

Two New Species and Four New Records of Holothuroidea from Korea

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Two new species, *Pentathyone kojinsensis* n. sp. and *Pseudocnus pawsoni* n. sp. belonging to the families Sclerodactylidae and Cucumariidae are described. In addition, four species, *Thyone bicornis*, *Thyone fusus chinensis*, *Thyone micra*, and *Molpadia changi*, are reported as new records from Korea. *Pentathyone kojinsensis* n. sp. closely resembles *Cucumaria mirabilis* Théel and *C. constricta* Ohshima in ossicle form, but the latter two species are clearly distinguished from the new species in having the posterior processes of the calcareous ring in several fragments, rather than stout and entire. *Pseudocnus pawsoni* n. sp. is similar to *Cucumaria koraensis* Östergren in general features and ossicle morphology though it has not biscuit-shaped plates. However, *Cucumaria koraensis* has ten tentacles of the same size, unlike *Pseudocnus pawsoni* n. sp. in which the two ventral tentacles are much smaller than the remaining eight.

The study on the Korean holothurians was begun by Östergren (1898) who reported two new species, *Cucumaria koraensis* and *Colochirus robustus* from the Korea Strait, and in 1905, he added two new species, *Myriotrochus minutus* and *Eupyrgus pacificus*. Since then 29 holothurian species have been reported in Korean waters by Mitsukuri (1912), Sato (1936), Kamita and Sato (1941), Rho and Shin (1984, 1986), Yi (1985), and Rho and Won (1993, 1995). They consist of 19 species in order Dendrochirotida, three species in order Aspidochirotida, six species in order Molpadida, and five species in order Apodida. This study is a result of an extensive collecting in the coastal seas of South Korea.

Among the examined species, two turned out to be new to science and the other four are new records to Korean fauna. All six species are thoroughly described and illustrated in this paper. The materials examined in this study are deposited in the Department of Biological Science, Ewha Womans University, Seoul, Korea.

Materials and Methods

The two new species and four new records in this work were collected from 13 localities (Fig. 1) during 1974 through 1996 in the coastal seas of Korea.

The materials were collected by SCUBA diving and from fishing nets. They were found from various habitats such as sand, mud, between seaweeds and

under rocks. Collected specimens were anesthetized with menthol and fixed in 75% methyl alcohol after relaxation.

For identification, the external feature, shape and number of tentacles, arrangements of podia, and so on, were examined. The calcareous ring and calcareous ossicles were inspected with a light microscope and a scanning electron microscope.

Systematic Accounts

Class Holothuroidea de Balinville, 1834
Subclass Dendrochirotea Grube, 1840
Order Dendrochirotida Grube, 1840
Family Phyllophoridae Östergren, 1907
Subfamily Thyoninae Panning, 1949
Genus *Thyone* Jaeger, 1833

Thyone bicornis Ohshima, 1915
(Fig. 2A-H)

Thyone bicornis Ohshima, 1915, p. 270, pl. 10, figs. 24a-d; Chang & Liao, 1964, p. 26; Liao & Clark, 1995, p. 503, fig. 305.

Material examined: One specimen from west of Cheju Island (33°N, 124°50'E), on 20 Sep. 1992 (J. S. Hong).

Description: Body fusiform and 3.8×1 cm in size (Fig. 2A). Color light brown or ivory in alcohol. Tentacles 10, ventral 2 smaller than others. Tube feet numerous, slender, hair-like and distributed all over body without distinct arrangement. Polian vesicle and stone canal

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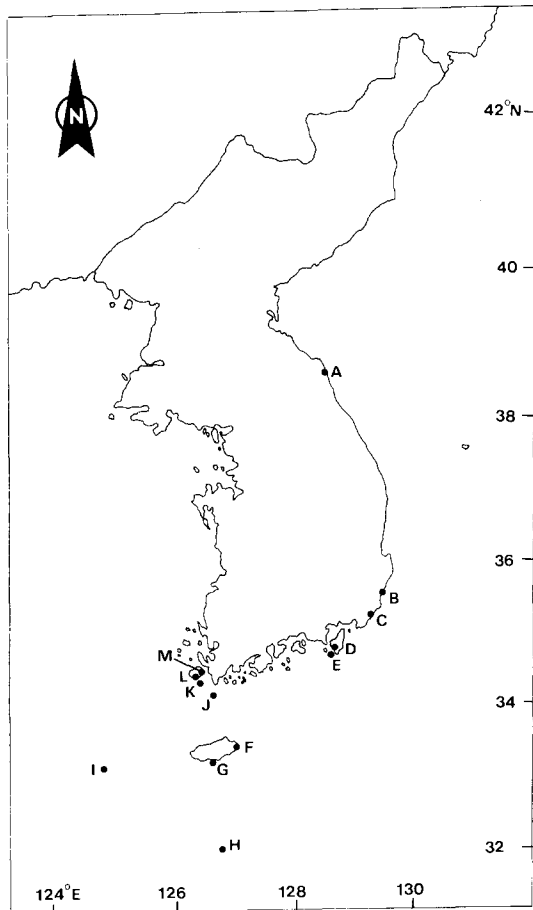


Fig. 1. Localities of collected specimen. A. Kōjin; B. Ulgi; C. Mip'o; D. Kudo; E. Pijindo; F. Sōngsanp'o; G. Pōmsōm; H. South of Cheju Island; I. West of Cheju Island; J. Pogildo; K. Chōpto; L. Kūmgap; M. Haedong.

single. Gonad very mature and composed of many simple gonotubules without branch in middle of body.

Ossicles of body wall scarce but a few tables present. Disk quadrate, 0.07-0.08 mm wide with 4 large and 4 small holes but occasionally with 8-12 holes (Fig. 2H). Spire with 2 pillars terminating in 2 or 4 teeth. In tube feet, supporting tables present, 2 ends of their disk bended down and spire 0.03 mm high with 2 or 4 teeth (Fig. 2E and F). In tentacles, slender rods and rosettes present (Fig. 2C and D). Most rods 0.08-0.11 mm long, and oval rosettes 0.03-0.06 mm wide. In introvert, rosettes and tables present (Fig. 2G). Rosette 0.04-0.08 mm and disk of tables 0.1-0.12 mm wide with many holes, spire up to 0.08 mm high.

