specimen from the Ogasawara Islands (UMUTZ-Ecn-SC10-03) is larger than that of the specimens from Okinawajima Island (about 35 mm in test diameter).

Family Temnopleuridae A. Agassiz, 1872

Genus *Microcyphus* L. Agassiz, 1846

***Microcyphus excentricus* Mortensen, 1940**

New Japanese Name: Kiriko-Uni

(Fig. 3, 4C)

Microcyphus excentricus Mortensen, 1940b: 46; 1943: 161, pl. XVII, figs. 22–24. A.M. Clark & Rowe, 1971: 155.

Materials examined. RUMF-ZE-00461, off Mizugama coast, Okinawajima Island, Ryukyu Islands, 9.6 m in depth, 25 February 2005, night, SCUBA diving, coll. M. Obuchi. BIK-EC-300, semi-bared specimen, off Cape Maeda, Okinawajima Island, Ryukyu Islands, 13.9 m in depth, 23 July 2004, night, SCUBA diving, coll. M. Obuchi. BIK-EC-301, semi-bared specimen, off Mizugama coast, Okinawajima Island, Ryukyu Islands, 7.0 m in depth, 19 June 2007, night, SCUBA diving, coll. M. Obuchi.

Diagnosis. Small species with globular test. Median naked area in both ambulacra and interambulacra conspicuously wide, almost throughout test. Pore-pairs uniserial. Single vertical series of tubercles in each column of ambulacra, but no distinct series in interambulacra. Spines sometimes banded with dark green.

Description. Test globular, slightly flattened below, 20 mm in width, 15 mm in height;

circumstance round-pentagonal with ambulacra forming corners (Fig. 3A, B).

Ambulacra consisted of 13–15 plates, about 2/3 of interambulacral width at ambitus. Pore-pairs uniserial, not forming oblique arcs of three (Fig. 3C). Primary tubercles arranged along pore-pairs, forming one vertical series in each column. Secondary tubercles much smaller; one located above primary tubercle, forming vertical series together with primary. In adoral side, one small tubercle located outside upper pore-pair of each plate; near peristome, one additional tubercle located outside lower pore-pair. Naked median area along perradial sutures conspicuously wide, as broad as pore-zone, about 1/3 of plate width at ambitus, starting from fourth or fifth plate from bottom.

Interambulacra consisted of 7–8 plates. Primary tubercles usually located at center of each plate. Secondary tubercles almost same size as primaries, arranged irregularly (Fig. 3D). Naked area along interradial and horizontal sutures conspicuously broad, starting from second or third plate from the bottom, giving tuberculated area appearance of triangular projection into naked area.

Angular pits distinct in some individuals, present on both ambulacra and interambulacra; in adoral side, elongated depressions located along horizontal sutures of ambulacra, deep depressions across the horizontal sutures of interambulacra.

Apical system not elongated, 5–7 mm in diameter, dicyclic (Fig. 3E). Ocular plates with one small tubercle above ocular pores. Genital plates with 3–5 tubercles along adapical edges; genital pores breaking through outer edges of genital plates. Anal opening located at center; periproctal plates without tubercles; no distinct suranal plate.

Peristome naked, 8–9 mm in diameter. Each buccal plate with up to 2 ophiocephalus pedicellariae. Buccal notches short but distinct.

Spines without distinct axial cavities, longer in adoral side, up to 3.8 mm in length; tips hyaline.

No lateral tooth on globiferous pedicellariae. Ophiocephalus pedicellariae with short, thick stalks.

Coloration (Fig. 4C). Tuberculated area of bared test white. Naked area greenish or reddish gray, often bordered from tuberculated area by dark lines. Spines dark green proximally, almost clear at tips, sometimes with green bands. Such coloration persistent in preserved specimens.

Ecology. *Microcyphus excentricus* is nocturnal. This species is usually situated in the mouths of crevices on shallow reef walls at nighttime.

