

## **The Ascidians (Tunicata) from Chindo Islands, Korea**

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### **ABSTRACT**

The study on the classification of the Chindo Islands ascidians was conducted by collecting the specimens from five localities in July and November, 1994 and the previous records. The ascidians were classified into 7 families, 11 genera and 16 species. They are all known species in Korean waters. Among them nine species were found to be new to the Chindo Is. From the standpoint of water forms, the composition of the ascidians from Chindo Is. is made up of three elements, viz., temperate (8 species, 50%), temperate-tropical (7 species, 44%) and tropical (1 species, 6%). A boreal water species and boreal-temperate species were not found. It may be attributable to the fact that the water of this area is warm because of Kuroshio Water Current.

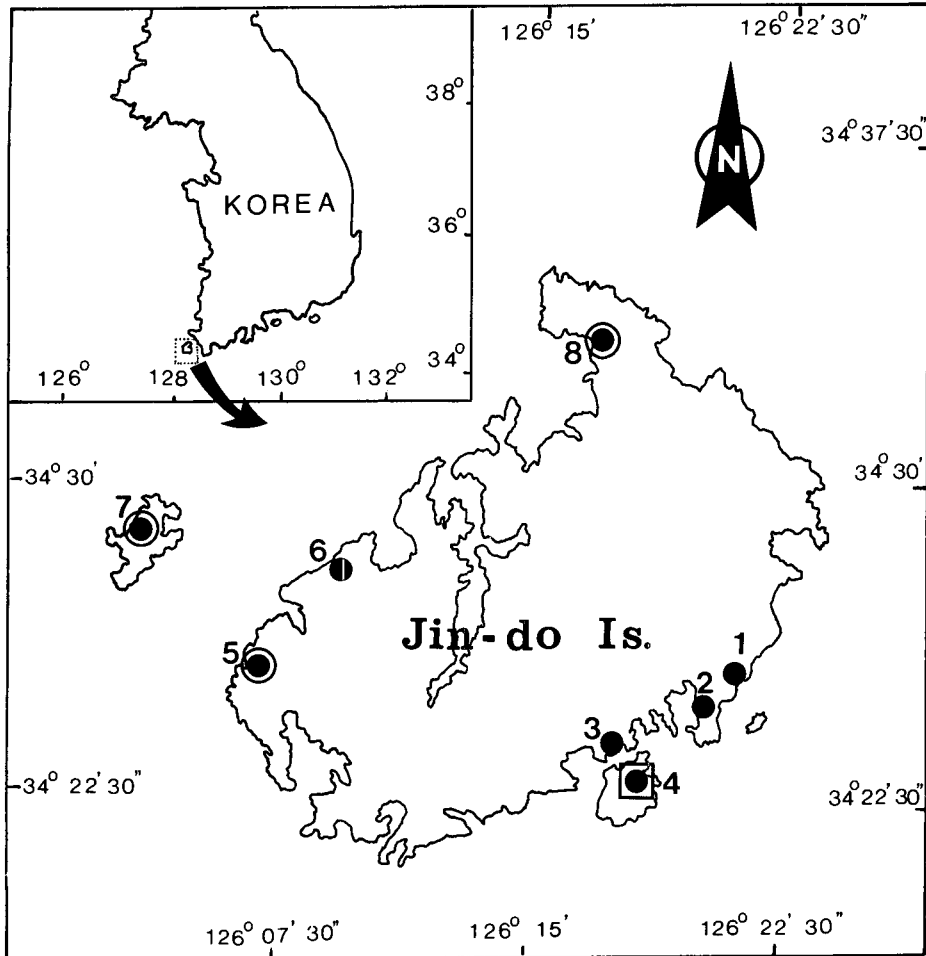
Key words: Systematics, ascidians, Chindo Islands, Korea.

### **INTRODUCTION**

The present work also dealt with an extensive collecting in the coastal areas of South Korea with a view of preparing a faunistic and ecological account of the Korean ascidians. In preparing the account of the ascidians from the Chindo Islands, the author conducted not only the materials collected from 5 localities in Chindo Is. (Chöpto, Pojŏn, Kunp'ŏ, Haedong, Kŭmgap) in July and November, 1994 (Fig. 1), but also the previous records from Chindo Is. which were reported by the present author (Rho, 1975).

Our knowledge in regard to the ascidians of the Chindo Is. themselves was until very recently confined to the seven species obtained there by the author's collection, and they are as follows (Rho, 1975):

*Amaroucium multiplicatum* Redikorzev, 1927



**Fig. 1.** Map showing the localities where the previous species and the present materials were collected: 1. Haedong (海東), 2. Kulp'o (巨포), 3. Kūmgap (金甲), 4. Chōpto (接島), 5. Gahag (加鶴), 6. Pojŏn (寶田), 7. Gasado (加沙島), 8. Nogjin (鹿津). (○ previous record, ● present materials, ◻ both previous record and present materials)

*Didemnum (D.) moseleyi* Herdman, 1886

*Botrylloides violaceus* Oka, 1927

*Styela partita* (Stimpson, 1852)

*Styela clava clava* Herdman, 1881

*Pyura vittata* (Stimpson, 1852)

*Boltenia transversaria* (Sluiter, 1904)

The ascidian fauna of the Chindo Is. is moderately rich in both the compound form and the solitary form in the number of species, and the both forms are very abundant and common around the islands. The most abundant species of the compound ascidians are *Amaroucium pliciferum*, *Botryllus schlosseri*, *Botrylloides magnicoecum*, and *Symplegma connectans*, and of the solitary ones are *Ciona intestinalis*, *Styela plicata*, and *Styela clava clava*, and *Didemnum (D.) moseleyi*. *Pyura vittata* and *Boltenia transversaria* are not appeared in the present work.

The system of classification employed is based upon that of Van Name (1945) and also, in part, those adopted by Tokioka (1953) and Kott (1985). Each species is briefly described in remarks and four species (*Trididemnum sauginii*, *Ciona intestinalis*, *Botryllus schlosseri*, *Symplegma connectans*) are illustrated.

### SYSTEMATIC LIST

The species marked with one asterisk (\*) are newly reported from Chindo Islands, the ones with two asterisks (\*\*) are already reported and the ones with three asterisks (\*\*\*) are not recorded by the present work but reported by previous works from Chindo waters.

