

A New Record of Deep-Sea Scleractinian Coral of the Family Flabellidae (Anthozoa: Hexacorallia) from Korea

Eunae Choi¹, Hye-Won Moon^{2,*}

¹Independent Researcher, Seoul 05778, Korea

²Department of Taxonomy and Systematics, National Marine Biodiversity Institute of Korea, Seocheon 33662, Korea

ABSTRACT

This study newly records a deep-sea coral, *Flabellum (Ulocyathus) deludens* from Korea. The specimens were collected by trawling at a depth of 100 m off Jeju Island in 2019. The newly recorded species is described and compared with the other similar consubgeneric species in detail based on morphological characteristics, including corallum size, calicular diameter, calicular edge, face angle, edge angle, and septal arrangement. *Flabellum (Ulocyathus) deludens* is characterized by its solitary, highly compressed, wedge-shaped corallite with a small cylindrical pedicel, radiating inverse chevron-patterned lateral stripes on thecal faces, highly jagged calicular edges, and hexamerous septal arrangement in five cycles. As a result of this study, five species in the family Flabellidae have been recorded from Korea.

Keywords: *Flabellum (Ulocyathus) deludens*, flabellid, Scleractinia, azooxanthellate, Korean waters

INTRODUCTION

The family Flabellidae Bourne, 1905 consists of the representative azooxanthellate solitary corals that inhabit both soft and hard substrates (Tokuda et al., 2010). The flabellid corals currently comprise 100 extant species in 14 genera worldwide (Cairns, 2017). Among them, the genus *Flabellum* is one of the cosmopolitan scleractinian genera, with a depth range of 36–3,186 m (Cairns and Zibrowius, 2016). Two subgenera, *Flabellum (Ulocyathus)* and *Flabellum (Flabellum)*, are free-living, but the former is mainly distinguished from the latter by having serrate or jagged calicular edges (CE) in the skeletal structures (Cairns, 1989), as well as external soft tissues (Tokuda et al., 2010). It has been suggested that the development of external soft tissues in deep-sea corals helps to protect them from chemical corrosion of the calcareous skeleton (Roniewicz and Stolarski, 1999). With the presence of external soft tissues, *Flabellum (Ulocyathus)* species have been reported to live in deeper waters (up to 3,200 m deep) than other free-living flabellids. To date, 21 species have been recorded in the subgenus *Flabellum (Ulocyathus)* (Hoeksema and Cairns, 2021). Despite its wide distribution over the Atlantic, Pacific, Indian Ocean, and Subantarctic at

a depth of 180–3,200 m (Cairns, 1989), any species of the subgenus *Flabellum (Ulocyathus)* has not been reported in Korean waters until now.

In Korea, four species of three genera in the family Flabellidae: *Flabellum (F.) pavoninum* Lesson, 1831; *Javania insignis* Duncan, 1876; *Truncatoflabellum carinatum* Cairns, 1989; and *T. formosum* Cairns, 1989 have been reported (Song, 1982, 1991). The present study newly reports *Flabellum (Ulocyathus) deludens* Marenzeller, 1904 from Korea with a diagnosis and figures based on its morphological characteristics.

The specimens were collected using a trawl at a depth of 100 m from the subtidal zone off Seogwipo-si, Jeju-do, Korea in 2019. The specimens were fixed in 99% ethyl alcohol and dissolved in sodium hypochlorite solution diluted with distilled water for 24 h to remove all soft tissues, washed in distilled water, and dried for examination of the skeletal structures. The external structures were measured with a Vernier caliper and photographed using a digital camera (D810A; NIKON Corp., Tokyo, Japan). Edge angles and face angles were measured with a microscope image analyzer (ZEN 3.3 Blue Edition; Carl Zeiss, Jena, Germany). The internal skeletal structures were examined, measured, and photographed using

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***To whom correspondence should be addressed**