Distribution. This species had been recorded

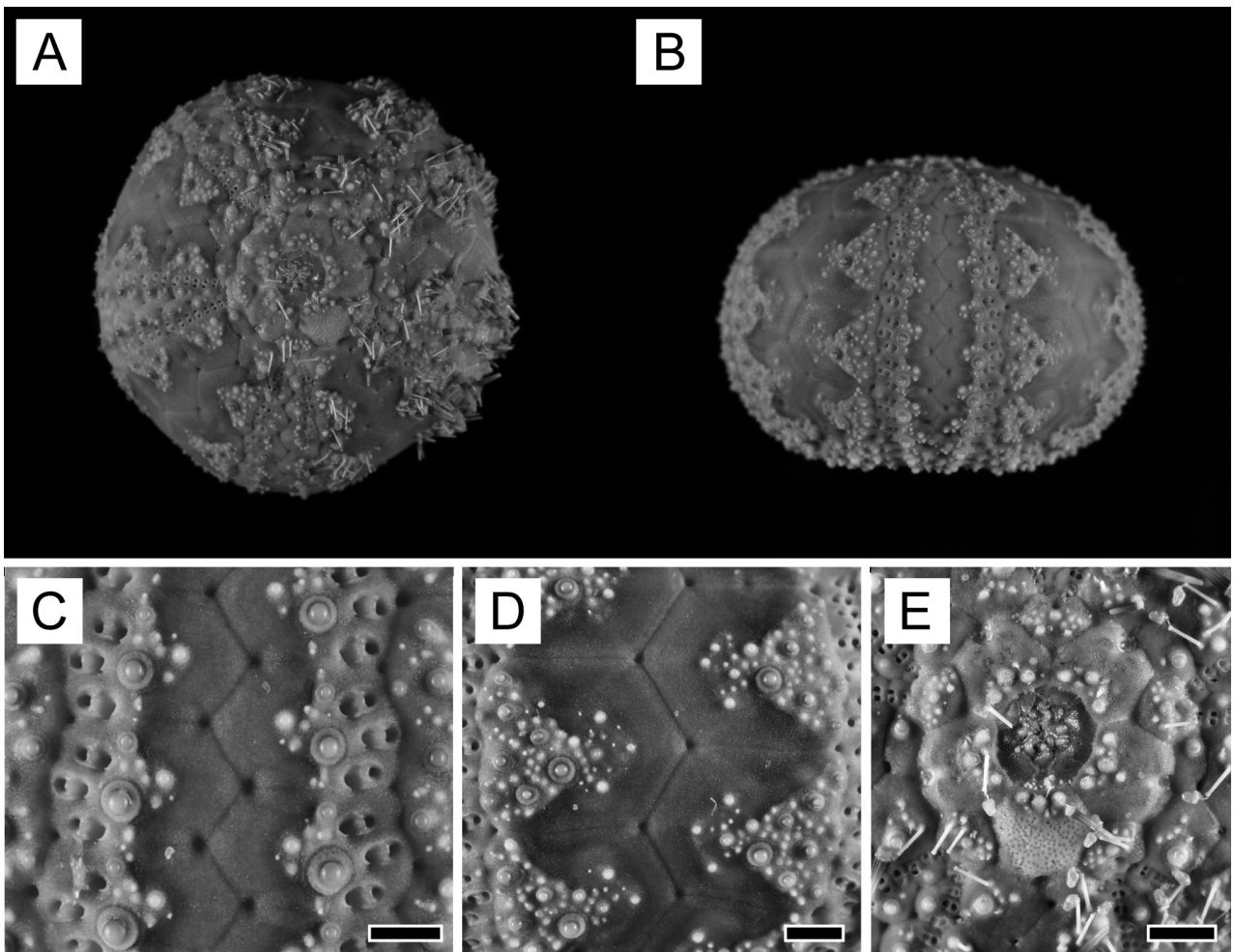


Fig.3. *Microcyphus excentricus* (BIK-EC-300, 19.8 × 15.0 mm). A, dorsal view; B, lateral view; C, ambulacral plates and pore-pairs; D, interambulacral plates; E, apical system. Scale bars, 1 mm.