Calcareous ring 10 mm high at radial segment with long bifurcated posterior projection, made up of 8-10 small pieces (Fig. 2B). Interradial segments short (about 2.5 mm) at 2 lateral-dorsal interradii, 5.5 mm high at mid-dorsal interradius and 7.5 mm at 2 ventral interradii.

Remarks: This specimen was collected in the Yellow Sea and agrees in essentials with the description and figures of *Thyone bicornis* given by Liao and Clark (1995) from China. However, the type specimen of Ohshima (1915) is somewhat different from ours. He explained that *T. bicornis* has small and rudimentary end plates, but we found no end plate in podia. In spite of the absence of end plate, both specimens are very similar to each other in ossicles and the other characters.

Distribution: Korea (Yellow Sea), Japan (Suruga Bay), China (south coast of China; from the Gulf of Tonkin to eastern Guangdong, in 23-61 m).

Thyone fusus chinensis Yang, 1937
(Fig. 3A-H)

Thyone fusus var. *chinensis* Yang, 1937, p. 7, pl. 1, fig. 1.

Thyone fusus chinensis: Liao & Clark, 1995, p. 504.

Material examined: One specimen, Haedong, on 25 Jul. 1994 (J. H. Won).

Description: Body fusiform and 3.5×1.2 cm in size (Fig. 3A). Color yellowish gray with dark brown patches. Tentacles 10 and ventral 2 smaller than others. Tube feet thorny, extremely numerous and scattered all over body but without arrangement in distinct rows. Anus surrounded by 5 pairs of anal papillae and inside of them 5 anal teeth visible. Polian vesicle single and 8 mm long. Stone canal single. Retractor muscles divided from longitudinal muscle at lower 1/5 portion of body. Gonad very mature, located in middle of body, composed of 5 simple and long (2 cm) gonotubules without branch.

Ossicles of body wall tables, disk of which oval, 0.04-0.06 mm wide, usually with 4 large holes but occasionally with 2-4 accessory holes. Low spire composed of 2 pillars and terminating in few teeth (Fig. 3G). Tube feet with 0.12-0.15 mm end plate as well as tables but no supporting table (Fig. 3H). In introvert, rosettes (0.025-0.04 mm) and tables visible. Tables a little larger than those of body wall as 0.075- 0.095 mm wide, spire 0.045 mm high with 4-11 accessory holes (Figs. 3D-F). In tentacles, rosettes and rods present. Rosettes usually 0.05 mm wide, rods slender and almost 0.1 mm long (Fig. 3C).

Calcareous ring thin, very high (about 15 mm in radial segment), tube like and each made up of small pieces (Fig. 3B). Radial segment 14 mm with 7-8 mm long bifurcated posterior projections. Interradial segment 5 mm long in dorsal side and 2 ventral ones 6.5 mm long.

Remarks: *Thyone fusus* (O.F. Müller) was known from European and adjacent Atlantic waters. Yang (1937)

