

A Systematic Study on the Korean Anthozoa 16. Order Stolonifera

Jun-Im Song

Department of Biology, College of Natural Sciences, Ewha Womans University, Seoul 120-750, Korea

Three stoloniferan species in two genera and two families are newly recorded from Korea: *Cornularia komatii*, *Clavularia racemosa* and *Clavularia mikado*. The specimens were collected from 14 locations in Korea from 1978 to 1994.

KEY WORDS: Systematics, Stolonifera, Anthozoa, Korea

The present investigation is a continuous work on Korean Anthozoa. The stoloniferan octocorals have been rarely found in shallow waters of Korea and there are still poor knowledge of stoloniferan species.

The stoloniferans are distinguished from telestaceans by the production of daughter polyps from the creeping stolon that forms a meandering ribbon adhering to the substrate, a complex network of ribbons, or a membranous sheet. The stolon and anthosteles are often covered with the thin and horny periderm. This primitive order of alcyonarians contains three families, Clavulariidae, Cornulariidae and Tubiporidae, which are found primarily in shallow, tropical and temperate seas (Hyman, 1940; Bayer, 1956; Dunn, 1982).

For the present faunal study of Korean stoloniferans, the collections of materials had been done at a number of localities along the coasts of South Korea during the period from 1978 to 1994 (Fig. 1).

The samplings were carried out during low tide from sublittoral zone with skin and SCUBA diving. Some materials were taken from the fishing nets. They were preserved in 70-80% alcohol after relaxation in the dark place with menthol crystals. For the identification of the species, the following characters were mainly examined: the growth form of corallum, the shape of creeping stolons, the size and shape of polyps and sclerites, the

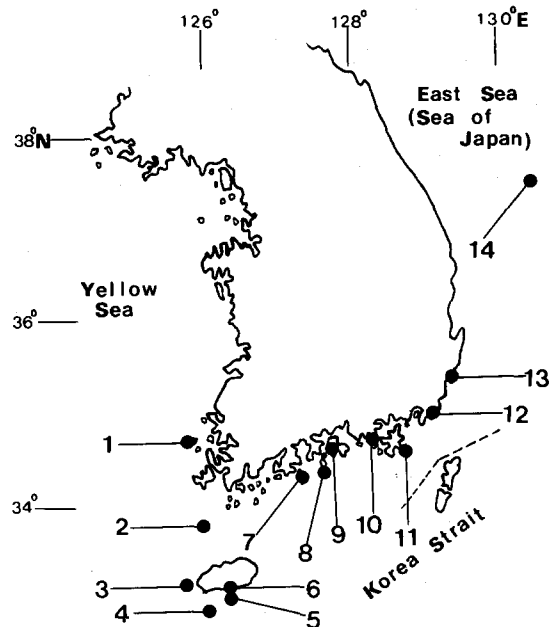


Fig. 1. The sampling sites for the stoloniferans dealt in this study. 1. Hongdo (홍도); 2. Ch'ujado (추자도); 3. Ch'agwido (차귀도); 4. Marado (마라도); 5. Pömdo (법섬); 6. Sögwip'ö (서귀포); 7. Narodo (나로도); 8. Sorido (소리도); 9. Yangp'ung (양풍); 10. Ch'ungmu (충무); 11. Yundoldo (윤돌섬); 12. Mip'ö (미포); 13. Ulgi (울기); 14. Namyang (남양).

arrangement of sclerites, the cross section of stolon and the number of endodermal canals. The size of sclerites were measured with an ocular micrometer. The stoloniferans newly known in the Korean fauna were redescribed with figures. The specimens are deposited in the Department of Biology, Ewha Womans University.

Results

Phylum Cnidaria Hatschek, 1888 자포동물 문
Class Anthozoa Ehrenberg, 1834 산호충 강
Subclass Octocorallia Hackel, 1866 팔방산호
아강 (=Alcyonaria Dana, 1846)
Order Stolonifera Hickson, 1883 근생 목
Family Cornulariidae Dana, 1846 꽃이끼 과
Monogeneric (*Cornularia*) family in which the polyps are completely separate and lack spicules. The horny cuticle around the stolons and anthosteles is sole skeleton.