図3. キリコウニ (BIK-EC-300, 19.8 × 15.0 mm). A, 背面; B, 側面; C, 歩帯板および孔対列; D, 間歩帯板; E, 頂上系. スケール: 1 mm.

from only the type locality, Pangasinan Island, Philippines (Mortensen 1940b). This report represents the first record from Japan. The distributional range is now extended to the northwestern Pacific.

Notes. The examined specimens were identified as *Microcyphus excentricus* by having a globular test, a single pore-pair line not forming arcs of three, the interambulacra without horizontal nor vertical tuberculation, the conspicuously large naked area on both ambulacra and interambulacra, and the dark lines bordering tuberculated and naked area. This unique combination of these characters is peculiar to *M. excentricus*. It is interesting that the holotype of *M. excentricus* has an elongated apical system, but all of our specimens from Okinawajima Island have an apical system that is not elongated. Mortensen (1943), however, mentioned that it is unclear whether the elongated apical system is constant with the status of this species or not, as he

examined only the holotype which is a washed test without an apical disk. To understand the range of morphological variation, and especially variation of the apical system, future investigations based on multiple specimens are required.

Microcyphus excentricus is distinguishable from three congeners recorded from Japan. *Microcyphus olivaceus* (Döderlein, 1885), an endemic species to Japan, is known from Sagami Bay to Kagoshima Bay at depths of 70–700 m (Shigei 1986). This species is easily recognized by the arrangement of tubercles that are horizontally aligned, or densely crowded, on the interambulacral plates. *Microcyphus zigzag* L. Agassiz, 1846, and *Microcyphus maculatus* A. Agassiz, 1846, were recorded from Kagoshima and from Amami-Oshima Island, Ryukyu Islands, respectively (Yoshiwara 1898). The records are, however, considered misidentifications because of deviation from their original distributions

