

Three New Records of Actiniaria (Anthozoa: Zoantharia) from Korea

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ABSTRACT

Some actinarians were collected from the coasts of Jeju and Baekdo Islands in Korean waters from 1971 to 2004. They are identified into three species within three families, which are newly recorded to Korean actinarian fauna: *Halcampella maxima* Hertwig, 1888 within the tribe Athenaria, and also *Aulactinia coccinea* (Verrill, 1866) and *Stichodactyla tapetum* (Ehrenberg, 1834) within the tribe Thenaria. They are described in detail with figures and tables together with the distribution and size of cnidae. In preserved specimens, mature oocytes of *H. maxima* were observed in winter. Also oocytes and sperm sacs of *S. tapetum* were surveyed at separate individuals in summer. The unique feature of *A. coccinea* is a body wall with simple adhesive verrucae extended from margin to limbus in longitudinal rows. In the genus *Stichodactyla*, the smallest species, *S. tapetum* is distinguished from *S. haddoni* by short bulbous tentacles, less than 1.0 mm long, densely packed on the oral disc and also conical marginal ones, 1.5-2.0 mm long. As a result of this study, the Korean actinarian fauna consists of four athenarian and 23 thenarian species in suborder Nynantheae

Key words: taxonomy, Actiniaria, Zoantharia, Korea

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INTRODUCTION

The order Actiniaria containing the true sea-anemones is wide at the range of morphological variation (Manuel, 1988). Some of the group such as tribe Athenaria are burrowing in soft sediment from intertidal zone to deep waters by the physa of proximal end (Carlgren, 1949). Most of them belonging to tribe Thenaria strongly adhere to the rocks by the flat pedal disc. Moreover, some forms can secrete a chitinous cuticle around the column or on the base, and some attach pebbles of debris to the column by means of adhesive spots (Dunn, 1982).

The purpose of this study is to clarify the fauna and distribution of actinarians of Korean waters. By adding three new species reporting in this study, Korean actinarians become 4 athenarians and 23 thenarians in suborder Nynantheae (Song, 1984, 1992, 2003; Song and Lee, 1998; Cha and Song, 2001; Song and Cha, 2002).

MATERIALS AND METHODS

For this taxonomic study of actinarians, specimens stocked in the Department of Life Sciences and the Natural History Museum, Ewha Womans University during the period from 1971 to 1999 and new ones collected from 2000 to 2004 were examined. They were collected at sandy mud flat of Jejudo Islands by trawl and fishing nets and also sampled at rocky coasts of Baekdo (127° 34'E, 34° 03'N) and Jejudo (127° 34'-127° 00'E, 33° 10'-34° 05'N) Islands by SCUBA diving. Samples were fixed in 5% neutral formalin after anesthetization with menthol or 10% MgCl₂ solution.

The identification was done on the base of morphological characters with microscope systems (Stemi SV VI and Zeiss Axioscop 2 microscope system, Zeiss Inc.). The observation of internal characters was facilitated by the microtome serial section using tissue processing systems (Reichert-Jung). To see the size and distribution of cnidae, they were examined and measured with an ocular micrometer at ×1,000 of photo microscopes (Zeiss Axioscop 2 microscope system and Olympus BH2) by squashing a bit of tissue on a drop of phenol-glycerol solution. For the classification, the systematic schemes of Carlgren (1949) and England (1987) were basically followed.

RESULTS

Phylum Cnidaria Hatschek, 1888

Class Anthozoa Ehrenberg, 1834

Subclass Zoantharia R. Blainville, 1830

Order Actiniaria R. Hertwig, 1882

Suborder Nynantheae Carlgren, 1899

Tribe Athenaria Carlgren, 1899

Family *Halcampoididae (Appelhof, 1896)

Athenaria with usually elongated body and with proximal end physa-shaped, rarely flattened.

Column sometimes without regional differentiation sometimes divisible into physa, scapus and scapulus. No sphincter. Tentacles few up to 40, inner not shorter than outer. A single siphonoglyph or no distinct ones. Perfect pairs of mesenteries (macrocnemes) variable in number up to 20. Retractors of perfect mesenteries strong, diffuse to restricted, more or less reniform. Parietal muscles distinct.

Genus ^{1*}*Halcampella* Andres, 1883

Elongate body divisible into physa, scapus and scapulus. Physa more or less distinct, scapus with tenaculi. No sphincter. Tentacles short, more numerous than mesenteries in aboral part of body, their longitudinal muscles ectodermal. Siphonoglyphs weak.

Six pairs of perfect and fertile mesenteries. two pairs of directives. Microcnemes only in uppermost part of body. Retractors strong, diffuse, restricted, forming numerous high folds. Parietal muscles rather well developed.