Genus *Cornularia* Lamarck, 1816 꽃이끼 속 (신칭)

Primitive genus. Polyps united basally by ribbon-like stolons.

***Cornularia komaii* Utinomi, 1950** 꽃이끼산호 (신칭) (Pl. 1, Figs. 1-2)

Cornularia komaii Utinomi, 1950a (p. 76, text-figs. 1-3); 1955 (p. 124).

Material examined: Narodo, Jul. 23, 1982, two cols. (J. I. Song); Sögwip'o, Jul. 11, 1985, many cols. (Song, J. I. & S. J. Yun); Yangp'ung (Namhaedo), Apr. 27, 1990, two cols. (J. I. Song); Pongnam (Narodo), Jul. 1, 1991, two cols. (Seo, J. E. & J. I. Song). at littoral zone.

Description: In full extension, polyps mostly about 2.5-3.5 mm in length, 1 mm in diameter, occasionally up to 6.5 mm in length, 1.5-1.8 mm in diameter of specimens collected from Narodo and Yangp'ung.

Anthostele slightly contractile, about 2.5-3.0 mm long, subequal in length to anthocodia. In completely retracted polyp, it becomes slightly shorter and wider, about 1.0-2.0 mm long and 1.0-1.5 mm wide. Greater part of anthostele covered with thin, dusky brown, chitinous

envelope extending from stolon.

Fully expanded anthocodia as long as proximal anthostele or a little longer, and about 1 mm in diameter. Eight opaque, whitish lines run along mesenteries from between bases of tentacles downwards to top of anthostele.

Tentacles pinnate, moniliform, up to 1.5 mm long. Pinnules arranged in one row, 10-12 on either side of tentacle. Pinnules of tentacle bear mass of nematocysts, especially only 2 different sizes (μm) of spirocysts: $9.9-11.5 \times 3.7-4.0$, and $10.5-11.2 \times 6.0-7.0$.

Colonies consist of an open network of narrow stolon strands having a wide mesh. These strands bear at compact intervals cone-shaped prominences. In many cases, meshes about 5-10 mm wide and cone about 3-5 mm apart, so that stolon may as usual arise branches at bases of cones. Stolons very narrow, flattened and brittle, measuring about 1.0-2.2 mm wide and about 0.2 mm thick, covered invariably with a very thin, soft, wrinkled, chitinous periderm, much like perisarc together with cone-shaped basal parts of polyps (anthostele).

