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A New Species of *Synandwakia* and Two Newly Recorded Species of Athenaria (Anthozoa: Actiniaria) from Korea

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ABSTRACT

Actiniarians were collected from the sandy mud flat of Deokjeokdo, Jak-yakdo, Yeoungjongdo and Hupo of Korean waters from 1962 to 1998. They are identified into three species of two families, which are newly recorded to Korean athenarian fauna: *Synandwakia multitentaculata* n. sp., *Edwardsioides japonica* (Carlgren, 1931) and *Metedwardsia akkeshi* (Uchida, 1932). They are described in detail with figures and tables. *Synandwakia multitentaculata* n. sp. is easily distinguished from *S. hozawai* by having up to 200 in the number of tentacles and by the peculiar macrobasic amastigophores of tentacles and the larger microbasic p-mastigophores of acontia in the macrocnidae.

Key words: taxonomy, Athenaria, Actiniaria, Korea

INTRODUCTION

The elongate vermiform actiniarians, tribe Athenaria, are generally divisible into a long scapus, short scapulus, sometimes a thin capitulum and a naked ampullaceous physa. These actiniarians burrowing in soft sediments are known from intertidal zone to deep waters (Fautin, 1982). Aboral end of the body being used for digging is usually rounded, which sometimes adheres to small object and then becomes more or less flattened (Hand, 1954).

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The purpose of this study is to investigate the fauna of tribe Athenaria in Korean waters. The tribe Athenaria is consisted of 9 families (Carlgren, 1949), of which two families, Edwardsiidae and Andwakiidae, are first recorded in Korea. The present paper reports on three species, *Edwardsioides japonica* (Carlgren, 1931) and *Metedwardsia akkeshi* (Uchida, 1932) of the Edwardsiidae, and *Synandwakia multitentaculata* n. sp. of the Andwakiidae.

MATERIALS AND METHODS

For this systematic study of tribe Athenaria, specimens stocked in the Department of Life Sciences and the Natural History Museum, Ewha Womans University during the period from 1962 to 1998 were examined. They were collected at sandy mud flat of four localities of Korean waters, Deokjeokdo (37° 50′N, 126° 45′E), Jak-yakdo (36° 80′N, 126° 30′E), Jeongjongdo (37° 23′N, 126° 33′E) and Hupo (36° 36′N, 129° 30′E). Samples were fixed in 5% neutral formalin after anesthetization with menthol or 10% $MgCl_2$ solution.

The identification was done on the basis 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, Carlgren's (1949) and England's (1987) systematic schemes were basically followed.

Holotype and most of paratypes are deposited in the Natural History Museum, Ewha Womans University (EWNHM) and the remaining paratypes are deposited in the Department of Life Sciences, Ewha Womans University (EWDLS).

SYSTEMATIC ACCOUNTS

Phylum Cnidaria Hatschek, 1888
Class Anthozoa Ehrenberg, 1834
Subclass Zoantharia R. Blainville, 1830
Order Actiniaria R. Hertwig, 1882
Suborder Nynantheae Carlgren, 1898
Tribe *Athenaria (Abasilaria) Carlgren, 1898

Nynantheae without basilar muscle. Body usually very elongate, more or less vermiform, often divisible into different regions. Aboral end of body usually rounded being a physa often used for digging. No sphincter, but when present this may be endodermal or mesogloeal. Tentacles few in number, never more than 36.

Mesenteries few, differentiated into macro- and microcnemes. Retractors usually strong,

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circumscript or circumscript-diffuse. Parietal part of longitudinal mesenterial muscles commonly differentiated from retractors forming a distinct parietal muscle (parietals) together with parietobasilar muscles. Acontia absent.

Key to the families of Athenaria

1. 8 perfect mesenteries (macrocnemes) and at least 4 imperfect (microcnemes) ..... Edwardsiidae
   At least 6 pairs perfect mesenteries ..... Andwakiidae

Family *Edwardsiidae Andres, 1881

Athenaria with elongate, vermiform body usually divisible at least into two regions, a long scapus provided with a cuticle and a short upper scapulus. Often a rounded, naked physa at aboral end and a very short, thin capitulum below tentacles. No sphincter or acontia. Mesenteries divisible into 8 macro- and at least 4 microcnemes. Two pairs of directives. Retractors diffuse to strongly restricted. Parietal muscles always distinct.

Key to the genera of Edwardsiidae

1. Scapus with batteries of nematocysts (nemathybomes) ..... *Edwardsioides*
   Scapus without nemathybomes ..... *Metedwardsia*

Genus **_Edwardsioides_ Danielssen, 1890

Body divisible into physa, scapus, scapulus and capitulum. Aboral part, ampullaceous physa, without nemathybomes or cuticle. Scapus long with nemathybomes sunk in mesogloea and containing only one type of nematocyst, basitrichs. A weak ventral siphonoglyph. 8 perfect mesenteries (macrocnemes) and at least 4 imperfect very weak ones (microcnemes) being minute and usually confined to region of capitulum. First 4 microcnemes always paired with macrocnemes. Gonads, filaments, and parietal and retractor muscles on macrocnemes only. Parietal muscles well developed retractors strong-diffuse to restricted-reniform.