^{2*}*Halcampella maxima* Hertwig, 1888 (Figs. 1-2, 7A)

Halcampella maxima: Wassilieff, 1908, p. 6, text-fig. 1, pl. 3, figs. 30-33; Carlgren, 1931, p.

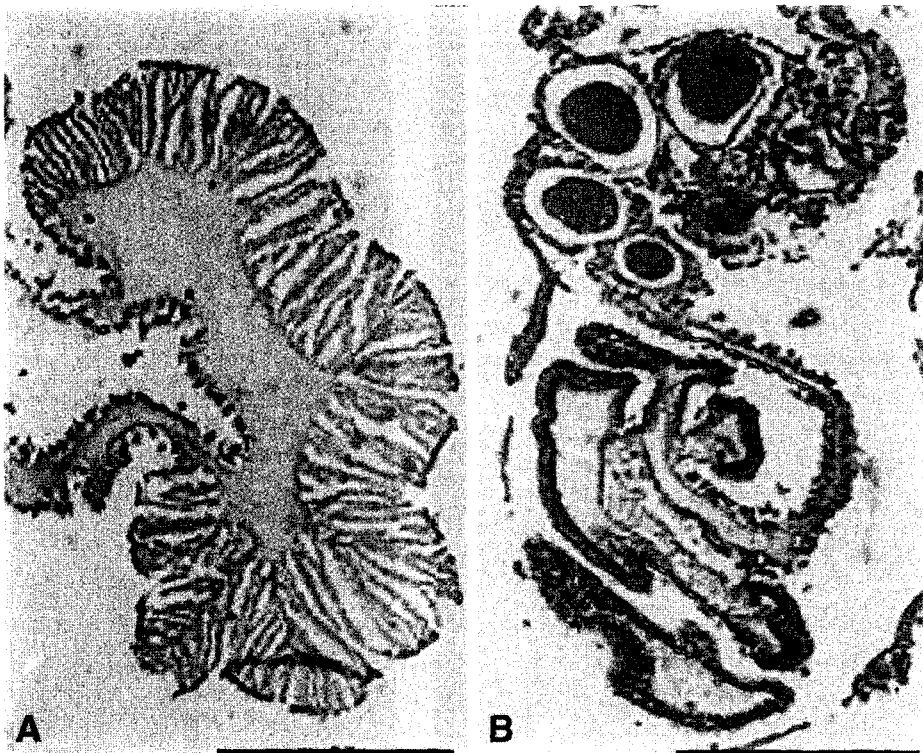


Fig. 1. Mesenteries of *Halcampella maxima*. A, complete mesentery; B, mesenterial filament with oocytes. Scale bars = 0.5 mm.

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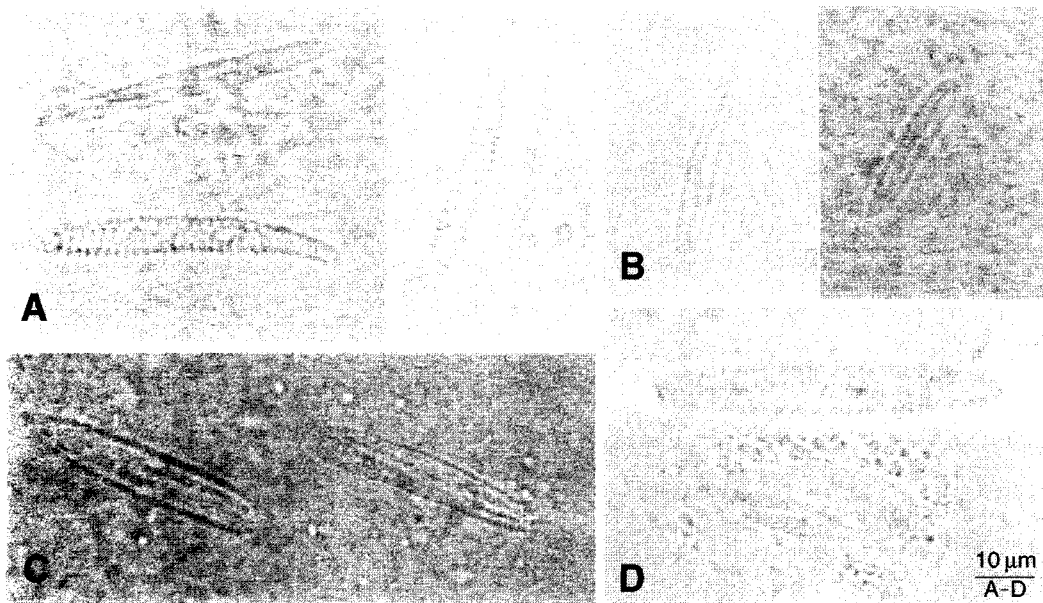


Fig. 2. Cnidae of *Halcampella maxima*. A, tentacle; B, actinopharynx; C, column; D, mesenterial filament.