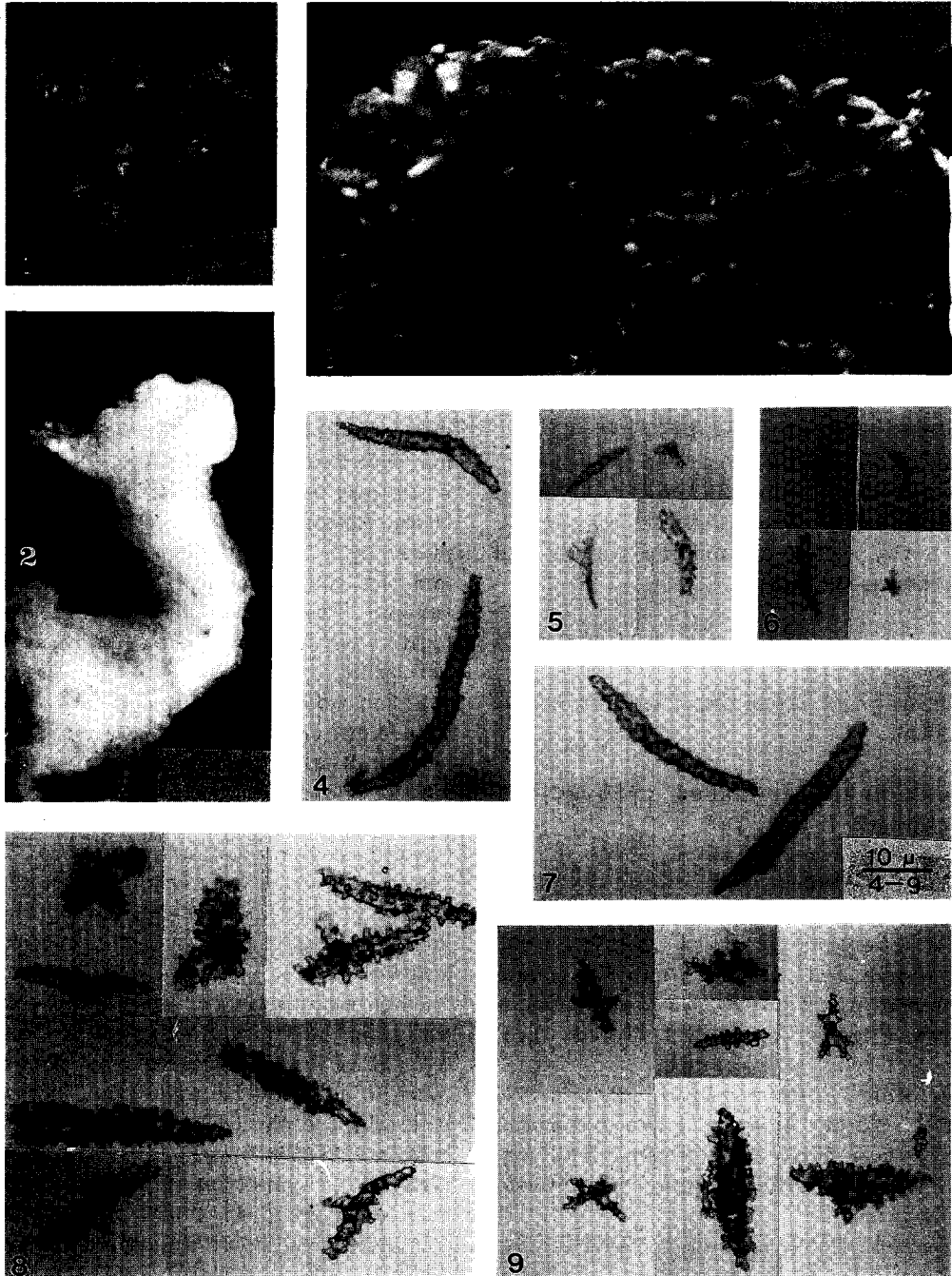
Stolon occupied with 4-7 parallel rows of endodermal canals (en.c), arranged horizontally. Number of canals variable according to width of stolon. These canals comparatively wide and almost similar in diameter, surrounded by a thin, loose, less homogenous mesogloea. Outer chitinous envelope extremely thin and generally loosely attached to ectoderm. Arrangement of these canals easily shown through transparency of body wall.

When fully expanded, polyp body uniform, transparent and pinkish or yellowish orange in color. Basal part of polyp and stolon dirty brown owing to a thin chitinous envelope. These colors fade away, and whole colony becomes milky white in alcohol. No spiculation.

Habitat: Colonies have ribbon-like stolon and form mass up to 45×34 mm. It is found commonly under stones or underside of rocks in the shaded places of littoral. Stolons are creeping on the calcareous tubes of polychaetes, tunics of ascidians and other substrata.

Remarks: In general features such as the colonial formation and the shape of polyps, these

PLATE 1

**Plate 1;**

Cornularia komaii: 1, a colony; 2, an expanded polyp.

Clavularia mikado: 3, a colony; 4, spicules from point of anthocodia; 5, from tentacles; 6, from neck zone; 7, from crown of anthocodia; 8, from anthostele; 9, from stolon.

specimens are similar to Utinomi's original description (1950a). But the number of present specimens's pinnules is more than that of *C. komaii* and within the range of *C. sagamiensis* Utinomi, 1955.

Distribution: Korea (Korea Strait and Cheju Is.) and Japan.

Family Clavulariidae Hickson, 1894 곤봉산호과 (신칭)

Stoloniferans with small to large tubular polyps, armed with spicules which are usually separate but occasionally inseparably fuse, and commonly also a horny cuticle.