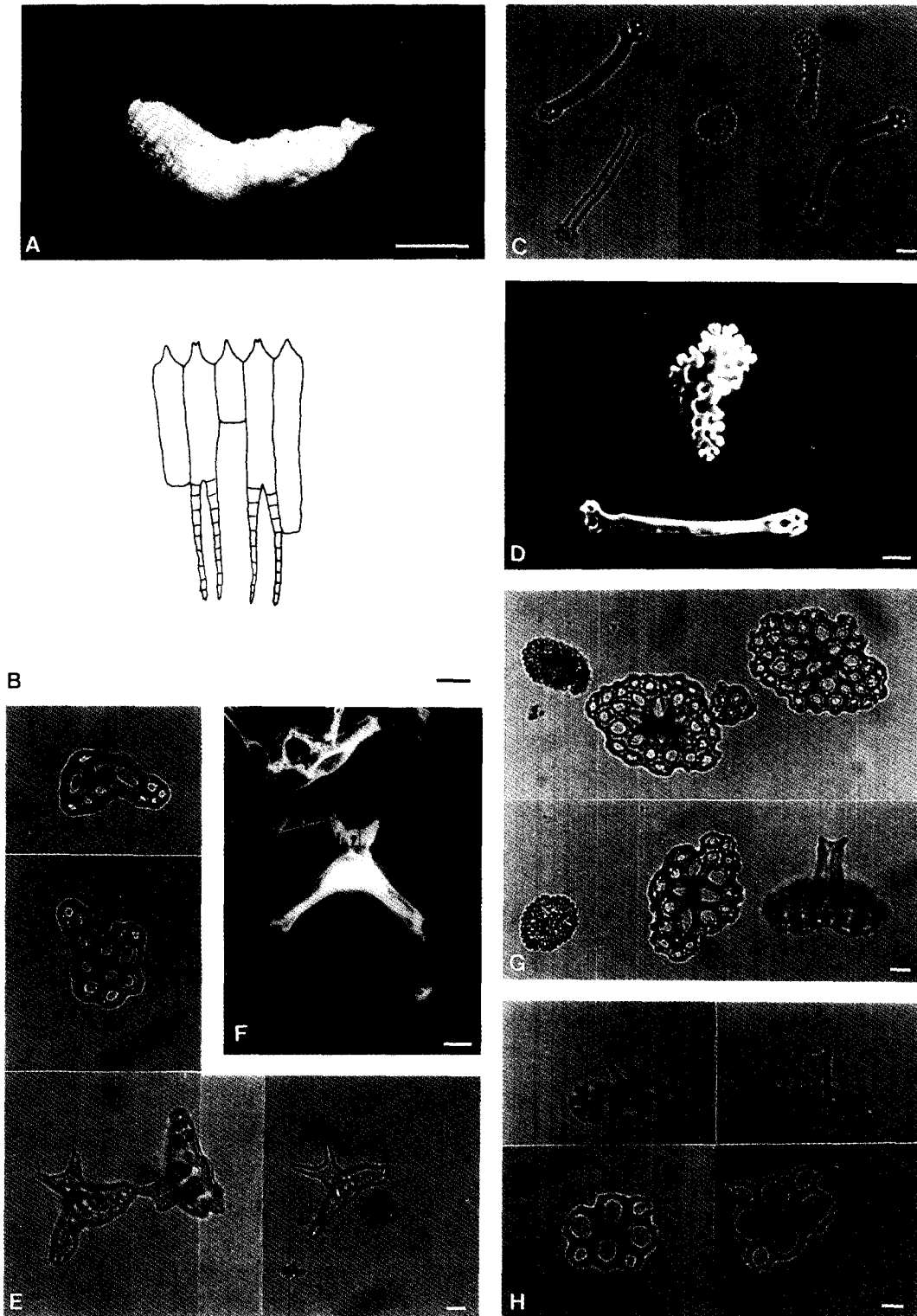


Fig. 2. *Thyone bicornis* Ohshima, 1915. A, Lateral view of body. B, Part of calcareous ring. C, D, Rods and rosettes from tentacles. E, F, Supporting tables from podia. G, Tables and rosettes from introvert. H, Tables from body wall. Scale bars=0.01 mm (C-H), 1 mm (B), and 1 cm (A).

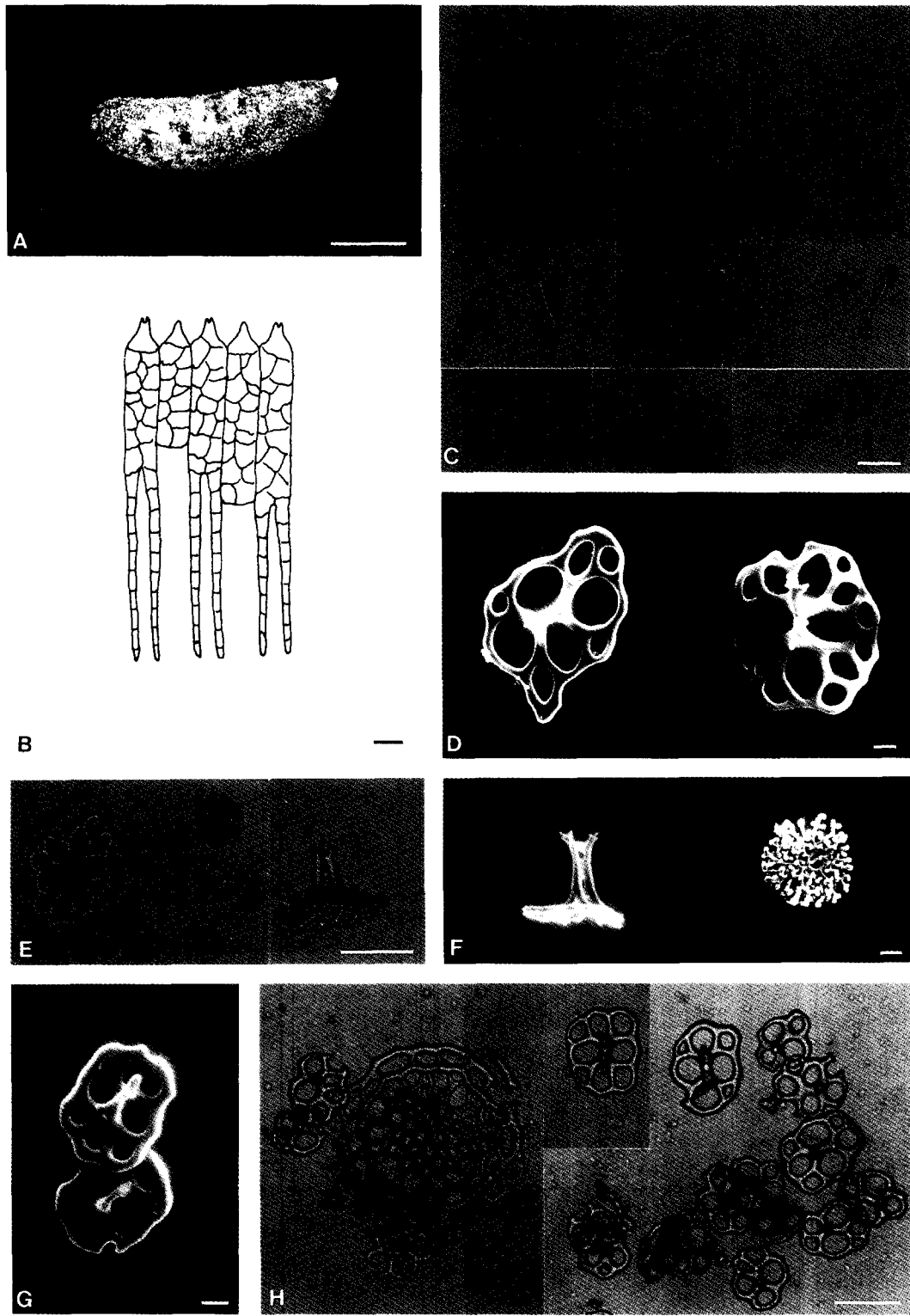


Fig. 3. *Thyone fusus chinensis* Yang, 1937. A, Lateral view of body. B, Part of calcareous ring. C, Rods and rosettes from tentacles. D, E, Tables and rosettes from introvert. F, Tables and rosettes from introvert. G, Tables from body wall. H, End plate and tables from podia. Scale bars=0.01 mm (E, D, G), 0.05 mm (C, F, H), 1 mm (B), and 1 cm (A).

recorded a variant of *T. fusus* from Fukien coast of China as *T. fusus* var. *chinensis* in terms of a geographical form. But *T. fusus* var. *chinensis* was questioned by Liao and Clark (1995) because this Chinese form had not been collected since Yang (1937) and differed from *T. fusus* in many morphological features.

However our specimen from southern Korea agrees with *T. fusus* var. *chinensis* in the ossicle form, calcareous ring and the other morphological features. One great difference from *T. fusus* var. *chinensis* is that our specimen has no needle-like ossicles in the body wall. However these ossicles might be of a sponge because they have not been found in the other dendrochirotes (Liao and Clark, 1995). *T. fusus* has well developed supporting tables in podia and only rosettes in introvert and tentacles (Deichmann, 1930), but *T. fusus* var. *chinensis* has no supporting tables in podia, and it has rosettes and tables in introvert, rosettes and rods in tentacles. The present specimen has no supporting tables in podia and the other ossicles are same as those of *T. fusus* var. *chinensis*, except simple needle-like ossicles in the body wall.