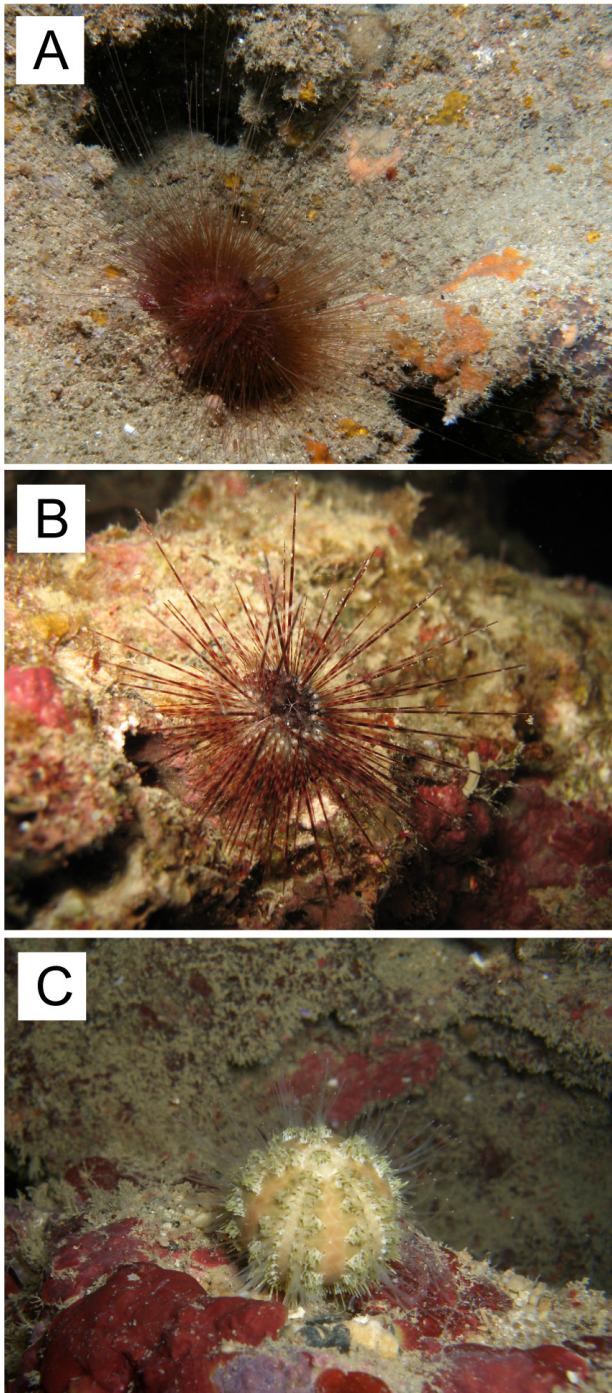


Fig.4. Live coloration of three echinoids. A, *Lissodiadema lorioli* (RUMF-ZE-00509); B, *Centrostephanus asteriscus asteriscus* (specimens not collected, 30 July 2008, night, off Cape Maeda, 6 m depth); C, *Microcyphus excentricus* (BIK-EC-300).

図4. ウニ類3種の生時の様子。A, スベトゲガンガゼ (RUMF-ZE-00509) ; B, アスナログンガゼ (未採集個体, 2008年7月30日夜, 真栄田岬, 水深6mで撮影) ; C, キリコウニ (BIK-EC-300)。

(Mortensen 1943; Shigei 1981). *Myrocyphus zigzag*, a species endemic to South Australia (Rowe & Gates 1995), is characterized by having a thick test, pore-pairs arranged in distinct arcs of

three, horizontal arrangement of tubercles in both ambulacra and interambulacra, and unique coloration (yellowish red test with dark brown naked area). Although Yoshiwara's descriptions are too fragmentary to confirm its identity, he mentioned the presence of a primary tubercle on each ambulacral and interambulacral plate of his specimen (Yoshiwara 1898), which does not fit *M. zigzag*. *Microcyphus maculatus* has a low hemispherical test and biserial pore-pairs. The naked area is narrow and limited to the aboral side in ambulacra, but broad in interambulacra. *Microcyphus maculatus* was considered to be endemic to Mauritius (Mortensen 1943), but now is known to be a widespread species in shallow waters of the Indo-West Pacific (Rowe & Gates 1995). Yoshiwara's specimen differs from this species by having an interambulacral naked area that is limited to the aboral side (Yoshiwara 1898). *Microcyphus maculatus* may be discovered from southern Japan in further studies.

In addition, *Microcyphus keiensis* Mortensen, 1942, known from Indonesia, also has the potential to be distributed in southern Japan. *Microcyphus keiensis* can be distinguished from *M. excentricus* in its horizontal tuberculation on the interambulacral plates, as seen in *M. olivaceus*, as well as the presence of red-banded spines.

We propose a new Japanese name, "Kiriko-Uni", since the zigzag lines of sutures on the naked area associate Japanese cut glasses, "Kiriko". "Uni" is the common name for sea urchins in Japanese.

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- 沖縄島沿岸のサンゴ礁から得られた3種のウニ類について
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- 要旨.** 沖縄島で採集されたウニ類 3 種, スベトゲガンガゼ *Lissodiadema lorioli*, アスナロガンガゼ *Centrostephanus asteriscus asteriscus*, キリコウニ (切子海胆, 新称) *Microcyphus*

excentricus について、形態学的観察を行なった。本稿は、スベトゲガンガゼ、アスナログンガゼの国内産標本に基づいた初の報告である。キリコウニに関しては、国内における新記録であるとともに、原記載以来の報告である。これら 3

種はいずれも夜行性種で、沿岸のサンゴ礁域において採集された。

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