Table 1. Comparison of sizes (mm) in relation to state of specimens.

Parts	Expanded		Contracted	
	length	width	length	width
Total height	(63)85-97/120-135		82-93/120-130	
Scapulus	8-13/13-15	6-12/13-18	0-1/0-6	0-5/0-14
Scapus	(55)75-85/115-120	13-17/18-20	82-87/109-120	17-21/22-24 (40)
Physa	5-6/7-8	5-7/8-11	0-1/0-7	0-4/0-9
Oral disc		10-15/18-20		
Tentacle	2.5-4/6-10			

young/old

28; 1949, p. 28; Uchida and Soyama, 2001, p. 85.

Materials examined. Seopseom, 6 Feb. 1971, 3 inds. (BJ Rho); Seogwipo, 23 Dec. 1971, 7 inds. (BJ Rho); Seogwipo, 8 Jan. 1990, 3 inds. (JW Lee); Jejudo, 2 Sep. 1992, 2 inds. (KORDI); Marado, 4 Nov. 2000, 1 ind. (JI Song); Seogwipo (Munseom-Saeseom), 8 Jun. 2001, 1 ind. (JI Song); Seogwipo (Munseom-Beomseom), 10 Jun. 2001, 8 inds. (JI Song); Seongsanpo, 1 May 2004, 1 ind. (KS Choi), 40-105 m deep by trawl and fishing nets.

Description. Halcampoidiidae with cylindrical and elongate body. Column divisible into scapulus, scapus and physa. In contracted state, scapulus retracted into body, up to 120-130 mm long, 22-24(40) mm in widest middle part of column. Column with tenaculi thick and hardened with adherent materials, a lot of sand. Physa more or less distinct and a bit round. Tentacles arranged at

two circllets, short and slender, more numerous than mesenteries of body. In length of tentacles, inner a little longer than outer. No sphincter. Oral disc small, with a slight hypostome. Mesenteries divisible into macro- and microcnemes, 6 pairs macrocnemes, 2 pairs of directives, 6 pairs microcnemes at upper part of body. Siphonoglyphs weak. Retractors diffuse and strongly developed. Parietobasilar muscles well-developed. No acontia and sphincter. Zooxanthellae lacking.

Cnidom: spirocysts, basitrichs, microbasic p-mastigophors.

Distribution and size (μm) of cnidae are as follows:

Tentacle	.....spirocysts	.....	9.5-33.5 \times 2.5-3.0
	.....basitrichs	.....	19.5-22.8 \times 2.0-2.5, 28.5-34.0 \times 2.8-3.5
Actinopharynx	.....basitrichs	.....	19.5-23.5 \times 2.0-2.5
Column	.....basitrichs	.....	25.5-36.8 \times 3.2-3.8
Mesenterial filament	.....basitrichs	.....	33.5-39.0 \times 2.8-3.5
	.....microbasic p-mastigophors	.....	28.5-33.5 \times 3.5-4.8

Coloration. In full extension, tentacles and oral disc orangish yellow, scapulus pastel yellow, scapus yellowish brown to brownish gray owing to adherent materials. In preserved specimens, tentacles and oral disc pastel peach, scapulus and physa pale pink, scapus yellowish brown to brownish gray towards lower part.

Habitat. This species inhabits in sandy mud flat of intertidal to subtidal zone.

Remarks. The species shows restrict distribution in southern part of Jejudo Island, Korea. It has been distributed along the warm currents from Philippines to northern part of Japan. The morphological character of its digging physa and adhesive materials of column have provided information that they usually burrow into smooth substrates in living. In preserved specimens collected in winter, oocytes were observed.

Distribution. Korea (southern part of Jejudo Is.), Japan (Suruga Bay, Sagami Bay 50-180 m deep) and Philippines (Cebu).

Tribe Thenaria Carlgren, 1899

Subtribe Endomyaria Stephenson, 1921

Family Actiniidae (Gosse, 1858)

Thenaria. Column smooth or provided with projections verrucae, marginal spherules, pseudospherules or vesicles. Sphincter absent or usually endodermal diffuse to circumscribed. Tentacles simple, arranged in cycles. Mesenteries not divisible into macro- and microcnemes. Perfect pairs of mesenteries rarely six, as a rule more than six.

Genus **Aulactinia* Verrill, 1864 (= *Bunoductis*)

Pedal disc well developed. Most part of column with more or less distinct adhesive verrucae which may or may not be arranged in obvious vertical rows. No marginal spherules, sometimes pseudospherules. Sphincter more or less circumscribed, sometimes circumscribed-diffuse.