#### Class Ascidiacea 海鞘綱

Order Enterogona Perrier, 1898 내성해초목

Suborder Aplousobranchia Lahille, 1886 무관아목

Family Polyclinidae Verrill, 1871 만두멍게과

\*\*1. *Amaroucium pliciferum* Radlkozyev, 1927 만두멍게

\*2. *A. multiplicatum* (Sluiter, 1909) 주름만두멍게

Family Didemnidae Verrill, 1871 흰덩이멍게과

\*\*\*3. *Didemnum (D.) moseleyi* (Herdman, 1886) 흰덩이멍게

\*4. *Trididemnum sauginii* (Herdman, 1886) 세줄흰덩이멍게

Suborder Plebobranchia Lahille, 1886 편새아목

Family Cionidae Lahille, 1886 유령멍게과

\*5. *Ciona intestinalis* (Linnaeus, 1767) 유령멍게

Family Ascidiidae Herdman, 1880 대추멍게과

\*6. *Ascidia sydneyensis divisa* (Sluiter, 1898) 갈래대추멍게

Order Pleurogona Perrier, 1898 측성해초목

Suborder Stolidobranchia Lahille, 1886 강새아목

Family Botryllidae Verrill, 1871 판멍게과

\*7. *Botryllus schlosseri* (Pallas, 1766) 스크로세르판멍게

\*8. *Botrylloides magnicoecum* Hartmeyer, 1912 붉은판멍게

\*\*9. *B. violaceus* Oka, 1927 보라판멍게

Family Styelidae Sluiter, 1895 미더덕과

\*10. *Symplegma connectans* Tokioka, 1949 새공멍게

\*\*11. *Styela partita* (Stimpson, 1852) 두줄미더덕

\*12. *S. plicata* (Lesueur, 1823) 주름미더덕

\*\*13. *S. clava clava* Herdman, 1881 미더덕

Family Pyuridae Hartmeyer, 1908 멍게 (우렁챙이)과

\*14. *Pyura lepidoderma* Tokioka, 1949 비늘가죽멍게

\*\*\*15. *P. vitia* (Stimpson, 1852) 끈멍게

\*\*\*16. *Boltenia transversaria* (Sluiter, 1904) 가로줄멍게

## SYSTEMATIC ACCOUNT

Family Policlinidae Verrill, 1871 만두멍게과

1. *Amaroucium pliciferum* Redikorzev, 1927 만두멍게

*Amaroucium pliciferum* Redikorzev, 1927, p. 387, figs. 9-10.

*Amaroucium pliciferum*: Tokioka, 1953, p. 183, pl. 6, figs. 1-10, pl. 7, fig. 1; Tokioka, 1954, p. 77, pl. 5, figs. 2-5; Utinomi, 1962, p. 127, pl. 64, fig. 2; Rho, 1966, p. 211, pl. 1, figs. 1-5; Tokioka, 1967a, p. 32, fig. 6; Rho, 1967, p. 362; Rho, 1968, p. 88; Rho, 1971, p. 107; Rho, 1975, p. 125; Nishikawa, 1984, p. 113; Rho and Huh, 1984, p. 5; Rho and Lee, 1989, p. 62; Rho and Lee, 1991, p. 197.

Material examined. 8 colonies, Chōpto, 23 July 1994, Jun-Im Song; 6 colonies, Pojōn, 24 July 1994, *ibid*; 4 colonies, Kūmgap (oyster bed, 4 m), 6 Nov. 1994, *ibid*.

Remarks. The colony forms a large hemispherical, or somewhat depressed. The largest colony measures 110 × 110 × 20 mm in extent and attached to the rock by whole underside. Test is gelatinous, rather hard and whitish red in colour. Zooids are arranged in many elongate or oval systems. Largest systems measures 10 mm in length and each system contain 30 zooids. Surface marked with many irregularly arranged grooves and several common cloacal apertures opening at the bottom of grooves. Zooids attains 4-23 mm in length. Thorax occupies 1.5-4 mm, anterior abdomen 1-2 mm, and post abdomen rather thin and very long, being 1.5-17 mm in length, and atrial lanquet cleft into three lobules or simple. Stigmatal rows 12-14, commonly 13, with 12-14 or 15-17 stigmata in each row. Tentacles 10-12, and ciliated groove a small, oval opening. Stomach with 32-34, well marked longitudinal plications and a pair of caecum at proximal end of rectum.

Testicular follicles rarely developed in specimens of November.

Distribution. Korea (East Sea, South Sea, Yellow Sea) and Japan.

2. *Amaroucium multiplicatum* (Sluiter, 1909) 주름만두멍게

*Aplidium multiplicatum* Sluiter, 1909, p. 101, pl. V, fig. 5.

*Amaroucium californicum* (?) Ritter, 1901, p. 254.

*Amaroucium californicum*: Van Name, 1945, p. 47, text-fig. 12, pl. 28, figs. 2-3.

*Amaroucium multiplicatum*: Tokioka, 1953, p. 180, pl. 5, figs. 1-4; Tokioka, 1954, pl. 76, pl. 5, fig. 1; Rho, 1975, p. 125, pl. 1, figs. 1-4; Rho and Huh, 1984, p. 102; Rho and Lee, 1989, p. 61; Rho and Lee, 1991, p. 197.

Material examined. 1 colony, Chōpto, 23 July 1994, Jun-Im Song; 15 colonies, Kūmgap (oyster bed, 4 m), 5 Nov. 1994, Rho, Lee and Won; 1 colony, Chōpto, 6 Nov. 1994, Rho, Lee and Won, (Gahag, 3 Aug., 1974).

Remarks. The colony encrusting the shells of oyster or attached to the simple ascidians *Styela clava*, *Styela plicata* etc., respectively 70 × 35 mm or 50 × 30 mm in extent and 6 mm in thickness. Test is semitransparent, gelatinous and surface smooth and free from foreign matters, and there are irregular groups surrounding each a small round common cloacal aperture.

Zooids yellowish orange in colour, 3.5 mm in length in large ones. Atrial lanquet moderate size and

simple, and seven to eight number of longitudinal muscle bands on each side of thorax. Stigmatal rows 6-9, rarely 10 and 9-11 stigmata in a row. Tentacles 9, and anus bilobed situated on the level of the fourth transverse vessel. About 10 plications on stomach.

**Distribution.** Korea (Chindo Is., Chejudo Is., Gōmundo Is.) and Japan.

Family Didemnidae Verrill, 1871 흰덩이멍게과

3. *Didemnum (Didemnum) moseleyi* (Herdman, 1886) 흰덩이멍게

*Leptoclinum moseleyi* Herdman, 1886, p. 272, pl. 37, figs. 9-14.