Genus *Clavularia* de Blainville, 1830 곤봉산호속 (신칭)

Polyps simple, arising from bandlike or membranous stolons.

***Clavularia racemosa* Utinomi, 1950** 송이곤봉산호 (신칭) (Pl. 2, Figs. 1-8)

Clavularia racemosa Utinomi, 1950b (p.38, text-figs. 1-3).

Material examined: Ch'ungmu, Jun. 3, 1978, two cols. (Rho, B. J. & J. I. Song); Sorido, Aug. 6, 1983, 21 cols. (Song, J. I., Yun, S. J. & H. S. Han); Mip'o, Nov. 26, 1983, many cols. (Song, J. I. & J. H. Park); Namyang, Jul. 11 1984, three cols. (J. I. Song); Yundoldo, Jul. 19 1989, many cols. (Song, J. I., Yun, S. J. & H. S. Han); Ch'ujado, Jul. 21, 1990, many cols. (J. W. Lee); Pömdo, Oct. 22, 1991, many cols. (Song, J. I. & J. H. Won); Ch'agwido, Oct. 23, 1991, many cols. (Song, J. I. & J. H. Won); Marado, Oct. 25, 1991, many cols. (Song, J. I. & J. H. Won); Ulgi, Jul. 16, 1994, five cols. (Song, J. I.) at sublittoral zone by SCUBA diving and fishing nets.

Description: This alcyonarian has a thread-like, anastomosing stolon, usually more than 10 cm long, with numerous polyps arising at short intervals.

Polyps closely arranged in one row on upper surface of stolon, from less than 1.0 mm to 4.0 mm apart. In many cases, this distance between neighboring polyps much shorter in proximal and middle parts of colony than terminal part of stolon.

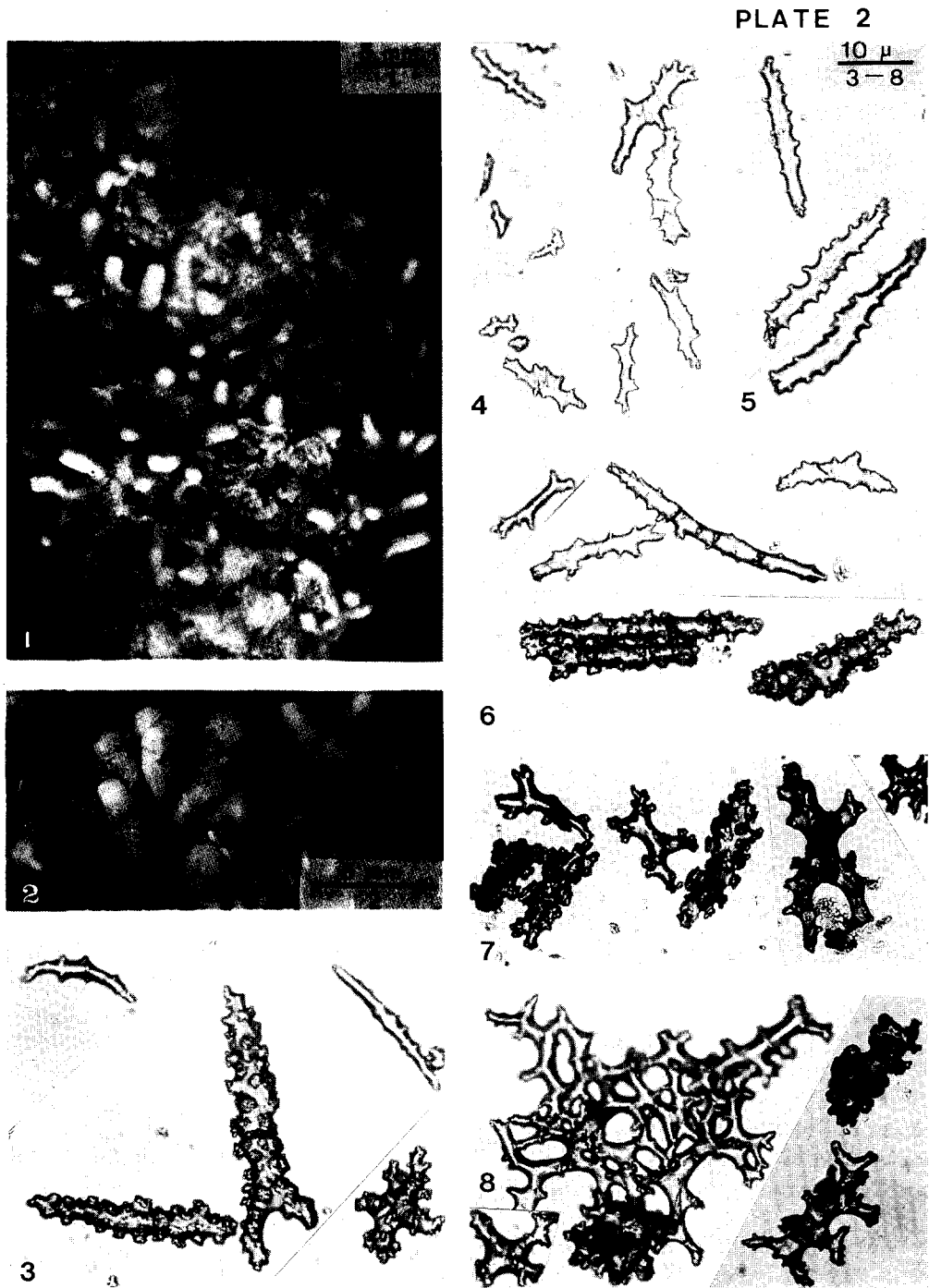
Body of polyp distinctly divided into proximal densely spiculated anthostele and distal anthocodia, this being completely retractile into that. In expanded state, polyps 1.5-2.0 mm in diameter, rather tall, up to 13 mm in height, excluding tentacles. In completely retracted colony, anthostele forms an elongated cone, measuring about 1.5-5.2 mm long and 1.0-1.5 mm broad.