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Tentacles rather short, simple. Longitudinal muscles of tentacles ectodermal or meso-ectodermal. Two developed siphonoglyphs. Two pairs of directives. All stronger mesenteries fertile, sometimes sterile directives. Retractors commonly strong, more or less restricted. Mesenteries more numerous in proximal part than distal.

****Aulactinia coccinea* (Verrill, 1866) (Figs. 3-4, 7B-D)**

Aulactinia coccinea: Uchida and Soyama, 2001, p. 67.

Material examined. Chagwido, 6 Nov. 2000, 1 ind. 20-25 m deep (JI Song); Chagwido, 23 Feb. 2001, 1 ind. (JI Song); Munseom-Saeseom, 11 Jun. 2001, 1 ind. (JI Song); Munseom, 3 Jul. 2001, 1 ind. (JI Song); Baekdo (Habaekdo), 13 May 2002, 6 inds. (JI Song), 10-15 m deep by SCUBA diving.

Description. In expansion, tentacles transparent, equal or greater than oral disc diameter, 12-20 mm long and 2 mm at basal diameter, tapering to tip, endocoelic somewhat longer than exocoelic. Their numbers rarely a multiple of six, commonly up to 50. One communicates with each exocoel and endocoel. Generally first three cycles regularly arrayed, irregularities in fourth. Tip perforate. Oral disc smaller than pedal disc, but slightly wider than column. In expanded individual, flat except for low oral cone. Mouth oval, lacking lips. Tentacles arranged in outer half.

Column, in full extension, diameter less than that of pedal disc, uniform for most of length, 17-27 mm in height. Contracted animal forms low dome, with tentacles completely hidden, although a tuft of tentacles remains visible in normally incomplete contraction. Body wall tough with simple adhesive verrucae extended from margin to limbus in longitudinal rows communicating with each endocoel. Most rows contain about 10 verrucae, largest of which third or fourth below margin with diameter of more than 1.0 mm, but largest more proximal. Some exocoel have a few small verrucae at distal end. No marginal spherules or pseudospherules, but most distal verrucae situated at or just below margin. Mesenterial insertions sometimes visible in well expanded specimens. Fosse prominent, average 1 mm in depth. Pedal disc roughly circular, pulled at edge along each mesenterial insertion. Average diater in life 25-30 mm.

Sphincter circumscribed, endodermal palmate form. Mesenteries regularly arranged, first two cycles complete, added from proximal end. Retractor muscles not strong, restricted to diffuse, with branches. Parietobasilar muscles well developed and wide, extend centrally as far as retractor muscle. Zooxanthellae lacking.

Cnidae: spirocyst, basitrichs, microbasic p-mastigophors

Distribution and size (μm) of cnidae are as follows:

Tentacle (inner)	.....spirocysts	.....29.5-40.5 \times 3.8-4.5, 43.0-46.3 \times 5.0-5.5
	.....basitrichs (rare)	.....27.0-33.3 \times 3.2-3.5
Tentacle (outer)	.....spirocysts	.....24.0-33.0 \times 3.2-4.0, 37.0-47.3 \times 4.5-5.5
	.....basitrichs (rare)	.....23.0-26.3 \times 3.0-3.8
Actinopharynx	.....spirocysts (very rare)	.....24.0-37.0 \times 3.2-4.0



Fig. 3. Mesenteries of *Aulactinia coccinea*. A, directive; B, complete and incomplete 2nd mesenteries. Scale bars = 0.5 mm.