***_Edwardsioides japonica_ (Carlgren, 1931) (Figs. 1A-C, 2A-E, 5A-B, Table 1)**

Edwardsia japonica: Carlgren, 1931, p. 12; 1949, p. 23; Uchida, 1941, p. 384.

Edwardsioides japonica: England, 1987, p. 218; Uchida and Soyama, 2001, p. 49.

Material examined. 3 ind., Deokjeokdo, 15 Jul. 1962 (B. J. Rho); 2 ind., Jak-yakdo, 25 Apr. 1971 (J. I. Song); 1 ind., Jak-yakdo, 17 Apr. 1992 (J. I. Song); young 2 ind., Hupo, 25 Apr. 1998 (Inha Univ.).

Description. Vermiform body divisible into physa, scapus, scapulus and capitulum, 80-128 mm long and 5 mm in diameter. In contracted state, capitulum and physa retracted into scapus. Capitulum short, about 5-6 mm long with 16 tentacles. Tentacles 10-12 mm long and 1 mm in diameter, outer ones longer than inner. Mouth slit-like. Scapus divided into 8 longitudinal ridges, covered with a rusty brown investment being ready peeled off. Nemathybomes 0.33×0.26–0.72×0.63 mm in diameter, round, scattered on surface of scapus. Physa, 6 mm long and 7 mm wide,

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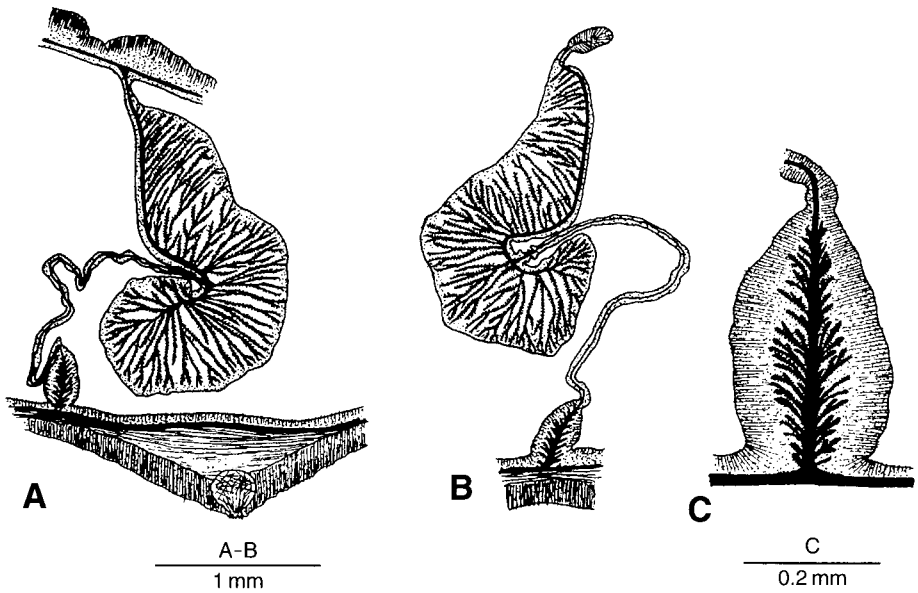

Fig. 1. Mesenteries of *Edwardsiodes japonica*. A. complete mesentery with nemathybome; B. 1st mesentery; C, parietal muscle.

ampullaceous without nemathybomes. Mesenteries 8, all perfect. Retractors circumscribe, 28-34 foldings branched from their bases, with well developed parietal muscles. In color, many stripe marked on oral disc in life. Peach colored body covered with rusty brown covering scattered reddish brown spots in preserved specimen. Physa, capitulum and tentacles uncolored.

Cnidom: Sprirocysts, Basitrichs, Microbasic b-mastigophores, Microbasic p-mastigophores.

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

Tentacle	Spirocysts	20.0–28.6×4.3–4.6
	Basitrichs	22.9–31.5×3.5–4.3
Actinopharynx	Spirocysts (rare)	15.7–24.3×3.1–4.0
	Basitrichs	20.0–35.8×3.5–4.3
Capitulum	Basitrichs (rare)	11.7–12.9×3.5–4.0
Scapus	Spirocysts (very rare)	15.7–17.2×4.0–4.3
	Basitrichs (very rare)	24.3–25.8×4.0–4.3
(nemathybomes)	Microbasic b-mastigophores	88.7–114.4×4.3–5.0
Mesenteric filament	Basitrichs	22.9–31.5×3.5–4.3, 30.0–40.9×5.7–7.0
	Microbasic p-mastigophors	21.4–25.8×5.0–5.8
Physa	Spirocysts	11.4–12.9×3.5–4.0
	Basitrichs	24.3–37.2×3.1–4.3
	Microbasic b-mastogophores	24.3–44.4×5.4–7.2, (rare) 101.5–105.8×4.3–5.0
	Microbasic p-mastigophores (rare)	21.4–25.8×5.0–6.4