Anthostele thick-walled, opaque, and densely beset with spicules. Distal part of spiculate region forms chevroned feature in each intermesenteric region.

Anthocodia thin-walled, flexible, translucent, a little longer than anthostele in expanded state, measuring about 5.0-5.5 mm long and 1.0-1.5 mm broad at base of tentacles. Upper one-third to one-fourth of anthocodia about 1.5 mm long, furnished with crown of spindle- or rod-shaped spicules. These spicules regularly arranged along *en chevron*, consisting of 8 double longitudinal rows, lying below bases of tentacles wider and comprise more numerous spicules than other 8 rows arranged along bases of mesenteries. In lower part of chevrons, spicules somewhat obliquely and transversely directed in basal part. Remaining part of anthocodia mostly devoid of spicules, and marked with 8 whitish lines due to absence of zooxanthellae. But neck zone of anthocodia transparent, scarcely transversal arrangement of minute spicules along each mesenteries.

Tentacles pinnate, long, and gently taper distally. In life they appear brownish and opaque owing to presence of zooxanthellae. In extended state, tentacles about 1.2-1.5 mm long and 0.5 mm broad at base. Dorsal surface of tentacle furnished with small spicules arranged in zigzag course, numbering 15 to 20 in a single tentacle. Pinnules slender, finger-shaped, about 0.8 mm long in middle and distal parts of tentacles, and 9-11 on each side of tentacles. They opaque, densely packed with zooxanthellae in endoderm, and with spirocysts: 9.0-11.5 × 3.5-4.0 (μm) in periphery, but completely devoid of spicules.

Stolon creeping on over twigs of kelp, and appears threadlike instead of being membranous as most species of *Clavularia*. Main branch

**Plate 2;**

Clavularia racemosa: 1, colonies growing on a shell of mussel; 2, partially expanded and retracted polyps; 3, spicules from neck zone; 4, from tentacles; 5, from anthocodia; 6, from middle part of anthostele; 7, from basal part of anthostele; 8, from stolon.

stretches along twig of kelp, and fuses irregularly with neighboring branches by short branchelets. Main branches show anastomoses, forming irregular network of fine meshes, bearing comparatively few polyps.