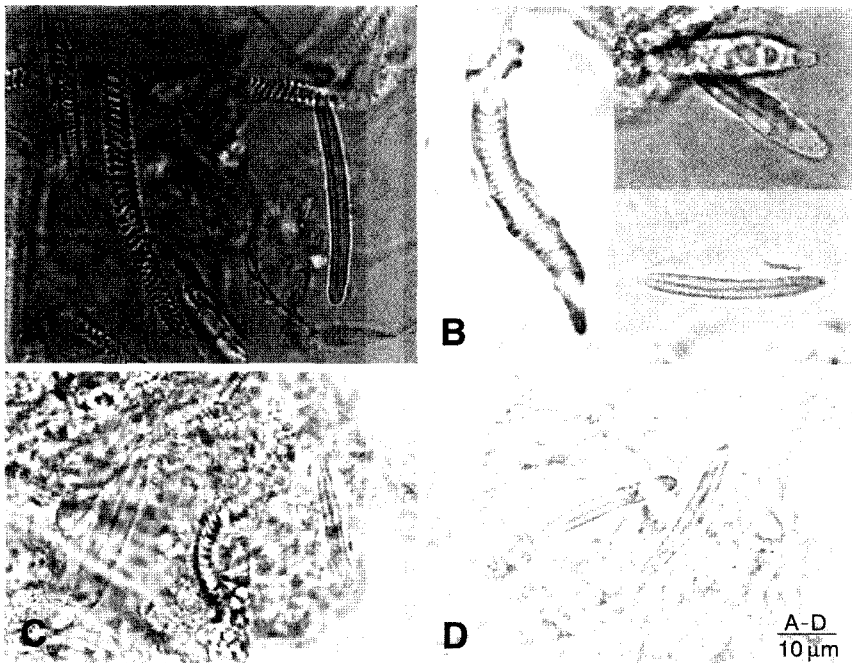


Fig. 4. Cnidae of *Aulactinia coccinea*. A, tentacle; B, actinopharynx; C, mesenterial filament; D, column.

Table 2. Comparison of sizes (mm) in relation to state of specimens.

Parts	State	Expanded		Contracted	
		length	width	length	width
Column		17-24	22-25	14-16 (23)	18-20 (27)
Oral disc			17-19		(8)9-12
pedal disc			28-30		23-25 (30)

	basitrichs (rare)	24.0-31.0 × 3.0-2.3
	microbasic p-mastigophors (rare)	23.0-26.0 × 5.0-5.2
Column	basitrichs (rare)	15.0-19.2 × 2.8-3.2,
		22.0-29.3 × 3.3-3.8
Mesenterial filament	basitrichs	18.0-21.3 × 2.8-3.2
	microbasic p-mastigophors	21.0-29.0 × 5.0-5.8

Coloration. In full extension, tentacles and oral disc even transparent orange to rose pink, Body wall yellowish orange to pink with darker verrucae. Underside of pedal disc red, dark mesenterial insertion. In preserved specimens, most part of body pale pink except for gray verrucae.

Habitat. This species inhabits on rocks of subtidal zone, 10-17 mm deep.

Remarks. The species shows wide distribution in southern part of Korea. Our specimens have larger sizes of spirocysts and no atrichs at tentacles in comparison with *A. incubans* (Dunn et al., 1981).

Distribution. Korea (South Sea, Jeju Is.), Japan.

Family ^{1*}Stichodactylidae Andres, 1883

Endomyaria with well developed pedal disc. Column usually with verrucae. Sphincter diffuse to circumscribed, usually not very strong. Tentacles short, wart-like or longer, never very long. From all or some endocoel tentacles arise in radial series, sometimes more than one row per endocoel or only one, rarely radial arrangement indistinct or absent. Only one tentacle communicates with each exocoel. Longitudinal muscles of tentacles and radial muscles of oral disc ectodermal. Retractors weaker or stronger, diffuse.

Genus ^{2*}Stichodactyla Brandt, 1835

Many relatively short globose, clavate, or bluntly pointed tentacles, endocoelic ones radially arranged two or more abreast. Number of siphonoglyphs and directives variable. Pedal discs well developed, narrower than oral. Body generally broader than tall.

^{3*}***Stichodactyla tapetum* (Ehrenberg, 1834) (Figs. 5-6, 7E-F)**

Actinia Isacmaea Tapetum Ehrenberg, 1834, p. 256, pl. 9, fig. 3

Stoichactis tapetum: Carlgren, 1949, p. 73

Stichodactyla tapetum: Dunn, 1981, p. 73, text-figs. 40-42; Uchida and Soyama, 2001, p.

^{1*}열말미잘과 (신칭), ^{2*}열말미잘속 (신칭), ^{3*}용단열말미잘 (신칭)