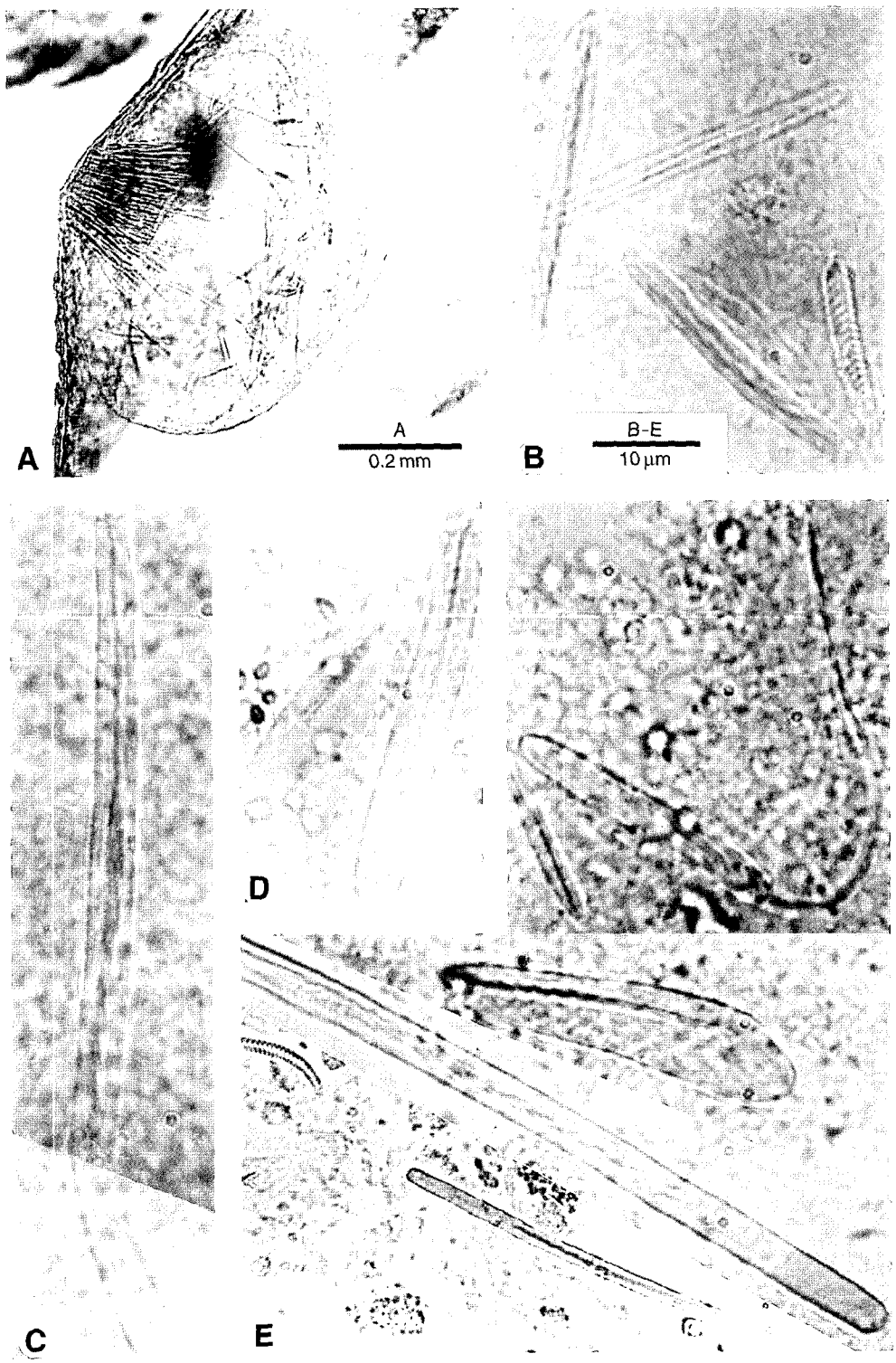

Fig. 2. Cnidae of *Edwardsiodes japonica*. A, nemathybome; B, tentacle; C, column; D, filament; E. physa.

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

State / Parts	Expanded		Contracted	
	Length	Width	Length	Width
Total height	80-128		8-9/45-60*	
Capitulum	5-6	4-5		1/4-5
Scapus	70-116	5-6		1.5-2/5-10
Physa	5-6	5-7	0-1/0-4	0-2/0-4

*: young/old.

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

Remarks. In England's work (1987), species with only one type of nematocyst in the nemathybomes were separated from those with two types of it. The arrangement of microcnemes was also regarded as a generic character. Morphological characteristics of our specimens coincide in general with those of Uchida's ones (Uchida, 1941) except for the size of bodies, the number of tentacles and foldings of retractors, and the size of nematocysts.

Distribution. Korea (Yellow Sea, East Sea), Japan (Okati Bat, Sagami Bay, Misaki).

Genus **Metedwardsia* Carlgren, 1947

Edwardsiidae with body divisible into physa, scapus and capitulum. Scapus and physa slightly differentiated from each other, the former with a thin epidermis without nemathybomes. No sphincter. Tentacles short, inner ones shorter than outer. Eight perfect and fertile mesenteries arranged as macrocnemes in *Edwardsia*. Several microcnemes. Not more mesenteries distally than proximally. Retractors of macrocnemes reniform to circumscribed. Parietal muscles distinct but weak. No nematosomes in coelenteron.