Distribution: Korea (Korea Strait), China (Chip-bee, Tseng-tsu-an, Nan-tai-wu).

Thyone micra Clark, 1938
(Fig. 4A-I)

Thyone micra Clark 1938, p. 468, fig. 41; 1946, p. 400; Clark and Rowe, 1971, p. 182.

Thyone papuensis: Liao and Clark, 1995, p. 504, fig. 306.

Material examined: One specimen between the oyster shells, Mip'o, on 29 Dec. 1974 (B. J. Rho and J. I. Song); one specimen, Pömsöm, on 22 Oct. 1991 (J. I. Song & J. H. Won).

Description: Body small, contracted, 1.5-1.6×0.4-0.5 cm and cylindrical or fusiform, with a little slender posterior (Fig. 4A). Color of body ivory with small brown spots. Tube feet relaxed and 0.2-0.3 cm long on ventral surface where they confined to radii, arranged in 3-4 rows and not visible at interradii. On dorsal surface, tube feet showed at interradii as well as radii, but a little more at radii. Tentacles 10, mid-ventral 2 ones of them smaller than others. Introvert smooth without tube feet or papillae.

Retractor muscles divided at middle of body. Polian vesicle small, single, and located in left ventral interradius. Stone canal single and shape of madreporite resemble 2 disks overlapped. Respiratory tree 2 in dorsal interradii. Gonad tufts 2 at both sides of dorsal mesentery without branch. In Pösmöm specimen, gonad very mature, front gonotubules short and slender but others long and thick.

Ossicles of body wall table, disk of which 0.08-0.09×0.03-0.05 mm wide (Fig. 4D and I), with 4 large holes in center and 1-2 small holes in both ends of disk. Spire of table low arch-shaped. In tube feet, tables present, disk of tables 0.15 mm long and bended down (Fig. 4C and H). End plates 0.15 mm wide and peculiar in shape (Fig. 4E). Small holes crowded in center, one row of large holes in outer side and 2-3 rows of middle ones at margin. In tentacles, rosettes 0.03-0.04 mm wide and rods very slender, 0.05-0.6 mm long with some holes or branch at both ends visible (Fig. 4F). Occasionally, 0.1-0.25×0.04-0.05 mm perforated plate also visible but they probably very developed large rosettes or rods. In introvert, mainly rosettes and a few tables present (Fig. 4G).

Calcareous ring long and mosaic like (Fig. 4B). Radial segment with one notch on anterior margin and long bifurcated posterior processes, posterior notch of radial segment up to 3/5 of interradii segment.

Remarks: This small *Thyone* species bears a considerable resemblance to the figures and description of *T. papuensis* Théel, 1886. Clark (1946) has interpreted the differences between *T. micra* and *T. papuensis* as that *T. micra* has tables, disk of which is about twice as long as wide, with 4 large holes and no supplementary holes, while *T. papuensis* has disk about as wide as long, usually with 4 small holes alternating with the large ones. However these two species are very similar to each other in other characters. The number of holes on disk is mostly 4 but occasionally 5-6 holes are also found in ours. The figures of *T. papuensis* given by Liao (1995) are very similar to ours. While *T. micra* has only been recorded in North Australia, *T. papuensis* is found in Ceylon, Bay of Bengal and East Indies as well as North Australia (Clark and Rowe, 1971). These two species therefore seem similar enough to be recognized as the same species.

Distribution: Korea (Korea Strait, Cheju Island), Hong Kong, Sri Lanka area, Bay of Bengal, East Indies and northern Australia.

Family Sclerodactylidae Pawson & Fell, 1965
Subfamily Sclerodactylinae Panning, 1949
Genus *Pentathyone* Clark, 1938

Pentathyone kojimensis n. sp.
(Fig. 5A-H)

Type specimens: One specimen, Holotype: SPH 801101, Kōjin, East Sea, on 22 Nov. 1980 (B. J. Rho & S. Shin).

Description: Relaxed body 5.7×2.2 cm. Tentacles and introvert 1.7 cm long (Fig. 5A). Body fusiform, color of body light brown, but tentacles, introvert and ends of