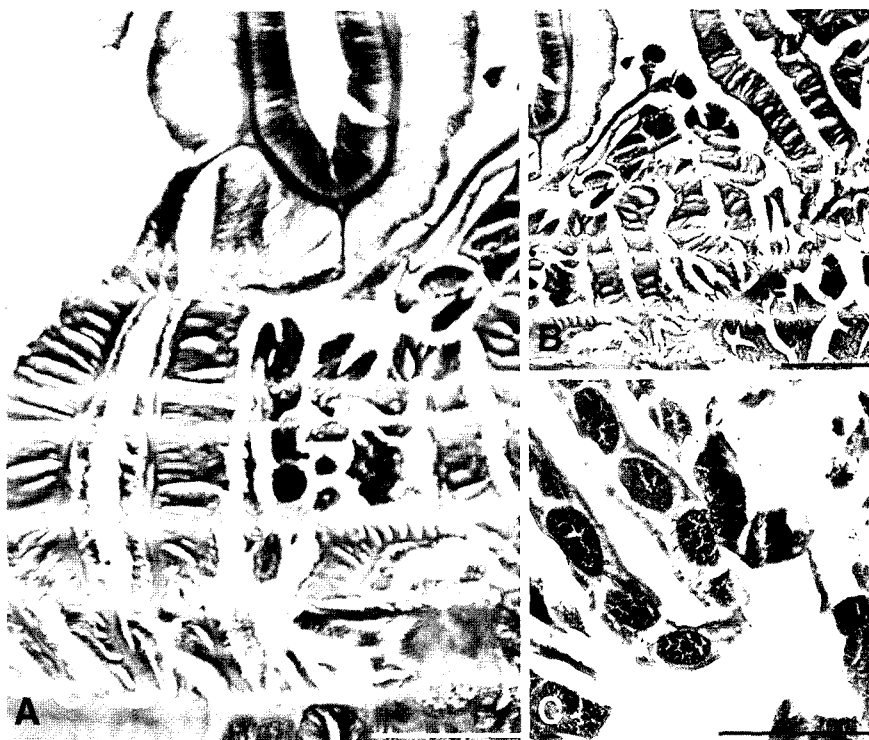


Fig. 5. Mesenteries of *Stichodactyla tapetum*. A, directive, incomplete 2nd and 3th mesenteries; B, incomplete 2nd, 3th and 4th mesenteries; C, mesenterial filaments with sperm sacs. Scale bars = 0.5 mm.

97.

Material examined. Munseom, 13 Jul. 1990, 1 ind. 10-18 m deep (IB Seo); Chawido, 6 Nov. 2000, 1 ind. (JI Song); Munseom, 6 Jun. 2001, 1 ind. male (JI Song); Beomseom, 6 Jun. 2001, 1 ind. (JI Song); Chagwido, 8 Jun. 2001, 1 ind. (JI Song); Munseom-Saeseom, 11 Jun. 2001, 1 ind. female (JI Song); Seongsanpo, 18 Aug. 2001, 1 ind. (JI Song); Munseom, 13 Jul. 2004, 1 ind. male (SJ Hwang), 5-17 m deep by SCUBA diving.

Description. Tentacles very short, bulbous, no more than 1 mm long, less than 0.5 mm in diameter, densely packed at rectangular long axis perpendicular to radii. Rectangular tentacles as much as 1 mm across long axis. Those communicating with a single endocoel at least two abreast, often as many as six across, may vary in size due to crowding. Especially, marginal tentacles conical, 1.5-2.0 mm long. Oral disc flat, sometimes undulate slightly, occasionally with lips. Rows of tentacles communicating with first or first and second order endocoel approach mouth to even reach it. Tentacles communicating with each endocoel in wedge-shaped row, with mostly five obvious cycles. Mouth elongate, as much as a quarter as long as oral disc diameter, with mostly two prominent siphonoglyphs.

Column smooth, texture firm due to thick mesoglea, narrower diameter towards middle part from pedal disc, flaring abruptly at distal end. In preserved specimens, length typically about half to 2/3 pedal disc diameter, transverse folds up to 16 in number at back side of flaring part. Fosse

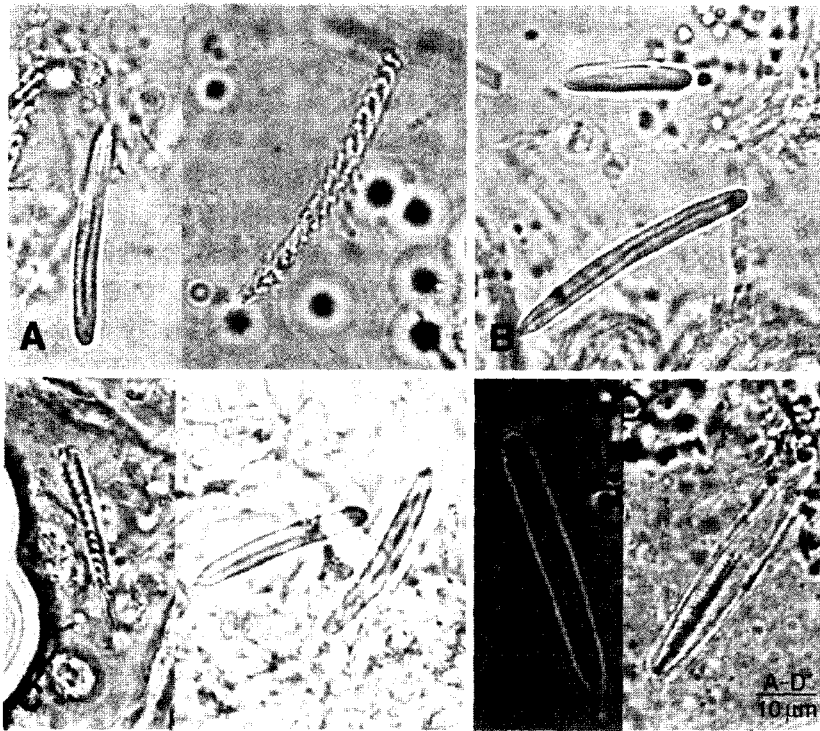


Fig. 6. Cnidae of *Stichodactyla tapetum*. A, tentacle; B, actinopharynx; C, column; D, mesenterial filament.