***Metedwardsia akkeshi* (Uchida, 1932) (Figs. 3A-F, 5C, Table 2)**

Milne-Edwardsia akkeshi Uchida, 1932a, p. 571, text-figs. 1-4; 1940, p. 266.

Metedwardsia akkeshi: Carlgren, 1947, p. 1; 1949, p. 26; Uchida and Soyama, 2001, p. 49.

Material examined. 5 ind., Deokjeokdo, 15 Jul. 1962 (B. J. Rho).

Description. Edwardsiidae with vermiform body divisible into physa, scapus and capitulum. Scapus and physa being narrower than capitulum. In contacted state, capitulum and physa deeply concealed into body, 35-70 mm long, 3-4 mm wide in upper part and 2-3 mm wide in physa. Tentacles short, conical, 24 in number and inner ones shorter than outer. In young anemones, tentacles 12 in number, arranged in a circlet. Scapus without nemathybomes, surrounded by a thin covering, imbued with detritus particles. Scapulus with a smooth and thin wall showing lines of insertion of mesenteries, gradually being obscured towards proximal part owing to thick ectoderm and mesogleal muscle. Physa small with an aperture at terminal, barely distinguished from scapus. Mesenteries 24 in number, 8 perfect macrocnemes and 16 imperfect microcnemes. Two pairs directives. Between dorso-lateral and ventro-lateral mesenteries, and also between ventro-lateral

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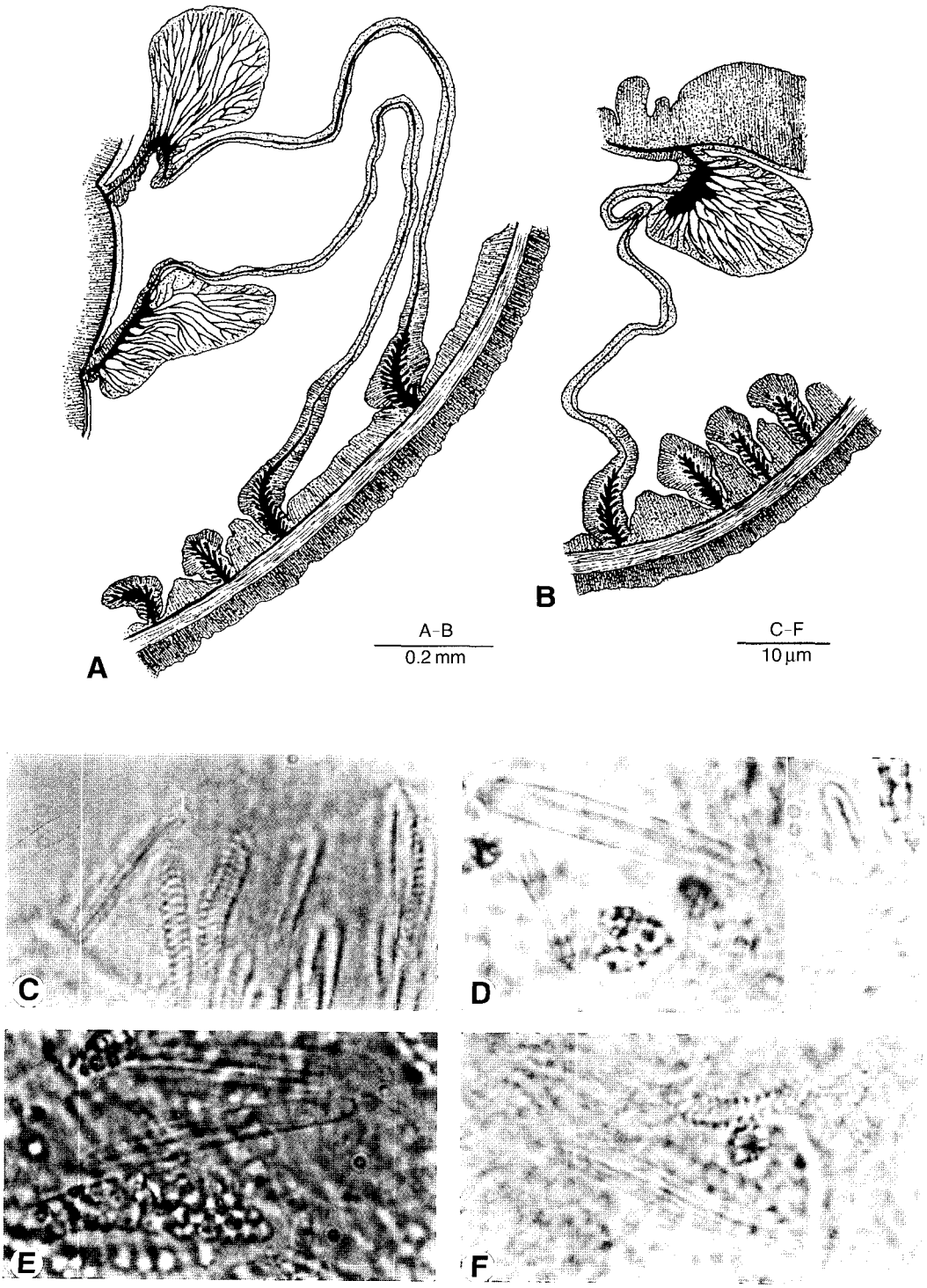