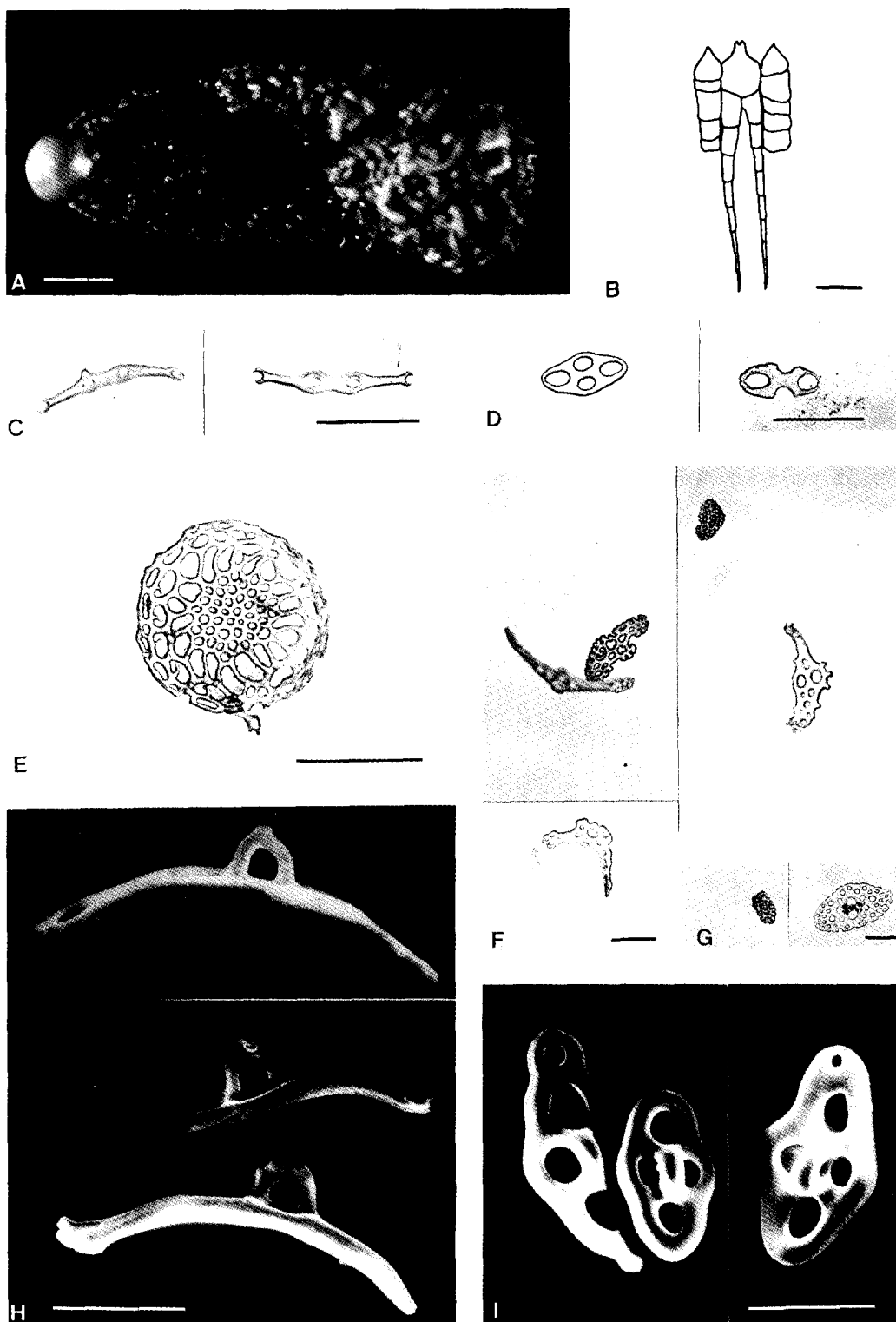


Fig. 4. *Thyone micra* Clark, 1938. A, Lateral view of body. B, Part of calcareous ring. C, Reduced tables from podia. D, Reduced tables from body wall. E, End plate from podia. F, Rosettes and rods from tentacle. G, Table and rosette from introvert. H, Lateral views of tables from podia. I, Disks of tables from body wall. Scale bars=0.02 mm (F-G), 0.05 mm (H-I), 0.1 mm (C-E), 1 mm (B), and 2 mm (A).

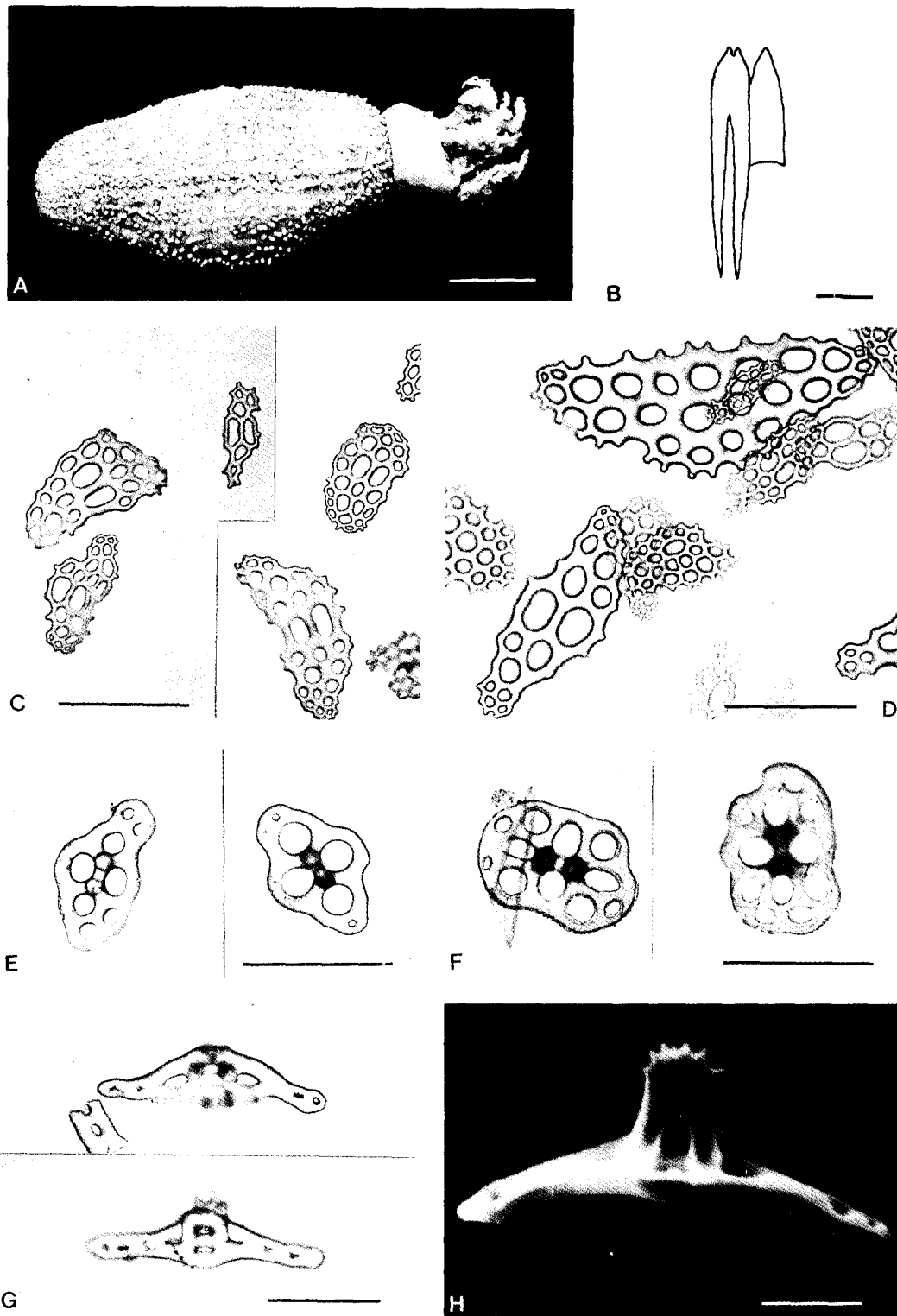


Fig. 5. *Pentathyone kojimensis* n. sp. A, Lateral view of body. B, Part of calcareous ring. C, D, Plates from tentacle. E, Tables from body wall. F, Tables from introvert. G, Tables from podia. H, Tables from podia. Scale bars=0.05 mm (H), 0.01 mm (C-G), 5 mm (B), and 1 cm (A).