Table 3. Comparison of sizes (mm) in relation to state of specimens.

Parts	State	Expanded		Contracted	
		length	width	length	width
Column		18-30	16-18	12-15	14-15
Oral disc			38-40		27-30
Pedal disc			23-30		16-18
Mouth			11-12		8-10

shallow or absent. Margin slightly scalloped, being pulled at mesenterial insertions.

Mesenteries regularly arranged, each siphonoglyph connected to a pair of directives. All stronger mesenteries including directives, fertile, and thoes of highest order fertile in some. Sex separate. Retractor lamellae short to moderate length, all those of a mesentery of equal length, slightly branched. Strong basilar muscles, parietobasilar muscles short, not well developed. Sphincter very weak, small. Endodermal zooxanthellae $4 \times 4 - 5 \times 5 \mu\text{m}$ and $6 \times 6 - 10 \times 9 \mu\text{m}$ in diameter, dense in tentacles, oral disc, actinopharynx, upper column, upper mesenteries, extend to base.

Cnidae: spirocyst, basitrichs, microbasic p-mastigophors

Distribution and size (μm) of cnidae are as follows:

Tentacles (inner) spirocysts $22.0-26.3 \times 2.8-3.0$,

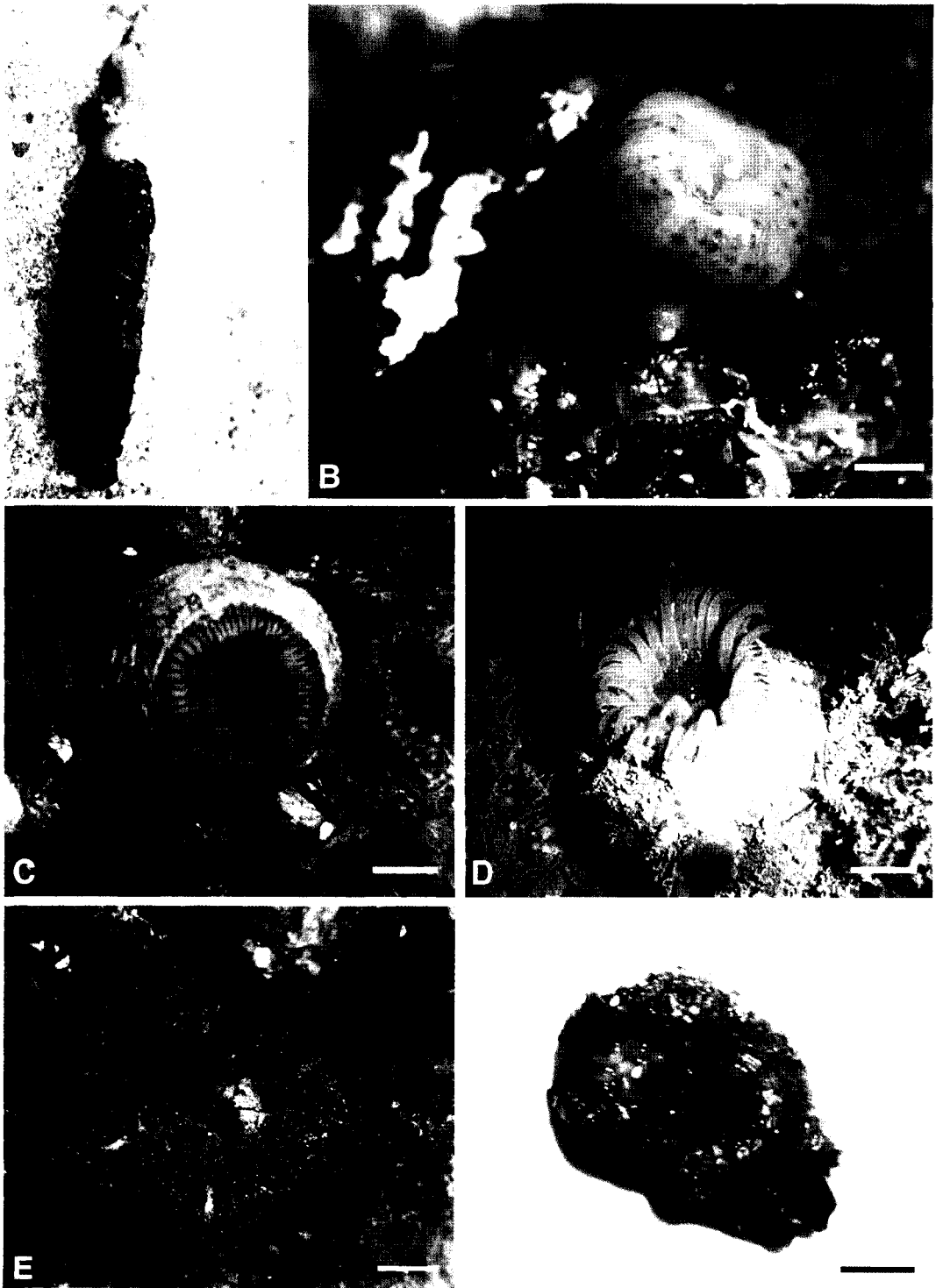


Fig. 7. External feature. A, *Halcampella maxima*; B-D, *Aulactinia coccinea*; E-F, *Stichodactyla tapetum*. Scale bars = 1 cm.

		28.0-38.2 × 3.2-4.0
	basitrichs	22.3-34.0 × 2.8-3.5
Tentacles (outer)	spirocysts (rare)	27.0-34.0 × 3.0-3.2
	basitrichs	20.0-23.3 × 3.0-3.3, 25.0-27.3 × 3.3-3.5
Actinopharynx	basitrichs	17.0-23.2 × 2.8-3.8, 28.0-33.3 × 3.2-3.5
Column	spirocysts (very rare)	27.0-34.0 × 3.0-3.2
	basitrichs	16.0-26.0 × 3.0-3.5
Mesenterial filaments	spirocysts (very rare)	30.0-33.3 × 3.2-3.5
	basitrichs	17.0-18.0 × 2.8-3.0, 28.0-32.2 × 3.2-3.5, 37.0-43.0 × 3.8-4.0
	microbasic p-mastigophore	27.0-34.2 × 5.0-6.0