Fig. 3. Mesenteries and cnidae of *Metedwardsia akkeshi*. A, directives; B, complete, incomplete 1st and 2nd mesenteries; C, tentacle; D, filament; E, actinopharynx; F, column.

ones and ventral directives, three imperfect ones arranged. Paired imperfect mesenteries same size, located between dorsal directives and dorso-lateral ones. Retrectors of macrocnemes kidney shaped, circumscribed, 10-12 foldings branched from their bases, with weak parietal muscles. Microcnemes without filaments furnished with weak parietal muscles in body wall.

In color, peach colored body with black spots tentacles in preserved specimen.

Cnidom: Sprirocysts, Basitrichs, Microbasic b-mastigophores, Microbasic p-mastigophores.

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

Tentacle ..... Spirocysts ..... 14.3-21.5×2.8-3.2
Basitrichs ..... 14.3-17.2×2.6-2.8,
Actinopharynx ..... Basitrichs ..... 21.5-24.4×3.2-3.5
Microbasic p-mastigophores ..... 25.7-30.0×4.3-5.7
Scapus ..... Spirocysts ..... 24.3-34.3×3.2-4.3
Basitrichs ..... 10.0-11.5×2.8-3.2,
24.3-31.5×3.2-3.5
Mesenteric filament ..... Spirocysts (rare) ..... 25.7-32.9×4.3-4.7
Basitrichs ..... 11.4-14.3×2.6-2.8,
25.7-30.0×2.8-3.2
Microbasic p-mastigophors ..... 8.6-11.5×3.5-4.3,
21.5-25.8×4.3-5.0,
32.9-40.0×5.7-7.2
Physa ..... Spirocysts ..... 21.5-28.6×4.0-5.0
Basitrichs ..... 10.0-11.5×2.8-3.2,
(rare) 25.7-27.2×2.8-3.3

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

State / Parts	Expanded		Contracted	
	Length	Width	Length	Width
Total height	70-75		35-58	
Proximal part of column		3		3-4.5
Distal part of column		3		2-4
Physa		2		2-3

Habitat. These worm-like actiniarians live in sandy mud flat of intertidal zone.

Remarks. This species is closely related to *Milne-Edwardsia akkeshi* (see Uchida, 1932a) except for the number of foldings at retractor. Especially nematocysts are in detail described at this study.

Distribution. Korea (Yellow Sea), Japan (Hokkaido).

Family *Andwakiidae (Danielssen, 1890)

Athenaria (Abasilaria) with elongate, cylindrical body, divisible into physa, scapus and capitulum.

*유사벌레붙이말미잘과(신칭)

Physa rounded but may be flattened. Scapus sometimes with cinclides. Sphincter mesogloeal, long, usually very strong. Mesenteries more or less distinctly divisible into macro- and microcnemes. Not more than 6 pairs of perfect mesenteries, which are fertile and have well developed filaments strong retractors and acontia.

Genus *Synandwakia* Carlgren, 1947 유사벌레붙이말미잘속(신칭)

Andwakiidae with body divisible into physa, scapus and capitulum. Scapus smooth, without tenaculi but cinclides, capitulum very short. Sphincter mesogloeal, small, situated at margin. Tentacles rather numerous. Two siphonoglyphs. Mesenteries distinctly into macro- and microcnemes, 6 pairs perfect and fertile. More mesenteries at margin than at physa. Retractors of macrocnemes strong, sometimes restricted. Parietal muscles rather weak. Acontia few.

***Synandwakia multitentaculata* n. sp. (Figs. 4A-E, 5D, Table 3, 4)**

Material examined. Holotype: 1 ind., Jak-yakdo, 18 Apr. 1984 (J. I. Song), EWNHM60273. Paratypes: 2 ind., Jak-yakdo, 19 Jun. 1965 (J. I. Song), EWNHM60274-60275; 4 ind., 5 Apr. 1969 (J. I. Song), EWNHM60276-60279; 7 ind., 6 Jun. 1970 (J. I. Song), EWNHM60280-60286; 1 ind., 28 Apr. 1979 (S. Shin), EWNHM60287; 2 ind., 6 Apr. 1981 (J. W. Lee and J. E. Seo), EWNHM60288-60289; 1 ind., 18 Apr. 1984 (J. I. Song), EWNHM60290; 4 ind., 4 May 1985 (J. I. Song), EWNHM60291-60294; 2 ind., 15 Jun. 1991 (J. I. Song), EWNHM60295-60296; 1 ind., 7 Apr. 1992 (J. I. Song), EWNHM60297; 4 ind., Yeoungjongdo, 6 Apr. 1969 (B. J. Rho), EWDLS03091-03094.