tube feet ivory in alcohol. Tube feet small, 1 mm long, scattered all over body but a little more in ventral side. Surface of body coarse for ossicles. Tentacles 10, mid-ventral 2 ones of which much smaller (0.2-0.3 cm) than others (1.2 cm). Anal teeth 5 and anal papillae not clear for contraction.

Retractor muscles divided at lower 1/2 portion of body in dorsal side and lower 1/3 portion of body in ventral. Respiratory 2 extending to anterior end. Gonad tuft single and gonotubules long, slender, without branch. Polian vesicles 3 and 1.5 cm long, located in 3 ventral radii. Stone canal single and shape of madreporite like 3 leaflets connected in face to face. Short and tough stomach visible at lower 2 cm portion of calcareous ring. Large cloaca connected with many muscle fibers.

Ossicles of body wall two-spined tables (Fig. 5E). Disk oval, 0.1 × 0.17 mm wide and usually with 4 large holes and some small holes at margin. Spire 0.03-0.05 mm high. In tube feet, disk of tables 0.2-0.23 mm long, and spire 0.05-0.08 mm high (Fig. 5G and H). Both ends of disk bended down slightly and spire with 3-5 teeth at top. End plate 0.2-0.23 mm wide. In introvert, tables present and somewhat larger than those of body wall (Fig. 5F). In tentacles, long perforated plates visible (Fig. 5C and D). Most of plates about 0.08-0.23 × 0.07-0.1 mm wide and 2 holes in center long and larger than the others.

Calcareous ring large, radial segment 2 cm high including 1.5-1.6 cm long bifurcated posterior processes and interradial segment 1 cm high (Fig. 5B). All plates of ring perfect and not fractionized. Anterior of ring narrow and posterior notch of radial segment up to middle of interradial segment.

Etymology: The specific name, *kojinensis* is named after the type locality.

Remarks: This species has stout and entire calcareous ring with posterior processes. Subfamily Sclerodactylinae has such calcareous ring and is divided into genera according to the type of their ossicles. The species that has tables with two pillars like the present species belongs to genus *Pentathyone*. *Pentathyone* was established by Clark (1938) and a few species have been recorded in this genus so far. *Pentathyone mirabilis* (Ludwig, 1875), type species of *Pentathyone*, is definitely distinguished from ours by having papillae as well as podia on body wall.

Cucumaria mirabilis Théel, 1886 is similar to ours in ossicles but posterior processes of calcareous ring is made up of several fragments and podia are mostly restricted to radii. *Cucumaria constricta* Ohshima, 1915 also has ossicles like the present species but podia of *C. constricta* are restricted to radii.

Family Cucumariidae Ludwig, 1894
Subfamily Cucumariinae Ludwig, 1894

Genus *Pseudocnus* Panning, 1949

Pseudocnus pawsoni n. sp.
(Fig. 6A-H)

Type specimens: One specimen, Holotype: CPH 810701, Pogildo, on 2 Jul. 1981 (S. Shin & M. K. Hur); 36 spec. Paratype: CPH 810702, collected with holotype.

Additional material examined: 20 spec. Chöpto, on 6 Aug. 1974 (B. J. Rho); one spec. Chöpto, on 23 Jul. 1994 (J. H. Won); 18 specimens, Pijindo, on 19 Jul. 1978 (B. J. Rho & S. Shin); 2 spec. Söngsanp'o, on 8 Oct. 1987 (B. J. Rho, J. W. Lee); 30 specimens, Ulgi, on 15 Jul. 1994 (J. H. Won); 13 spec. Ulgi, on 16 Jul. 1994 (J. H. Won); one spec. Kümgap, on 23 Jul. 1994 (J. H. Won); 11 spec. Haedong, on 25 Jul. 1994 (J. H. Won); 20 spec. Haedong, on 5 Nov. 1994 (B. J. Rho and J. H. Won); one spec. Kudo, on 6 Feb. 1996 (J. H. Won).

Description: Body small, 0.9-2.0 × 0.4-0.8 cm wide and fusiform (Fig. 6A). Both ends of body slightly bended up. Body wall thick. Tube feet large relatively and arranged in 2 rows in each radius but a few ones also visible in interradial. Dorsal side and both ends of body dark gray and ventral side ivory with some orange spots in alcohol. Tentacles 10, of which mid-ventral 2 smaller than others. Oral papillae 2-3 arranged in zigzag at each radius. 5 anal papillae and 5 anal teeth visible.

Retractor muscles divided at lower 3/5-1/2 portion of body. Polian vesicle single in left dorsal interradius. Stone canal single. Respiratory tree 2. Gonad 2 located in both sides of dorsal mesentery and gonotubules long, cylindrical without branch.

Ossicles of body wall biscuit-shaped plates. Biscuit oval, 0.05-0.08 mm wide with 4-7 holes and wavy in margins (Fig. 6E). Biscuits occasionally developed as large as 0.2-0.3 mm wide with 2-3 rows of holes. Besides biscuits, very large fir-corn shaped bodies which 0.3-0.5 mm in size with one spiny end visible (Fig. 6G and H). In tube feet, end plates 0.2-0.3 mm wide and rods 0.15-0.18 mm long with holes (Fig. 6F). In tentacles, rosettes 0.03-0.04 mm wide and long rod-like plates much variable in size and shape (Fig. 6B). In introvert, rosettes 0.02-0.03 mm wide and rods 0.1-0.23 mm long (Fig. 6C).

Calcareous ring simple (Fig. 6D). Radial segment a little higher than interradial one, with single notch on anterior margin and single deep notch in posterior.