*Didemnum (D.) moseleyi*: Tokioka, 1949, p. 43, fig. 3; Tokioka, 1953, p. 185, pl. 15, pl. 16, figs. 1-11, pl. 17, figs. 1-6; Tokioka, 1954, p. 77, fig. 1; Tokioka, 1959, p. 206; Tokioka, 1967a, p. 65, fig. 20d; Tokioka, 1967b, p. 239-240; Rho, 1967, p. 365, fig. 2; Rho, 1968, p. 88; Rho, 1971, p. 109; Rho, 1975, p. 126; Nishikawa, 1980b, tab. 1; Rho and Huh, 1984, p. 105; Rho and Lee, 1989, p. 62; Rho and Lee, 1991, p. 199; Nishikawa, 1991, p. 100, fig. 4.

**Material examined.** None, (Gahag, 3 Aug., 1974).

**Remarks.** This species has been collected by the author from Gahag in 1974, and already reported by the author (Rho, 1975).

4. *Trididemnum savignii* (Herdman, 1886) 세줄흰덩이멍게 (Fig.?)

*Didemnum savignii* Herdman, 1886, p. 261, pl. 34, figs. 1-5.

*Didemnum savignii*: Van Name, 1902, p. 358, pl. 50, figs. 27 and 35, pl. 59, fig. 112.

*Trididemnum savigni*: Van Name, 1921, p. 314, figs. 7-9; Van Name, 1930, p. 428, figs. 7-8; Van Name, 1945, p. 101, pl. 18, fig. 4, text-fig. 45; Berrill, 1932, p. 77; Pérès, 1951, p. 1056; Pérès, 1960, p. 40; Tokioka, 1953, p. 197, pl. 21, figs. 4-8; Tokioka, 1962, p. 3; Tokioka, 1967a, p. 80, fig. 26; Eldredge, 1965, p. 178, fig. 3; Kott, 1966, p. 285; Kott, 1975, p. 9; Plough, 1978, p. 17; Rho and Huh, 1984, p. 105, pl. 7, figs. 1-4; Rho and Lee, 1991, p. 199, pl. 1b.

**Material examined.** 1 colony, Pojŏn, 24 Jul. 1994, Jun-Im Song.

**Remarks.** The colony encrusting a piece of seaweeds, irregular form, measures 50 × 30 mm in extent and 2-3 mm or 10-15 mm in thickness, in some parts, there are numerous papillae, and at the tip of the mammary papillae opened common cloacal aperture. The test is pale blue in color, gelatinous, rather soft and opaque owing to the abundance of the white stellate spicules, which are uniformly distributed throughout the colony, and the pigment cells are chiefly contained in the superficial parts of the test and regularly oval in shape and the zooids are not clearly seen from the surface, obscured by the abundance of spicules.

Zooids are blackish white, elongate and slender, attains about 1.5 mm in length, of which thorax is dark black in color, their length and thickness are very variable. Branchial siphon with six lobes, atrial ones round, situated on the dorsal side of the thorax at about the middle portion. Tentacles are about 10. Branchial sac with three rows of stigmata, and there are not over eight or ten stigmata in a row on each side. The stomach is rounded, intestinal loop small.

Trunk of larve oval in outline and about 700-900 μm in length from the end of the papillae to the base of the tail, with three papillae. The sensory vesicle has both ocellus and otolith and arranged dorso-ventrally.

**Distribution.** Korea (Tolsando Is., Gōmundo Is., Chindo Pojun), Japan, North and South America,

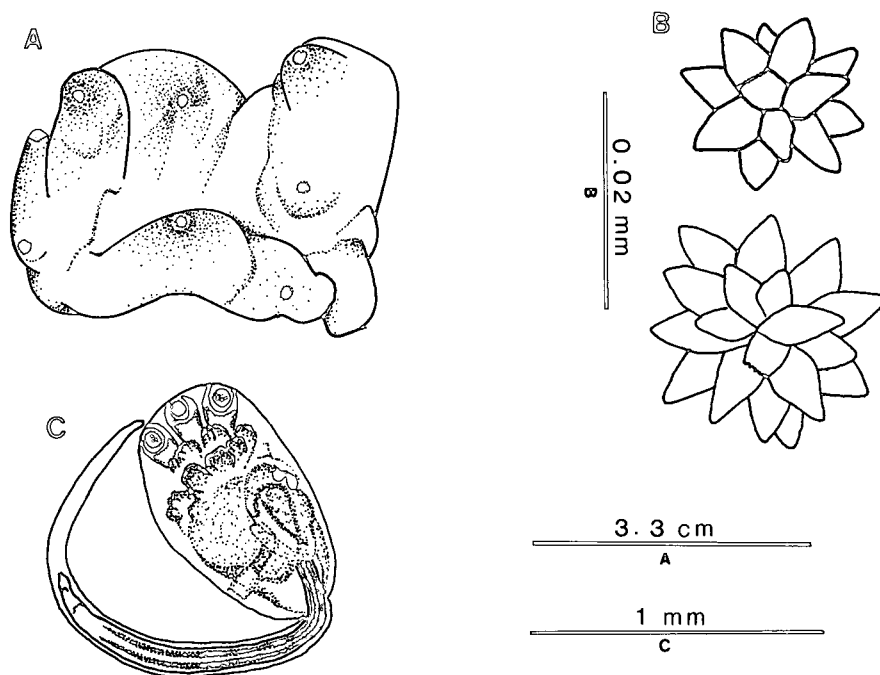


Fig. 2. *Trididemnum sauginii* (Herdman, 1886): A, a part of colony,  $\times 1.2$ ; B, calcareous spicules from the test,  $\times 160$ ; C, Larva from left side,  $\times 42$ .

Burmuda, west coast of Indo Islands, Philippines, Hawaii Islands, Mariana Islands, Palau Islands, and Africa.

Family Cionidae Lahille, 1886 유령멍게과

5. *Ciona intestinalis* (Linnaeus, 1767) 유령멍게 (Fig. 3)

*Ascidia intestinalis* Linnaeus, 1767, p. 225.