Description. Andwakiidae with body divisible into physa, scapus and capitulum. Body broadly cylindrical, though extremely variable in form owing to contraction. In contracted state, capitulum deeply concealed into body, 20-58 mm long, 8-19 mm wide in widest middle upper part and 0-9 mm in physa. A well-preserved specimen 105 mm long, 15mm wide in widest middle part and 7 mm wide in narrowest distal part of scapus. Tentacles hexamerous in arrangement, 5-6 cycles, up to 180-200 in number, outer ones 1-6 mm long slightly smaller than inner 7-9 mm long. their length of same cycle not synchronous. Oral disc shows several white radial stripes around a slit-like mouth. Siphonoglyphs two, lips somewhat elevated, forming 14-18 folds. Surface of scapus smooth, few acontia being emitted from surface of body wall though cinclids distributed in middle portion of scapus. In scapus, ectoderm thicker than endoderm and mesoglea. Insertions of mesenteries appears transparently in scapus and physa. Mesenteries arranged in 24 pairs, of which 6 pairs perfect, 18 pairs imperfect. Two pairs directives. Retractors of macrocnemes strong, circumscribe, parietal muscle rather weak. Microcnemes without retractors furnished with parietal muscles. In color, flesh colored body sometimes with two longitudinal black lines in tentacles of preserved specimen. In living state, whole body pastel peach (No. 26 in color chart) downwards pastel yellow (No. 25). Oral part burnt orange (No. 93), white spots at base and tip of tentacles, and white stripes in upper part of scapus.

Cnidom: Sprirocysts, Basitrichs, Microbasic b-mastigophores, Microbasic p-mastigophores, Macrobasic amastigophore.

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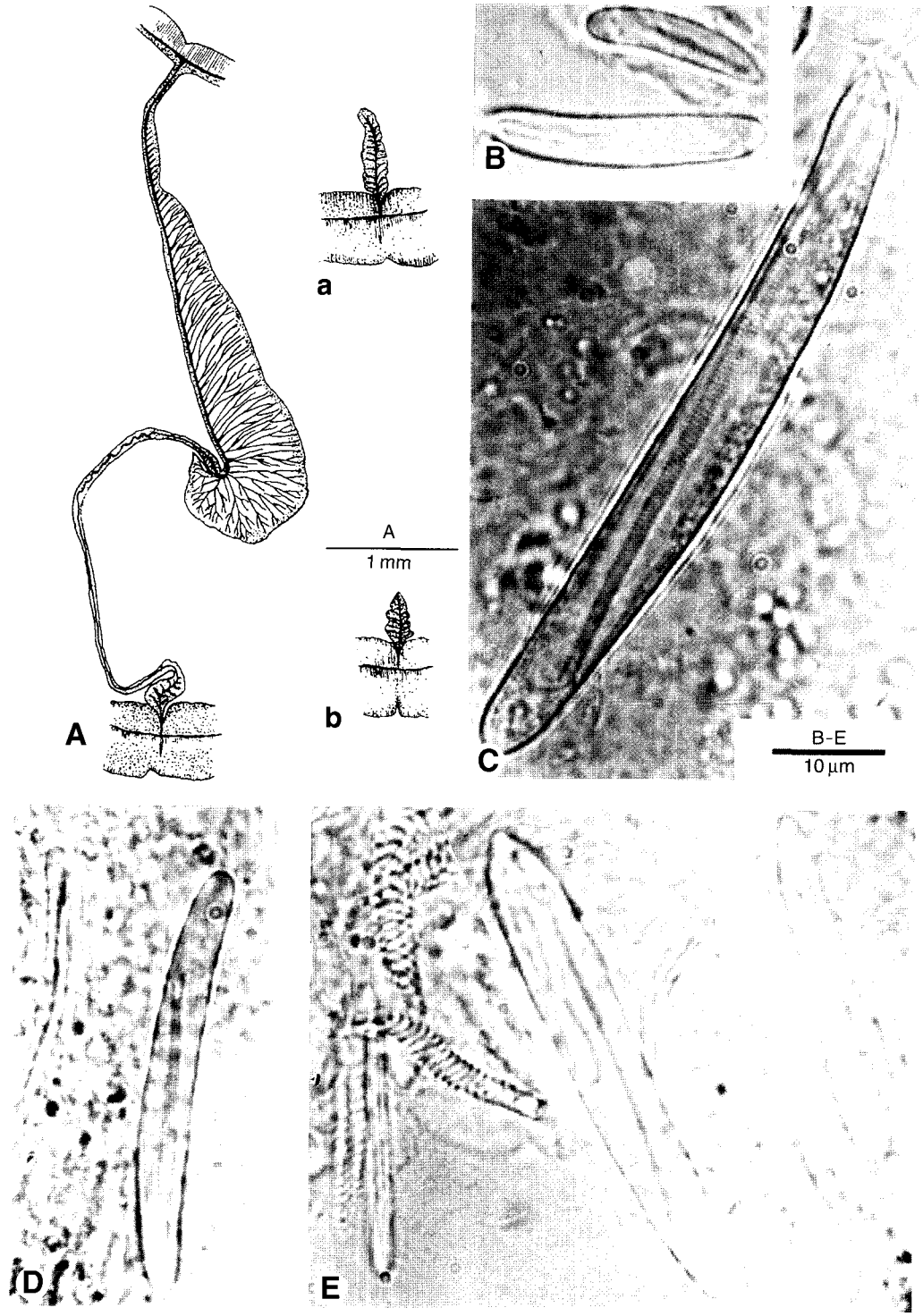