Etymology: The species name, *pawsoni* is named for Dr. David L. Pawson, who is famous for his studies on sea cucumbers of the world.

Remarks: The genus *Pseudocnus* has two types of ossicles in the body wall. One type is the large fir-corn

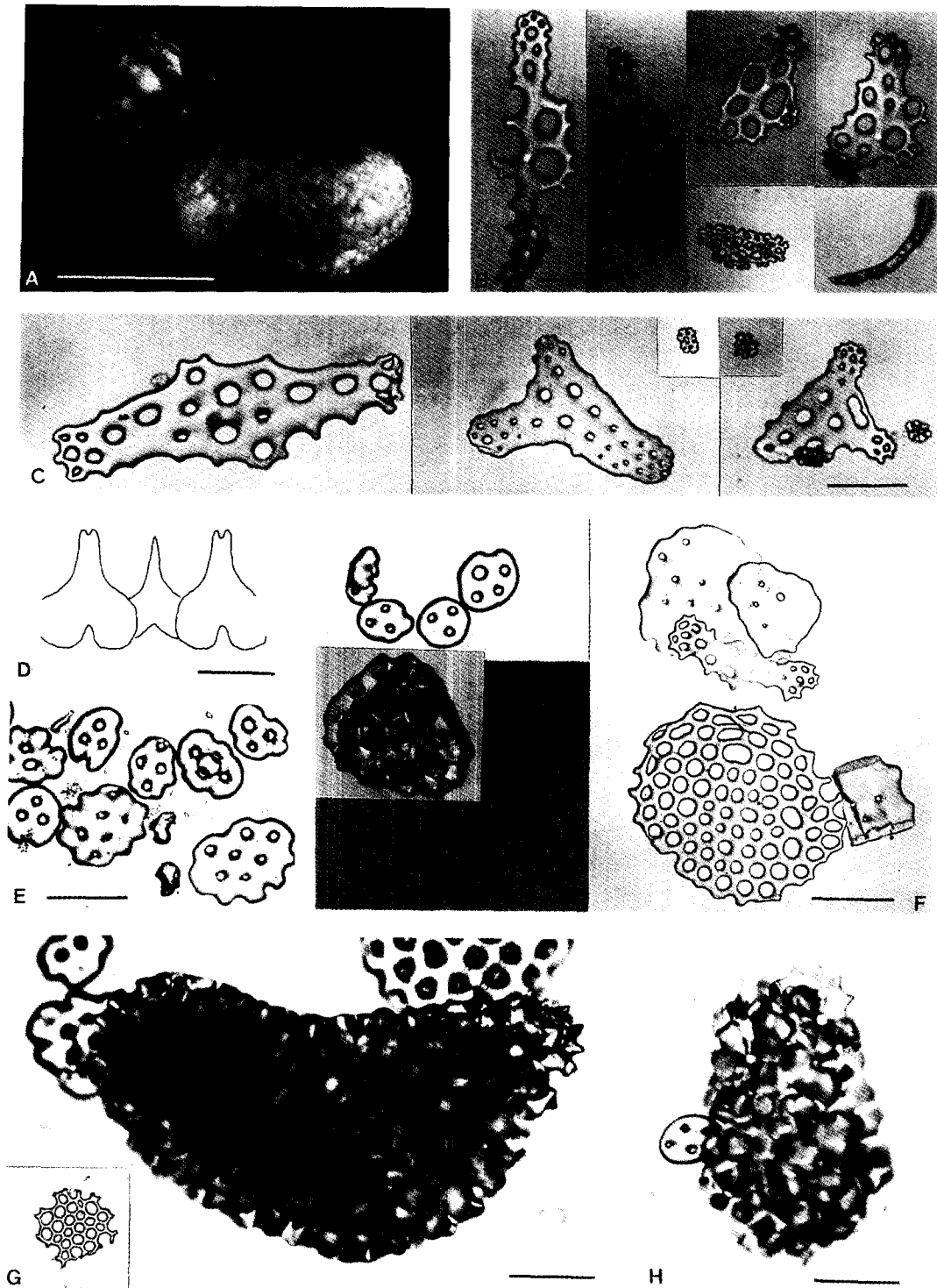


Fig. 6. *Pseudocnus pawsoni* n. sp. A, Lateral view of body. B, Rods and rosette from tentacle. C, Rods and rosettes from papillae of introvert. D, Part of calcareous ring. E, Bisquits from body wall. F, Deposits from ventral body wall. G, End plate and fir-cone plate from dorsal body wall. H, Fir-cone plate from dorsal body wall. Scale bars=0.05 mm (B, C), 0.1 mm (E-H), 1 mm (D), and 0.5 cm (A).