Tel: 82-41-950-0824, Fax: 82-41-950-0811
E-mail: hwmoon@mabik.re.kr

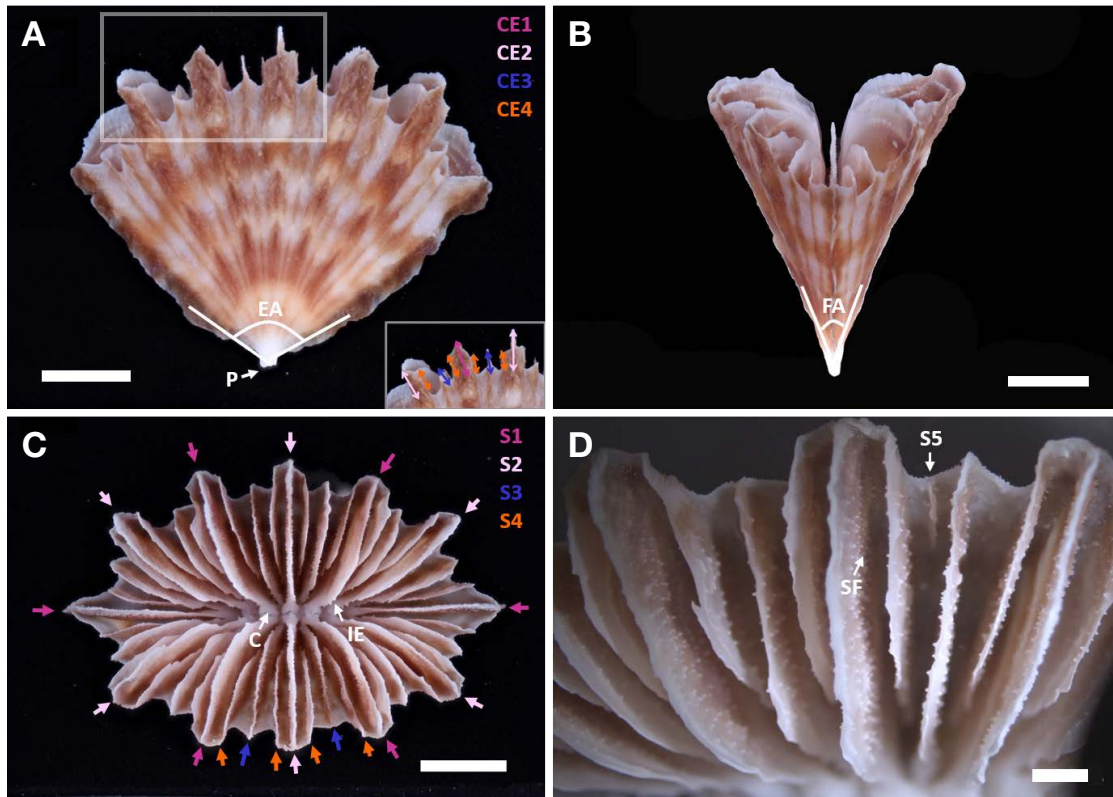


Fig. 1. *Flabellum (Ulocyathus) deludens* Marenzeller, 1904 (MABIK CN00081034): A, Lateral view; B, Edge view; C, Calicular view; D, Stereo microscope image of granulated septal faces. C, columella; CE, calicular edge; EA, edge angle; FA, face angle; IE, inner edge; P, pedicel; S, septa; SF, septal face. Scale bars: A–C=1 cm, D=2 mm.

a stereomicroscope (SteREO Discovery V8; Carl Zeiss) and an image analyzer (ZEN 3.3 Blue Edition; Carl Zeiss). The voucher specimens were deposited at the National Marine Biodiversity Institute of Korea (MABIK CN00081034).

SYSTEMATIC ACCOUNTS

Phylum Cnidaria Hatschek, 1888
 Class Anthozoa Ehrenberg, 1834
 Order Scleractinia Bourne, 1900
 Family Flabellidae Bourne, 1905
 Genus *Flabellum* Lesson, 1831

Diagnosis. Corallum solitary, fixed, or free. Corallum ceratoid, campanulate, or compressed; base not reinforced with stereome. Wall epithecal, usually lacking costae. Transverse division lacking. Pali, dissepiments, and synapticulae absent. Columella rudimentary, with a simple fusion of lower inner edges of larger septa. Exclusively azooxanthellate.

Key to the subgenera of the genus *Flabellum*

1. Calicular edge smooth *Flabellum (Flabellum)*
2. Calicular edge jagged *Flabellum (Ulocyathus)*

¹*Subgenus *Flabellum (Ulocyathus)* Sars, 1851

Diagnosis. Calicular edge serrated or jagged. External soft tissues present.

²**Flabellum (Ulocyathus) deludens* Marenzeller, 1904 (Table 1, Fig. 1)

Flabellum deludens Marenzeller, 1904: 269–272, Pl. 17, figs. 10, 10a; Yabe and Eguchi, 1942: 101–103, Pl. 5, figs. 9–11.

Flabellum (Ulocyathus) deludens: Cairns, 1989: 55, 56, Pl. 29a–f; 1994: 73, Pl. 32d, e; 1998: 395; 1999: 117, fig. 18f; Cairns and Zibrowius, 1997: 154–156.

Material examined. Korea: 3 inds., Jeju-do: Seogwipo-si, 33°21'58.41"N, 127°11'44.83"E, 100 m deep, 1 May 2019, Lee SH (MABIK CN00081034).

Korean name: ¹*톱니부채돌산호아속 (신칭), ²*사각톱니부채돌산호 (신칭)