Fig. 4. Mesenteries and cnidae of *Synandwarkia multitentaculata* n. sp.. A, 2nd (a), 3th (b) and complete mesenteries; B, capitulum; C, acontia; D, actinopharynx; E, tentacle.

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

Tentacle ····· Spirocysts ····· 21.5–31.5×3.5–4.8
Basitrichs ····· 24.3–28.6×2.8–3.2
Microbasic p-mastigophores ····· 12.9–14.3×4.0–4.3, 24.3–34.3×4.3–4.8
Microbasic b-mastigophores ····· 24.3–27.2×4.3–5.0
Macrobasic amastigophores ····· 40.0–48.6×7.1–8.6
Actinopharynx ····· Basitrichs ····· 28.6–34.3×2.8–3.2
Microbasic p-mastigophores ····· 34.3–44.4×4.3–6.0
Capitulum ····· Spirocysts (rare) ····· 21.5–27.2×4.0–4.3
Microbasic p-mastigophores ····· 12.9–18.6×4.0–4.6, 21.5–24.3×5.7–6.3
Microbasic b-mastigophores ····· 21.5–27.2×4.3–5.0
Scapus ····· Microbasic p-mastigophores ····· 18.6–21.5×4.6–6.4, 24.3–34.3×5.0–6.0
Microbasic b-mastigophores ····· 25.7–32.9×5.0–5.7
Acontia ····· Basitrichs ····· 12.9–25.8×2.8–3.3
Microbasic p-mastigophors ····· 21.5–37.2×5.4–6.4, 52.9–75.8×7.2–8.6
Physa ····· Basitrichs ····· 15.7–18.6×2.8–3.2
Microbasic p-mastigophores ····· 17.2–21.5×5.0–5.5, 24.3–31.5×5.4–5.7

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

State / Parts	Expanded		Contracted	
	Length	Width	Length	Width
Total height	18-35/50-105 (65)*		28/20-58	
Capitulum	0-3/3-17 (10)	3-7/8-10 (10)	2/0-10	3/4-11
Proximal part of column	10-15/27-47 (35)	5-8/10-17 (13)	15/15-30	5/8-19
Distal part of column	5-10/12-50 (15)	3-5/4-8 (4)	7/5-15	2/4-8
Physa	4-8/4-17 (5)	4-7/7-19 (8)	3/0-6	3/0-9

* : Yeoungjongdo/Jak-yakdo (holotype in preserved state).

Habitat. This species being exposed tentacles and capitulum lives in sandy mud flat of intertidal zone together with actiniarians *Paracondylactis hertwigi*, *Edwardsioides japonica*, *Flosmaris mutsuensis*, a tube anemone *Cerianthus filiformis* and a holothurian *Protankyra bidentata*. In living state, the scapus is universal in the same width and slender downwards to the physa.

Remarks. As Carlgren (1947, 1949) has previously pointed out, *Andwakia hozawai* (see Uchida, 1932b) described from Japan has been belonged to *Synandwakia hozawai* because of having more mesenteries distally than proximally. Since he has noted that the position of the genus is