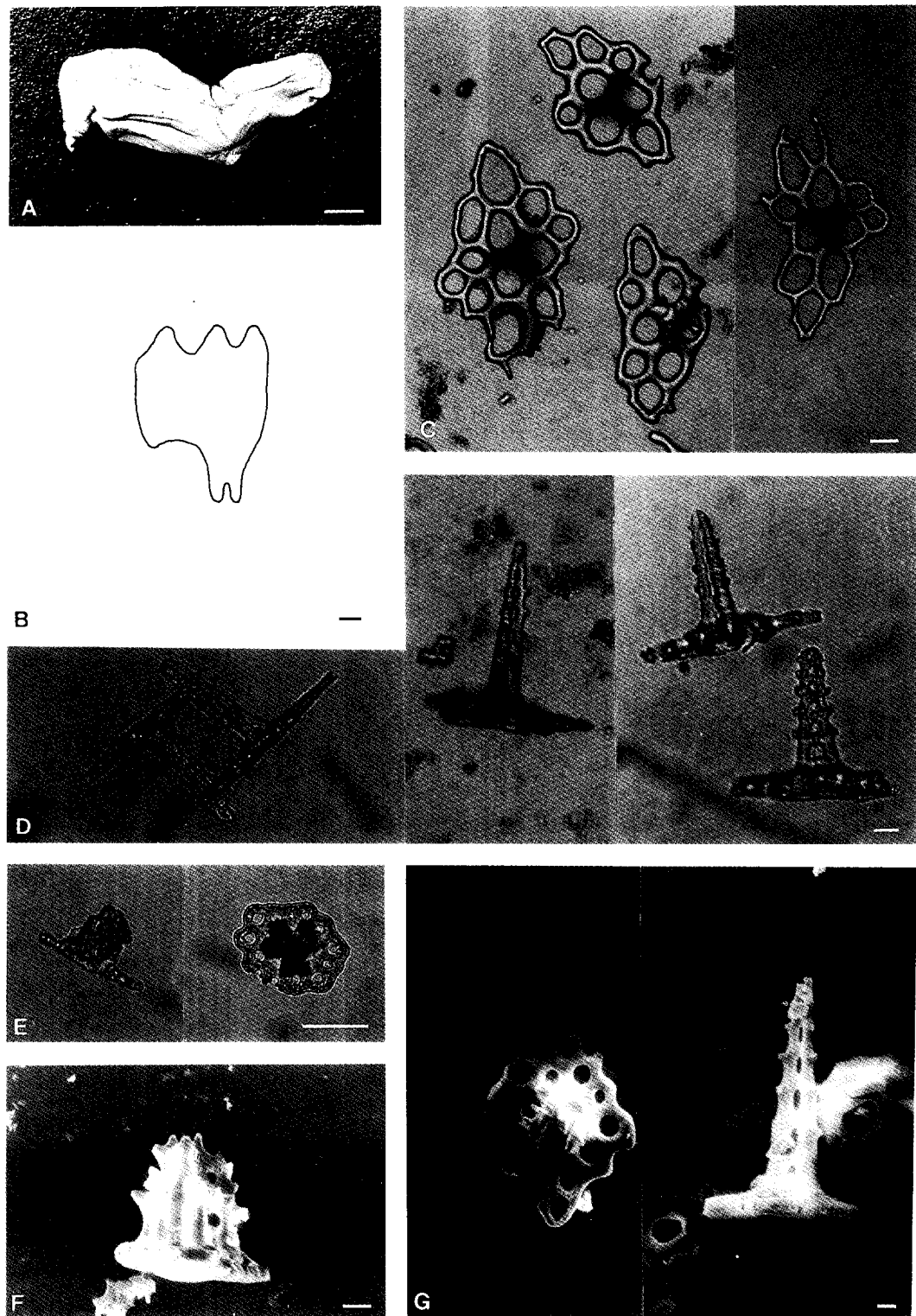


Fig. 7. *Molpadia changi* Pawson and Liao, 1992. A, Lateral view of body. B, Part of calcareous ring. C, D, G, Tables from body wall. E, F, Tables from tail part. Scale bars=0.01 mm (C, D, F, G), 0.05 mm (E), 1 mm (B), and 1 cm (A).

shaped bodies with one end denticulate and the other one is the smaller circular knobbed plates. These small holothurians rarely exceed 4 cm in length.

This species has particularly numerous small biscuit-shaped plates in body wall which are very weakly knobbed. The similarities in ossicle from between this species and *P. grubei* (von Marenzeller, 1874) are striking. Both species have biscuit-shaped plates with some holes. However, *P. grubei* is recorded only from the Mediterranean and is 10 cm long, larger than the present species. Moreover *P. grubei* has podia restricted in radii, such as 3-4 rows in ventral radii and 2-3 rows in dorsal radii. But podia of this species are also found in interradii as well as in radii, especially on dorsal side. In addition, *P. grubei* has fir-corn shaped bodies 0.182-0.255 mm in size, but this species has larger ones.

Cucumaria koraensis was recorded by Östergren (1898) from the Korea Strait, but specimens of this species have not been collected since 1898. The present species is the same as *C. koraensis* in external features and ossicles except the biscuit plates. However *C. koraensis* has 10 tentacles of the same size, but in the present species, the ventral 2 tentacles are smaller than the others. Moreover, *C. koraensis* has plates in tentacles and end plates in podia, but the present species has rosettes and plates in tentacles and rods also in podia. These differences seem enough to recognize our specimen as a new species of the genus *Pseudocnus*.

Subclass Apodacea Brandt, 1835
Order Molpadiida Haekel, 1896
Family Molpadiidae Müller, 1850
Genus *Molpadia* Risso, 1826

Molpadia changi Pawson and Liao, 1992
(Fig. 7A-G)

Molpadia andamanensis: Chang and Liao, 1964, p. 45 [not *M. andamanensis* (Walsh, 1891)].

Molpadia changi Pawson and Liao, 1992, p. 374, fig. 1; Liao & Clark, 1995, p. 521, fig. 318.

Material examined: One specimen from south of Cheju Island (32°N, 126°50'E), on 18 Sep. 1992 (J. S. Hong).

Description: Size of body 9×2.5 cm, much contracted with short tail (Fig. 7A). Body fusiform and color brown in alcohol. Tentacles 15 with terminal digit and one pair of lateral digits. 5 groups of minute anal papillae visible. Body wall 1-1.5 mm thick and slightly rough for its ossicles. Stone canal single. Polian vesicle single and 1.3 cm long at ventral radius.

Ossicles of body rare but, in anterior and posterior part of body, some tables visible (Fig. 7C, D, and G). Disks 0.14-0.18 mm wide and irregular in outline. Spines narrow, 0.1-0.15 mm high, composed of 3 pillars joined

by 6-8 crossbars and terminating in 1 or 2 points. Brown phosphatic bodies present. Their shape and size irregular but most of them 0.005-0.05 mm wide. Tables of tail different from those of body. Their disk 0.08-0.1 mm wide. Spire thick, short and 0.04 mm high with many teeth (Fig. 7E, and F).

Calcareous ring strongly fused (Fig. 7B). Radial segment with short bifurcated posterior projections. Total length of radial segment 7-7.5 mm including posterior projection of 2.5 mm and dorsal plates a little longer than those of ventral.

Remarks: Type specimen of *Molpadia changi* reported by Pawson and Liao, 1992 was also collected from Yellow Sea and is quite similar to the present specimen in external features and ossicle form.

Distribution: Korea (Yellow Sea), China (Yellow Sea), Philippines.

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