Coloration. Variable. Oral disc greenish or reddish due to greenish and reddish brown tentacles arrayed in radial stripes. Tentacles green, all or only exocoelic ones, with white tips. Column and base reddish orange. In preserved specimens, oral disc greenish with melon yellow, mouth lemon yellow, base and lower part of column rose beige, back side of flaring part deep olive green.

Habitat. Since this species inhabits in crevices of rocks and pebbles at 5-17 m deep of subtidal zone, it widely spreads oral disc, up to 150 mm in diameter. It has no fish symbionts and also spawned at Munseom in July, 2004.

Remarks. Our specimens nearly agree with the description of Dunn (1981) except for no taking microbasic p-mastigophores at actinopharynx and column. Mature oocytes and sperm sacs, up to 700 µm diameter and up to 220 × 180 µm diameter respectively, were observed at separate individuals in June, 2001. In the genus *Stichodactyla*, the smallest species, *S. tapetum* is distinguished from *S. haddoni* by short bulbous tentacles, less than 1.0 mm long, densely packed on the oral disc and also conical marginal ones, 1.5-2.0 mm long.

Distribution. Korea (southern part of Jeju Is.), Japan, Hong Kong, Tahiti, Gulf of Suez, Western Australia, Java, Red Sea, Zanzibar

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한국산 해변말미잘목 (산호충강: 말미잘아강)의 3미기록종

송 준 임* · 차 하 립

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요 약

제주도와 백도에서 1971년부터 2004년까지 채집된 해변말미잘류는 3과 3종으로 밝혀졌으며, 이들은 한국 미기록종이었다. 무족반족의 가지해변말미잘 (*Halcampella maxima*)과 족반족의 진홍혹해변말미잘 (*Aulactinia coccinea*)과 용단열말미잘 (*Stichodactyla tapetum*)으로서 이들의 자포에 대한 분포와 크기를 포함하여 형태학적 특징을 그림과 표와 함께 자세히 기술하였다. 가지해변말미잘은 겨울에 성숙한 난세포가 관찰되었으며, 용단열말미잘은 여름에 난세포와 정자낭이 각각 다른 개체에서 관찰되었다. 진홍혹해변말미잘은 체벽의 상연에서부터 하연까지 부착력이 있는 용상돌기가 종렬로 배열하는 특이한 외형을 갖고 있다. 열말미잘속 중 가장 작은 용단열말미잘은 구반 위에 길이 1.0 mm 이하의 구슬모양 촉수가 밀집해 있으며, 원추형의 연속수가 1.5-2.0 mm 정도로 배열하는 것으로 구별된다. 본 연구의 결과로 한국산 해변말미잘류는 니난트아목 내에 무족반족 4종과 족반족 23종이 보고된다.