Stolons very thin throughout, about 0.7-1.2 mm in diameter, and almost circular or semicircular in cross section, although becoming somewhat flattened in wider places. Points of branching usually free from polyps.

In color, polyps chocolate brown, owing to high density of zooxanthellae in anthocodiae and tentacles. Anthosteles and stolons paler, being light brown, orange or even whitish due to densely packed spicules. In contracted state, colonies as stolon and anthosteles in color. In alcohol these color fade away and colonies become milky white.

All spicules colorless and their measurements (μm) in size are as follow:

Tentacles	rodlets	5.3- 5.5 × 1.8- 2.3,
		6.0-15.0 × 3.0- 4.8
Anthocodia	spindles	10.5-21.0 × 2.7- 4.2
	*branched spindles	9.8-21.0 × 5.3- 6.0
Neck zone	spindles (very rare)	3.8- 7.5 × 1.5- 2.3,
		13.5-22.5 × 2.3- 4.5
	warted spindles (very rare)	19.5-28.5 × 4.5- 5.7,
		19.5-34.5 × 6.5- 7.5
Anthostele	spindles	10.5-27.0 × 2.3- 4.5
	warted spindles	15.8-21.0 × 4.5- 5.3,
		24.0-31.5 × 4.5- 7.5
	compound warted spindles	10.5-22.5 × 5.3- 8.3
	*branched spindles	12.0-31.5 × 4.5- 9.0
Base of anthostele	warted spindles	7.5-18.0 × 3.0- 6.0
	branched spindles	6.0-13.0 × 5.3- 9.0
	warted rods	10.5-25.5 × 4.5- 7.5
	*branched warted stelle	12.8-21.0 × 9.0-13.5
Stolon	warted spindles	7.5-19.5 × 4.5- 6.8
	compound warted spindles	21.0-33.8 × 7.5- 9.0
	*branched spindles	8.3-18.0 × 4.2-10.5
		18.0-25.5 × 9.8-13.5
	compound warted stelle	7.5-18.0 × 6.0-11.3

* Sclerites of stolon anastomose each other.

Habitat: Occasionally colonies are found on the rocky shore in shaded places. But sublittoral form typically occur down to at least 100 m. It grows on stems and roots of kelps (*Sargassum* sp.),

barnacles (*Megabalanus volcano*), shells of mussels and oysters, tunics of solitary ascidians and calcareous tubes of polychaetes, and appears much like mosses or an ivy. Sometimes, polyps are covered with hydroids (*Filellum serratum*), bryozoans (*Aetea anguina*), sponges and others.

Remarks: In general features such as the colonial shape and the spiculations, these specimens are similar to Utinomi's original description (1950b) except for having the long warted spindles of anthostele and stolon.

Distribution: Korea (Korea Strait and Cheju Is.), Formosa and southern Japan.

***Clavularia mikado* Utinomi, 1955** 미카도곤 봉산호 (신칭) (Pl. 1, Figs. 3-9)

Clavularia mikado Utinomi, 1955 (p.132, text-figs. 9-11); 1962 (p.105).

Material examined: Mip'o, Dec. 28, 1986, many cols. (J. I. Song); Hongdo, Jun. 25, 1992, many cols. (S. J. Yun). sublittoral zone by SCUBA diving.

Description: Masses of membranous colonies measure about $3 \times 3 - 15 \times 10$ mm, up to $35 \times 20 - 60 \times 15$ mm. Zooids closely situated, leaving slight free space between them. Stolons wholly membranous but not continuous altogether.

Zooidal verrucae and stolons unusually armoured with stiff spiculose cortex. Verruca into which polyp retracts measures 1.7-2.8 mm, up to 3.5 mm in height and 2.0-3.0 mm, up to 3.7 mm in basal diameter. Smaller zooids which placed close at each other have anthostele 1.0-1.7 mm in height, 1.2-2.0 mm in basal diameter. Zooids have entirely retractile anthocodiae and provided with a distinct, thick-walled anthostele in which sclerites closely placed in a longitudinal direction arranged in 8 converging double rows. Size and shape of zooids somewhat varying corresponding to degree of contraction. Specimens from Hongdo on June have fairly large eggs on mesenteries of zooids (Pl. 1, fig. 3).