*Ciona intestinalis*: Trausted, 1886, p. 424; Hartmeyer, 1903, p. 297; Hartmeyer, 1906, p. 26; Van Name, 1912, p. 606, text-fig. 43, pl. 66, fig. 130; Alder and Hancock, 1912, p. 95; Michaelsen, 1919, p. 114; Årnbäck, 1923, p. 6; Oka, 1935, p. 464, fig. 35; Redikorzev, 1941, p. 206; Van Name, 1945, p. 160, text-fig. 79; Berrill, 1950, p. 131, fig. 40; Pérès, 1951, p. 1057; Årnbäck, 1952, p. 17; Millar, 1952, p. 23; Tokioka, 1953, p. 16; Tokioka, 1954, p. 82, pl. 6, fig. 10; Pérès, 1956, p. 296; Pérès, 1958a, p. 147; Pérès, 1958b, p. 495; Utinomi, 1962, p. 126, pl. 63, fig. 7; Tokioka, 1962, p. 171; Tokioka, 1963, p. 720; Tokioka, 1964, p. 173; Tokioka, 1966, p. 36, fig. 23; Rho, 1968, p. 89, fig. 1; Rho, 1971, p. 110; Hoshino and Nishikawa, 1985, p. 61, figs. 1-4; Kott, 1990, p. 21, fig. 3; Rho and Lee, 1991, p. 201.

*Ciona intestinalis* f. *typica*: Hartmeyer, 1924, p. 90; Årnbäck, 1933, p. 15, text-fig. 1.

*Ciona robusta* Hoshino and Tokioka, 1967, p. 275, figs. 1-6, 8, pl. 7.

**Material examined.** 62 inds., Chōpto, 23 Jul. 1994, Jun-Im Song; 115 inds., Kūmgap, 5 Nov. 1994, Rho, Lee and Won; 2 inds., Chōpto, 6 Nov. 1994, Rho, Lee and Won.

**Remarks.** The present specimens attached to the surface of oyster shells or root of sea weeds, they

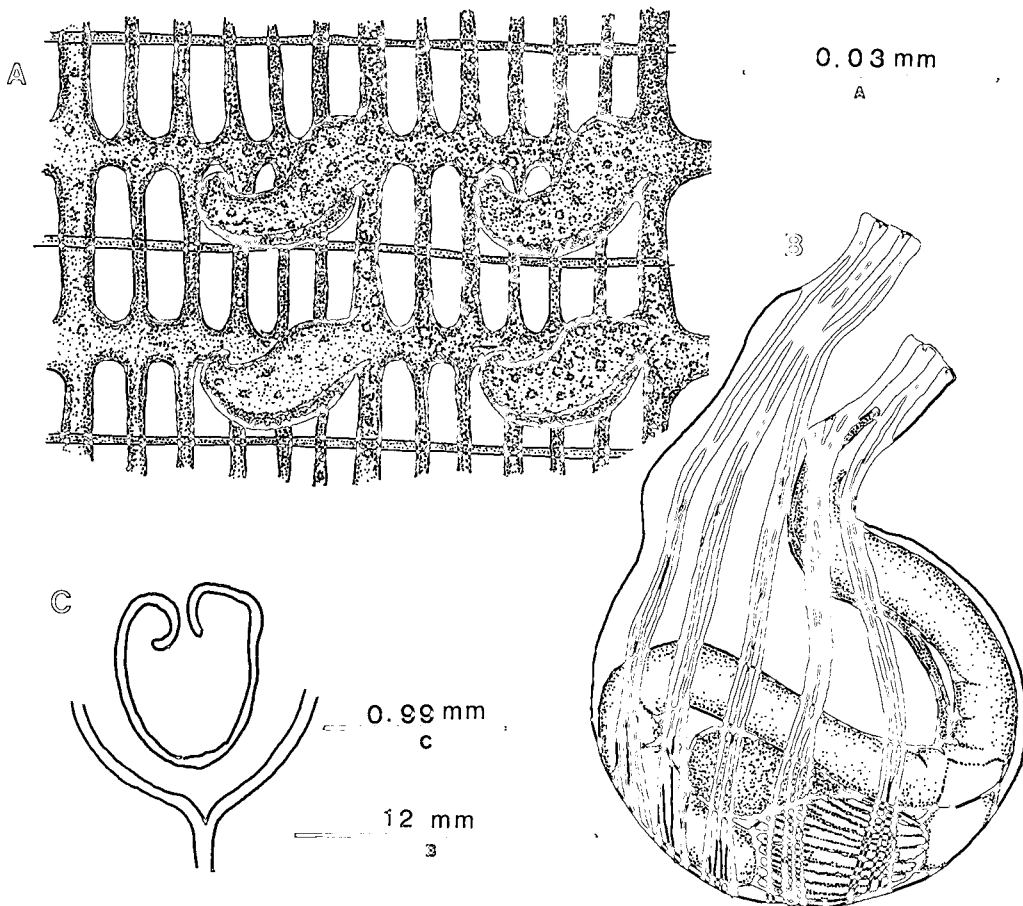


Fig. 3. *Ciona intestinalis* (Linnaeus, 1767): A, a part of branchial sac,  $\times 200$ ; B, mantle body of left side,  $\times 3.4$ ; C, ciliated groove,  $\times 25$ .

are all of small size, and many are young ones, the largest one measures 50 mm in long, and 20 mm in width, and the others measure hardly more than 30 mm in length and 10 mm in width. In most of the preserved material, the test and internal structures are usually found in a very soft and flabby condition and subject to distortion in shape.

The normal body is elongate oblong and generally somewhat tapering toward the anterior end. The branchial siphon is the longer and terminal with 8 lobes, and the atrial siphon is smaller and shorter with 6 lobes, and both siphones are 8 and 6 orifice with red or orange spots about its margin. Test in usually whitish yellow or colorless, soft and flexible, of varying thickness and more or less transparent. The mantle muscle bands on each side extending nearly the whole length of the body, and outside, there are numerous but very narrow circular muscle, and the both siphons are well developed, showing clearly with its five to seven broad, strong longitudinal, and branchial sac without folds, the inner longitudinal vessels are 22-25 per side, they bear long curved papillae at the intersection, and the transverse vessels are 50-130. Stigmata are narrow, increase in number with size of the individual, it varies from 6 to 8 or 5 to 10 in a mesh.

Tentacles simple, numerous and 25-45 with some regularity. Dorsal tubercles C-shaped, sometimes are different, and dorsal lamina well developed, replaced by a row of tentacle like languets. The oesophagus curves postero-dorsal corner of the pharynx, the stomach moderately small and short with a distinct longitudinal folds in its wall, intestinal loop small, and the rectum long.

The gonads are in the abdomen, testis follicles being minute tubules connected by vasa efferentia, the ovary a pear-shaped mass, situated the space in the intestinal loop, as well as the tubular male and female ducts which accompanies the rectum, and lying along its left dorsal side. Both gonoducts extend anterior to the anus, to open at the base of the atrial siphon. The tip of the gonoducts are swollen into small bulb with red in color which has 10 seperate minute openings on its upper side.