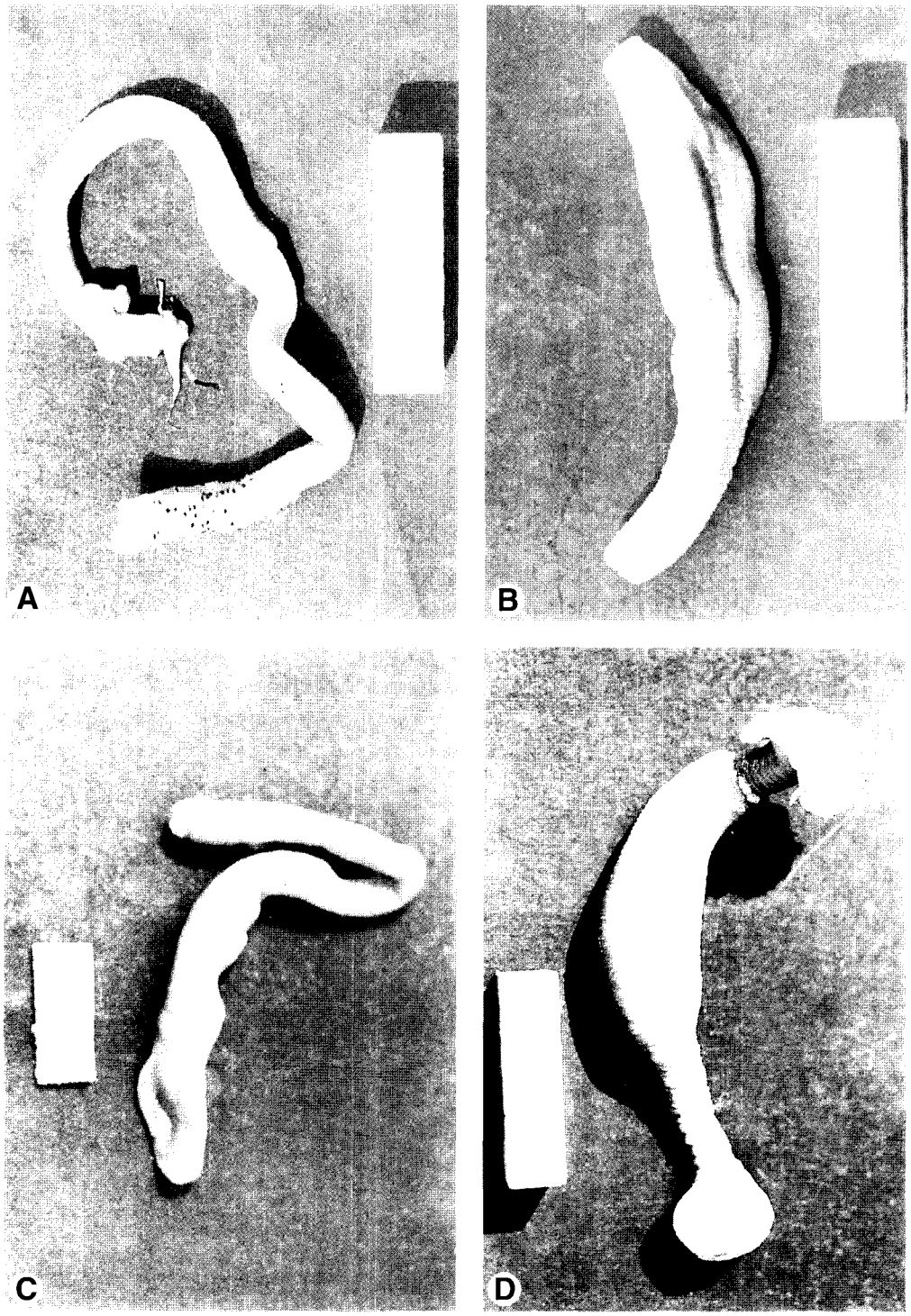

Fig. 5. External feature. A-B, *Edwardsiodes japonica*; C, *Metedwardsia akkeshi*; D, *Synandwarkia multitentaculata* n. sp. Scale bars = 1 cm.

Table 4. Comparisons of *Synandwakia hozawai* and *Synandwakia multitentaculata* n. sp.

Characters	*Synandwakia hozawai* (Uchida and Uchida, 1969)	*Synandwakia multitentaculata* n. sp.
Number of tentacles	up to 80	up to 200
Special cnidae of some part		
Tentacles	Microbasic p-mastigophores (20.8–25.6×3.8–5.2 μm)	Macrobasic amastigophores (40.0–48.6×7.1–8.6 μm)
Acontia	Microbasic p-mastigophores (24.0–32.0×4.6–7.0 μm)	Microbasic p-mastigophores (52.9–75.8×7.2–8.6 μm)

somewhat doubtful as the taxonomic categories on the nematocysts of acontia, Uchida and Uchida (1969) had redescribed in detail this species with the data of nematocysts. Morphological characteristics of our specimens coincide in general with those of Uchida's (Uchida, 1932b, 1938) except for the size of bodies, the number of tentacles, and the type of cnidae. Especially, our specimens have the peculiar macrobasic amastigophores in tentacles and the larger microbasic p-mastigophores in acontia than those of Uchida and Uchida (1969), and also more than double in number of tentacles comparing with others descriptions (Uchida and Uchida, 1969; Kostina, 2000) (Table 4). Up to now, *S. hozawai* has been known in the fine sand flat of intertidal zone around Mutsu Bay, Hokkaido of Japan and southeastern Sakhalin in the Sea of Okhotsk.

ACKNOWLEDGMENTS

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한국산 무족반족(산호충강: 해변말미잘목)의 유사벌레붙이말미잘속의 1신종과 국내 2미기록종

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요 약

한국산 산호충류의 분류학적 연구의 일환으로 1962년부터 1998년까지 덕적도, 작약도, 영종도와 후포에서 채집된 말미잘류를 동정 분류하였다. 그 결과 2과 3속 3종의 무족반류가 밝혀졌으며, 이들은 1신종인 유사벌레붙이말미잘(*Synandwakia multitentaculata* n. sp.)과 한국 2미기록종인 벌레붙이말미잘(*Edwardsioides japonica*), 가는벌레붙이말미잘(*Metedwardsia akkeshi*)로 형태학적 특징을 그림 및 표와 함께 기술하였다. 본 신종은 촉수의 수가 180-200개에 이르며, 촉수와 창사의 대형자포에서 호자와벌레붙이말미잘(*Synandwakia hozawai*)과 쉽게 구별된다.