In extended state, polyps 5.3×3.1 mm, up to 9.5×3.5 mm in height, and anthocodia 1.5-1.8 mm in height, about same width. They thickly armoured with longitudinal spicules in 8 double rows and each one intermediate spicule between them, and below these horizontal rows of

somewhat shorter spicules. Sclerites in upper part of antocodia curved, warty spindles, arranged *en chevron* in 8 double rows. Sclerites in lower part of them slender, usually straight spindles, arranged transversally. Lower neck zone of zooid scattered transversely with tiny spindles, 0.07-0.17 mm long and 0.03-0.06 mm wide. These anthocodial spicules all light yellow.

Tentacle rather plump, up to 1 mm long and bears about 10 pairs moniliform pinnules with 4 or 5 distinct annulations on each side. Dorsal surface of tentacle strongly armoured with flattened warty rods, which arranged in downward converging double row, not continuing to point-rows of anthocodia.

Stolons in somewhat flattened area free from verrucae also thickly covered with similar spicules to anthostele's.

All spicules light yellow and their measurements (μm) in size are as follows:

Tentacles	.....warty rods.....	4.0- 8.0	\times 2.0- 3.0
	thornscale.....	7.0-11.0	\times 2.0- 5.5
	bent rods ...	12.0-23.0	\times 4.0- 6.0
Anthocodia	...bent spindles...	22.0-58.0	\times 5.0- 6.5
	spindles.....	22.0-57.0	\times 4.0- 6.0
Neck zone	.....warty rods.....	7.0- 8.0	\times 5.0- 6.0
		9.0-17.0	\times 3.0- 5.0
	branched spindles.....	7.0- 7.5	\times 6.0- 6.5
Anthostele	.....spindles.....	6.0-11.0	\times 2.0- 3.0
		8.0-16.0	\times 3.0- 5.0
	spindles with complex tubercles.....		
	.....	15.0-47.0	\times 5.5-11.0
	butterfly...	28.0-35.0	\times 10.0-13.0
	warty club...	22.0-49.0	\times 8.0-13.0
	cross.....	7.0- 8.0	\times 6.0- 7.0
		25.0-34.0	\times 13.0-19.0
	branched spindles...	32.0-35.0	\times 18.0-25.0
Stolon	.....warty rods.....	7.0- 9.0	\times 2.0-3.0
	spindles.....	11.0-18.0	\times 4.0-5.0
	spindles with complex tubercles.....		
	.....	16.0-43.0	\times 6.0-11.0
	branched spindles...	14.0-22.0	\times 8.0-11.0
	cross.....	9.0-17.0	\times 6.5-12.0
		5.0- 7.0	\times 4.0- 5.5

Habitat: This alcyonarian has membranous stolon, usually covers over calcareous tubes of polychaetes, mass of sponges, bryozoans, shells of oysters and base of gorgonians with numerous

polyps arising at contact intervals.

Remarks: In general features such as the colonial formation and the shape of sclerites, the present specimens mostly agree with Utinomi's original description (1955) except for the differences on sclerites. Spindles of tentacles, anthocodia and neck zone are larger than those of original description, and also anthostele and stolon of present specimens have warty irregular form, that is branched spindles and cross. Moreover, these specimens are similar to *Clavularis griegii* (Madsen, 1944), which has up to 1.1 mm-long spindles from anthostele and bearing no irregular form of spiculations. Japanese specimens from type locality were recorded from depth of 70 m, but Korean specimens were from less than 30 m.

Distribution: Korea (Koera Strait) and Japan.

Acknowledgements

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한국산 산호충류의 계통분류학적 연구 16. 근생 목
송준임(이화여자대학교 자연과학대학 생물학과)

한국해역에서 처음 조사된 근생류는 2과 2속 3종의 한국 미기록종으로 밝혀져 재기재하였다: *Cornularia komaii*, *Clavularia racemosa* 및 *Clavularia mikado*. 이들은 1978년 부터 1994년 까지 남한의 14개 지역으로부터 채집되었다.