**Distribution.** Korea (East Sea, South Sea), Japan, South China Sea, Tasmania, Victoria, New South Wales, Spitsbergen, Bear Is., Norway, Sweden, Denmark, Netherlands, east coast of British Isles., Faeroe Islands, Greenland, West and South Africa, Indonesia, Arctic, Mediteranean, southern Alaska and Canada, North and South America, Australia, and New Zealand.

Family Ascidiidae Herdman, 1880 대추멍게과

6. *Ascidia sydneiensis divisa* (Sluiter, 1898) 갈래대추멍게

*Ascidia compta* Sluiter, 1898, p. 43, taf. 5, figs. 19-20, taf. 6, fig. 1.

*Ascidia canaliculata* Sluiter, 1898, p. 41, taf. 5, figs. 15-18.

*Ascidia divisa* Sluiter, 1904, p. 30, taf. 5, fig. 20.

*Ascidia sydneiensis divisa* Tokioka, 1953, p. 225, pl. 34, figs. 1-5; Tokioka, 1954, p. 84, pl. 6, fig. 17; Rho, 1970, p. 143, fig. 2; Rho, 1971, p. 111; Rho and Huh, 1984, p. 107; Rho and Lee, 1989, p. 66.

**Material examined.** 2 inds., Kümgap (oyster bed, 4m), 5 Nov. 1994, Rho, Lee and Won; one ind., Chöpto, 6 Nov. 1994, Rho, Lee and Won.

**Remarks.** The largest specimen attains 40 × 25 × 16 mm in extend from Kümgap specimens, the others are 35 × 20 × 8 mm. The body is moderately elongated and laterally compressed, the posterior end slightly rounded, and attached by the part of the left side. Test is cartilaginous, semitransparent, and the surface is irregularly wrinkled in larger specimen.

Mantle body is yellowish brown in color. Both siphons are moderate in length of which the branchial siphon is terminal with 6-7 lobed, the atrial ones situated approximately at the middle of the body with always 6 lobed. In base of the branchial siphon there are short longitudinal muscles, but most parts of right side of the body are provided with only transverse muscles, they are moderately long confined to area along the periphery of the body. On each side of the branchial sac the transverse vessels are 75-110 and inner longitudinal ones are 30-50 on each side, tentacles are 50-80 and ciliated groove is the complex with several pieces. Dorsal lamina ribbed, the tip of ribs is slightly beyond the plain margin.

The anterior end of the intestinal loop attains anteriorly the middle of the distance between both siphons. Anus situated on the level of the middle of the visceral mass and with 6-8 lobed margin, and the surface of alimentary canal covered densely with testicular follicles.

**Distribution.** Korea (East Sea, South Sea), Japan, tropical and subtropical waters of the world.



Family Botryllidae Verrill, 1871 판명계科

7. *Botryllus schlosseri* (Pallas, 1766) 스크로세르판명계 (Fig. 4)

*Alcyonium schlosseri* Pallas, 1766, p. 355.

*Botryllus schlosseri*: Van Name, 1910, p. 350, text-fig. 1, pl. 39, fig. 10; 1921, p. 398, fig. 73; Van Name, 1930, p. 477, figs. 46-47; Van Name, 1945, p. 220, fig. 131; Alder and Hancock, 1912, p. 54, pl. 61, figs. 1-2, text-figs. 116-121, 125a; Tokioka, 1953, p. 239, pl. XLIII, figs. 1-3; Rho, 1971, p. 114, pl. 2, figs. 5-6; Rho and Huh, 1984, p. 108; Kott, 1985, p. 267, fig. 130, pl. 5c; Rho and Lee, 1989, p. 67; Rho and Lee, 1991, p. 201; Nishikawa, 1991, p. 174.

Material examined. 4 colonies, Chŏpto, 23 July 1994, Jun-Im Song; 2 colonies, Kŭmgap, 5 Nov. 1994, Rho, Lee and Won; 1 colony, Chŏpto, 6 Nov. 1994, Rho, Lee and Won.

Remarks. The largest colony encrusting the seaweeds, 120 × 30 mm in extent and 3-5 mm in the