Diagnosis. Corallite (Fig. 1A) solitary, fragile, highly compressed, wedge-shaped, with a small cylindrical pedicel and jagged CE. Greatest calicular diameter (GCD) 30–50 mm, least calicular diameter (LCD) 20–30 mm, height 28–36 mm. GCD : LCD = 1.50–1.67. Pedicel cylindrical with an ellipse in cross-section. Greatest pedicel diameter 1.09–1.30 mm, least pedicel diameter 1.78–2.38 mm, height 1.09–1.31 mm. Edge angle (Fig. 1A) 95.46°–104.34°. Face angle (Fig. 1B) 45.04°–46.92°. Lateral edge length 25–35 mm. CE (Fig. 1A) deeply jagged with corresponding septal upper exsertness. CE1, 2 >> CE4 > CE3 >>> CE5, CE5 rudimentary. CE1, 2: 3.85–6.36 (mean = 5.12) mm; CE3: 1.65–3.26 (mean = 2.46) mm; CE4: 2.49–3.83 (mean = 3.18) mm in height. Thecal extensions (Fig. 1C) between S₁ or S₂ and its neighboring S_{4s} forming a rectangle with an apex of CE1 or CE2; those between S₃ and neighboring S_{5s} or S_{4s} forming a triangle with an apex of CE3. Thecal faces (Fig. 1A) slightly convex and granulated with ridged red brown costae and radiating inverse chevron (Λ) patterned lateral stripes upward in red brown and white. Septa (S) (Fig. 1C) 62–74, hexamerally arranged in five cycles, the fifth cycle incomplete. Septal size S₁, S₂ > S₃ > S₄ >> S₅, S₅ rudimentary (Fig. 1C, D). All septa straight. Inner edges (Fig. 1C) of S₁, S₂, and S₃ fused with the columella. Septal faces (Fig. 1D) finely granulated. Columella (Fig. 1C) narrow, elongate, rudimentary, 1.14–1.66 × 11.50–11.71 mm in width × length. Fossa narrow, deep. Overall color red brown and white in the pre-fixation and post-fixation conditions. Red brown stripe patterns on thecal faces distinctive. Septal faces light red brown and white. Costae red brown. Pedicel white.

Distribution. Korea (Jejudo Island); Japan (Honshu, Shikoku, and Kyushu); Philippines (Lubang Island to Moro Gulf); Vietnam; Indonesia (Banda sea, Arafura Sea, Sumatra). Elsewhere: Bay of Bengal, Andaman Sea, off Ceylon, Laccadive Sea, Saya de Malha, South China Sea (Spratly Islands).

Remarks. The key morphological characteristic differences of calicular edge and shape, edge angle, face angle, and septal arrangement in the four consubgeneric species from Japan, Philippine, and Indonesian regions: *F. (U.) deludens*, *F. (U.) marenzelleri* Cairns, 1989, *F. (U.) japonicum* Moseley, 1881, and *F. (U.) apertum borealis* Cairns, 1994 (sensu Marenzeller, 1904; Yabe and Eguchi, 1942; Cairns, 1994; Cairns and Zibrowius, 1997), are compared and summarized with the specimens of the present study (Table 1). The corallite shapes of the four species are laterally compressed, but *F. (U.) deludens* is distinguished from the other three species by having the largest edge angle and highest rectangular thecal extension (up to 6 mm). In particular, the thecal extensions between S₁ or S₂ and its neighboring S_{4s} forming a rectangle with an apex of CE1 or CE2 are much more distinctive in height than others, by which *F. (U.) deludens* differs from *F. (U.) marenzelleri*,

Table 1. Comparison of morphological characteristics of species within the subgenus *Flabellum* (*Ulocyathus*)

Characteristics	<i>Flabellum</i> (<i>Ulocyathus</i>) <i>deludens</i>	<i>F. (U.) marenzelleri</i>	<i>F. (U.) japonicum</i>	<i>F. (U.) apertum borealis</i>
Calicular edge	Deeply lacerate rectangular lancets to 6 mm height	Lacerate rectangular lancets to 4 mm height	Serrate triangular apices (S ₁₋₂) to 3.5 mm height	Serrate Triangular Apices (S ₁₋₂) To 4 Mm Height
Septal size and number	S ₁₋₂ > S ₃ > S ₄ >> S ₅ 62–74 septa	64–96 septa	S ₁₋₂ > S ₃ > S ₄ >> S ₅ 96 septa	S ₁₋₂ > S ₃ > S ₄ >> S ₅ 48 Septa
Thecal face concavity	Slightly convex	Little (almost planar)	Highly convex	Slightly Convex
Edge angle (°)	95–104	84–112	90–108	90–112
Face angle (°)	45–47	39–52	65–88	54–75
Robustness	Fragile	Robust	Fragile	Fragile
Reference	Present study	Cairns and Zibrowius (1997)	Cairns and Zibrowius (1997)	Cairns (1994)
	Marenzeller (1904), Yabe and Eguchi (1942), Cairns (1994), Cairns and Zibrowius (1997)			

whose thecal extensions are mostly even and lower in height. Although the edge angles of *F. (U.) deludens* in previous records vary from 90° to 150°, the edge angles of the specimens examined in this study (95.46°–104.34°) are closer to those (90°) in the original description. Furthermore, the high rectangular thecal extensions of CE (up to 6 mm) and radiating inverse chevron-shaped red brown growth lines of thecal faces along with the corresponding ridged red brown costae in these specimens are distinctive enough for *F. (U.) deludens*.

ORCID

Eunae Choi: <https://orcid.org/0000-0003-0050-2214>

Hye-Won Moon: <https://orcid.org/0000-0001-6956-6852>

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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