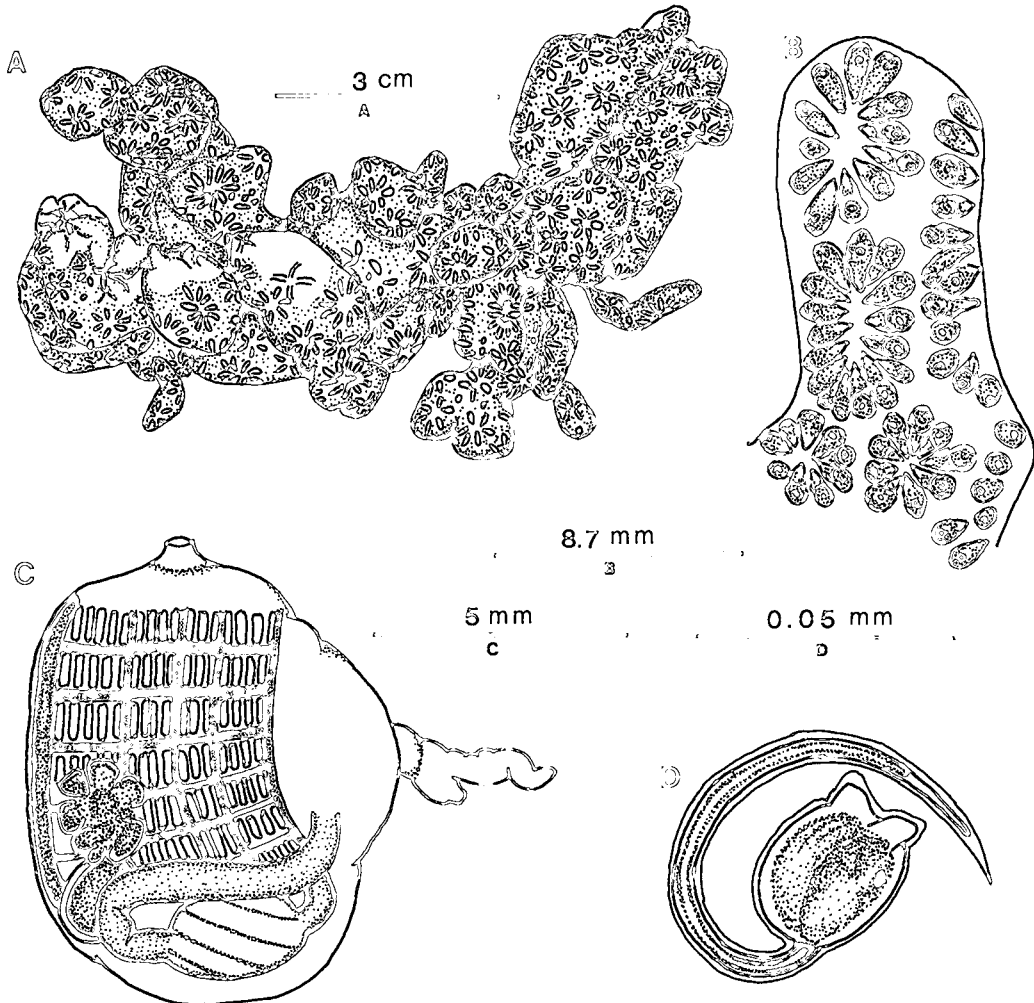


Fig. 4. *Botryllus schlosseri* (Pallas, 1766): A, colony, natural size; B, a part of colony, × 40; C, zooid from left side, × 7; D, larva from left side, × 800.

thickness, zooids are usually form the distinct stellate or slightly elongate systems, and composed of 9-15, and many whitish ampullae are seen between these systems, and forming irregularly lobed mass and small colonies which are 25 × 20 mm in extend and 1-2 mm in thickness, and composed of 5-12 zooids. The surface is smooth and free from any foreign matter. Test soft, gelatinous, transparent, and the common cloacal apertures are elongate or circular openings, and the living colonies are brownish-purple in color. Zooids reached 1-2.5 mm in length, and 1-1.5 mm in width, branchial aperture is terminal and atrial ones is considerably protruding on the posterior side with a short lanquet. The stigmatal rows are 6-8 or 9-10, usually 8, and the number of stigmata in a mesh is arranged as follows: D.4, 3, 4, 5 V. or D. 4-5, 4, 3, 4-5 V. Tentacles 8-9, and ciliated groove a small oval opening. The anterior margin of the intestinal loop reached the 7th transverse vessel and second ones very shallow and wide. Stomach globular, with 9-10 longitudinal plications and pyloric caecum prominent. Anus opens on the level of the 6-7th transverse rows.

Testis situated on the level of the 4-5th rows of stigmata on the left side and of the 6-7th rows of stigmata on the right side.

In the peribranchial cavity one or two embryos contained, anterior to the testis, and testicular follicles are five to seven lobes and with united at their bases into fan-shaped.

**Distribution.** Korea (East Sea, South Sea), Japan, Jiaozou Bay, Hong Kong, China, Australia, New Zealand, Indian coast of Africa, Chile, Atlantic coast of North America, Atlantic coast of Africa, Europe, Great Britain, Western France to Mediterranean, Adriatic and Black Sea.

**S. *Botryllus magnicoecum* (Hartmeyer, 1912) 붉은관멍게**

*Botrylloides nigrum* var. *magnicoecum* Hartmeyer, 1912, p. 271, pl. 41, fig. 11.

*Polycyclus rufus* Oka, 1927, p. 608.

*Botryllus rufus* Tokioka, 1953a, p. 240, pl. 2, fig. 5, pl. 43, figs. 4-7; Rho, 1966, p. 212, pl. 5, figs. 1-2.

*Botryllus magnicaecum*: Millar, 1955, p. 195, fig. 22; Millar, 1962, p. 175; Tokioka, 1967, p. 153, fig. 60; Rho, 1971, p. 114; Kott, 1985, p. 267, fig. 130, pl. Vc; Nishikawa, 1991, p. 75.

*Botryllus purpureus*: Kott, 1985, p. 267.

*Botrylloides magicoecus*: Kott, 1985, p. 276, fig. 134, pl. 6a-d.

**Material examined.** 4 colonies, Kŭmgap, 5 Nov. 1994, Rho, Lee and Won; 28 colonies, Chŏpto, 6 Nov. 1994, Rho, Lee and Won.

**Remarks.** The specimens encrusting the seaweeds or covered with *Ciona intestinalis* or *Styela plicata* or *Styela clava clava*. Test is soft, gelatinous, transparent and white, 1.5-4 mm in thickness and the colonies are dark purple or redish purple in colour. There are always round or elongated circular systems, and arranged 5 or 7-9 or 12 zooids and the largest ones composed of 20 zooids, and along the outside of these systems are seen the numerous whitish ampullae. Zooid attains 1-3 mm in long, with a long and wider lanquet in the wide atrial aperture. In the branchial sac 10-11 stigmatal rows on the left side and 11-12 stigmatal rows on the right side, stigmata arranged D. 4-5, 2-3, 2-3, 3-5 (or 4-5) V., and second row incomplete. Tentacles 10-11, stomach globular, short and wide, with 10 deep plications and has well developed the coecum. Anus opens on the level of 8th row of stigmata, with plain margin.

Testis located 8-10th row of stigmata on the left side and 10th row of stigmata on the right side,

and testicular follicles vary from 7 to 11 in number, and they are rosette formed.

**Distribution.** Korea (East Sea, South Sea), Japan, Hong Kong, Truk and Majuro, Australia, New Zealand, Indian Ocean, East, South and SW Africa.

9. *Botrylloides violaceus* Oka, 1927 보라관명게

*Botrylloides violaceum* Oka, 1927, p.608

*Botrylloides violaceum*: Tokioka, 1949, p. 7, pl. 3. figs. 5-6; Tokioka, 1951, p. 193; Tokioka, 1953, p. 241, pl. 3. figs. 1-2, pl. 44, figs. 1-5, pl. 45, figs. 1-4; Tokioka, 1954, p. 84; Tokioka, 1959, p. 227.

*Botrylloides violaceus*: Tokioka, 1967, p. 158, figs. 63; Rho, 1971, p. 115, pl. 4, fig. 1; Rho, 1975, p. 134, Rho and Huh, 1984, p. 108; Kott, 1985, p. 279, fig. 136; Rho and Lee, 1989, p. 67; Rho and Lee, 1991, p. 201; Nishikawa, 1991, p. 77.

**Material examined.** 8 colonies, Kŭmgap, 5 Nov. 1994, Rho, Lee and Won, (Nogjin, 4 Aug. 1974).

**Remarks.** The colony encrusting the seaweeds, or covered with the oyster shells, 50 × 25 mm in extend and 1-3 mm in thickness, and the system composed of 5-9 zooids, and the largest ones composed of 25 or 30, and the numerous purple ampullae are seen between these systems, and the living colonies are dark purple in colour, test rather soft, transparent and white.

Zooid is reddish purple or dark purple or yellowish brown in colour, attains 1.5 mm-2 mm in length, and 0.8 mm in width, and the branchial aperture is terminal and the atrial ones is very wide languet, exposing a large part of the branchial sac. In the branchial sac, 9-10 rows of stigmata on the left, and 10-11 rows of stigma on the right, and stigmata have no more than 13 in a row, and second row does not reach median line. Tentacles 6, and stomach with 9-10 plications and pyloric caecum is small and prominent.

Testicular follicles vary from 7 to 15 in number and ovary situated on testis, and always contains one egg.

**Distribution.** Korea (East Sea, South Sea: Yellow Sea); Japan; China, Truk and Majuro; Australia; New Zealand; India; East, South and SW Africa.

Family Styelidae Sluiter, 1895 미더덕과

10. *Symplegma connectans* Tokioka, 1949 새공명게 (Fig. 5)

*Symplegma connectans* Tokioka, 1949, p. 51, fig. 8; Tokioka, 1967a, p. 165; Rho and Huh, 1984, p. 108, pl.13, figs. 1-4; Rho and Lee, 1989, p. 68; Rho and Lee, 1991, p. 202.

**Material examined.** 22 colonies, Kŭmgap (oyster bed, 4 m), 5 Nov. 1994, Rho, Lee and Won; 1 colony, Chŭpto, 6 Nov. 1994, Rho, Lee and Won.

**Remarks.** The colony covered with *Styela plicata* or *Styela clava clava*, 50 × 30 mm in extend, and 1-2 mm in thickness. Test thin, transparent, very tough, and colorless. Zooid compressed dorsoventrally, attains 1-2 mm in length and 1 mm in width, branchial aperture subterminal, atrial ones situated near the middle of body, and both apertures are round, and bright orange in colour. Tentacles 14, the larger and smaller ones alternating, and ciliated groove an oval slit. Inner longitudinal vessels are four on each side, 8-11 rows of stigmata on dorsal side, stigmata arranged as D.7-6, 5, 5, 4, 5, V. Stomach globular, with 14 plications, and pyloric caecum indiscernible, and a vessel connects inner pyloric corner of stomach with intestine. The anterior end of the intestinal loop

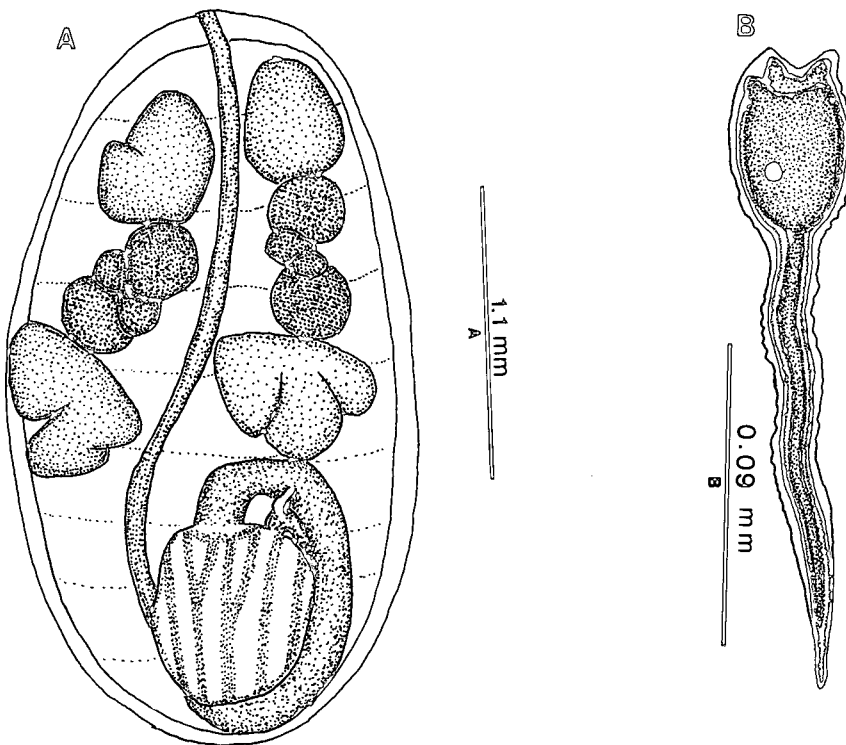


Fig. 5. *Symplegma connectans* Tokioka, 1949: A, zooid from ventral side,  $\times 370$ ; B, larva from right side,  $\times 470$ .

reaches the 6<sup>th</sup> row or middle of the body, and the tip of anus is two lobed.

A pair of gonads are well developed in the anterior one third to a half of the body, they composed of 1-3 testicular lobes, and ovary reddish yellow in color, containing at most 1-4 eggs, up to  $400 \mu\text{m}$  in diameter, and there are lots of tadpole larva in the peribranchial cavity.

Trunk of larva 1.8-2.2 mm in length, provided with a stretched tail, tail approximately 1.3 mm in length, up to 5 mm, and  $200\text{-}250 \mu\text{m}$  in width, three attachment processes are placed in a triangle, pigment fleck of sensory organ located near the middle of body, and the body organization is not yet completed even in well developed larvae.

Distribution. Korea (East Sea, South Sea) and Japan.

#### 11. *Styela partita* (Stimpson, 1852) 두줄미더덕

*Cynthia partita* Stimpson, 1852, p. 231.

*Styela partita*: Berrill, 1932, p. 78; Oka, 1934, p. 184, text-figs. A and B; Van Name, 1945, p. 290, text-fig. 188; P r s, 1951, p. 1066; Tokioka, 1951, p. 175, text-fig. 5; Tokioka, 1953, p. 262, pl. 60, figs. 1-4; Tokioka, 1954, p. 88, pl. 7, figs. 19-20; Tokioka, 1960, p. 213, pl. 28, figs. 23-26; Tokioka, 1961, p. 128, text-fig. 13; Tokioka, 1962, p. 17, pl. 3, figs. 33-35; Miller, 1960, p. 115, text-fig. 44; Rho, 1975, p.139, pl. 7, figs. 1-4; Rho and Lee, 1989, p. 71; Rho and Lee, 1991, p. 204.

*Styela atlantica*: Rho and Huh, 1984, p. 110, pl. 15, figs. 1-4.

**Material examined.** 32 inds., Chōpto, 23 Jul. 1994, Jun-Im Song; 2 inds., Kūmgap (oyster bed, 4 m), 5 Nov. 1994, Rho, Lee and Won, (Chōpto, 6 Aug. 1974).

**Remarks.** The specimen is dark brown or brownish yellow in colour, attains 8-15 mm in high, and 7-17 mm in wide, 4-10 mm in thickness, and attached to the substratum by the ventral side. Both siphons are moderately long, distinct, situated dorsal side and both apertures four lobed with red and white lines. Test leathery, thin, quite opaque, and strong in texture. Mantle is thin yellowish white in color. Branchial sac with four folds and inner longitudinal vessels are arranged as follows:

15 mm long individual: Left	D.	2(15)	5(12)	4(14)	4(13)	2	E.	
(Chōpto)	Right	D.	4(14)	4(14)	4(15)	4(11)	2	E.
14 mm long individual: Left	D.	2(15)	3(9)	3(10)	3(7)	2	E.	
(Kūmgap)	Right	D.	3(10)	4(11)	2(12)	2(6)	2	E.

About 2 or 3 thinner transverse vessels between a pair of thicker ones. Parastigmatic rows present, and about 5-9 stigmata in a mesh. Tentacles 27-41, composed minute ones. Dorsal lamina is membranous and ciliated groove simple and C-shaped. Stomach is elongate, and with plications, the second intestinal loop very wide and anus margin is lobated.

Gonads two on each side, they are elongated, sinuously curved ovary, and testes vary in shape, with several irregular branches, their ducts run to the ovary, and they unite to form the common spermduct.

**Distribution.** Korea (East Sea, South Sea), Japan, eastern coast of North America, Europe, Adriatic, Sea of Marmora, Northwest Africa, and West Australia.

## 12. *Styela plicata* (Lesueur, 1823) 주름미더덕

*Ascidia plicata* Lesueur, 1823, pl. 3, fig. b.

*Styela plicata*: Trausted, 1882, p. 123, pl. 5, fig. 6, pl. 6, fig. 16; Huntsman, 1912, p. 149; Huntsman, 1913, p. 489, fig. 13; Van Name, 1912, p. 435, figs. 102-105; Van Name, 1921, p. 435, figs. 102-105; Van Name, 1930, p. 492, figs. 58-59; Van Name, 1945, p. 295, pl. 12, figs. 1-3, text-figs. 192-194; Michaelsen, 1918, p. 36; Harant, 1927a, p. 243; Harant, 1927b, p. 7; Harant and Vernieres, 1933, p. 31, fig. 46; Oka, 1935, p. 447; P r s, 1951, p. 1065; Tokioka, 1953, p. 267, pl. 63, figs. 1-4; Tokioka, 1954, p. 89, pl. 8, fig. 21; Tokioka, 1960, p. 212, pl. 28, figs. 21-22; Abbott and Johnson, 1972, p. 96, fig. 2, fig. 8c; Kott, 1972b, p. 185; Kott, 1972c, p. 239; Kott, 1972d, p. 254; Tokioka and Nishikawa, 1975, p. 338; Kott and Goodbody, 1980, p. 537; Kott, 1985, p. 116, figs. 50a, 51, pl. 2h; Rho and Lee, 1991, p. 203, fig. 4; Nishikawa, 1991, p. 113.

*Tethyum plicatum*: Hartmeyer, 1909, p. 1359; Van Name, 1912, p. 569, fig. 36, pl. 62, figs. 104-105, pl. 63, fig. 108, pl. 68, fig. 136.

*Styela gyrosa*: Herdman, 1882, p. 155.

*Styela pinguis*: Herdman, 1899, p. 40.

**Material examined.** 2 inds., Chōpto, 23 July 1994, Jun-Im Song; 3 inds., Kunp'o, 25 July 1994, Jun-Im Song; 193 inds. (oyster bed, 4 m), Kūmgap, 5 Nov. 1994, Rho, Lee and Won; 38 inds., Chōpto, 6 Nov. 1994, Rho, Lee and Won.

**Remarks.** The largest specimen is  $55 \times 30 \times 8$  mm in extend, the smallest one  $15 \times 10 \times 7$  mm, and attached to the oyster shells by the posterior end. Body moderately oval or rounded, some specimens are strongly compressed laterally, the branchial siphon terminal, and the atrial ones at the one third of the body length from the anterior end of body, and both siphons 4 lobed with alternately arranged as four purplish brown lines and whitish lines.

Test is leathery, 1-2 mm in thickness, numerous plications on the surface, and it is milky white or brownish gray in colour. The inner longitudinal vessels are as follows:

15 mm individual:	Left	D.	3(14)	3(11)	2(12)	2(10)	2	E.
	Right	D.	5(12)	3(10)	3(11)	3(9)	3	E.
23 mm individual:	Left	D.	3(13)	4(14)	3(13)	2(11)	2	E.
	Right	D.	3(15)	5(10)	3(15)	4(11)	3	E.
30 mm individual:	Left	D.	4(17)	4(15)	3(16)	3(14)	2	E.
	Right	D.	4(17)	5(16)	4(17)	3(14)	3	E.
35 mm individual:	Left	D.	4(16)	4(17)	4(16)	4(12)	3	E.
	Right	D.	4(19)	4(18)	4(18)	4(13)	3	E.
45 mm individual:	Left	D.	4(19)	8(20)	6(21)	4(28)	4	E.
	Right	D.	5(20)	8(21)	5(20)	4(17)	4	E.
55 mm individual:	Left	D.	4(24)	5(19)	5(22)	5(19)	3	E.
	Right	D.	5(22)	5(21)	5(21)	5(16)	5	E.

Three to four or six to seven thinner vessels between a pair of the thicker ones. Parastigmatic vessels present, seven to nine or seven to 12 elongated stigmata in a mesh. Tentacles 36 to 60 including large and small ones, ciliated groove U-shaped, and with anterior ends slightly curled in, and dorsal lamina is membranous. Oesophagus very long, stomach elongate, and composed up to 40 plications on the surface, and many endocarps on the wall of the intestine. Anal margin is 10 to 14 lobed.

Gonads long, and well developed, two to three on the left side and 5-7 on the right side, many testicular follicles arranged along the lateral margin of each gonad. The vasa deferentia open near the opening of oviduct at the anterior end.

**Distribution.** Korea (South Sea), Japan, Hong Kong, warm region of Pacific, eastern coast of America, Australia, Indian Ocean, Atlantic Ocean, and Mediterranean Sea.

### 13. *Styela clava clava* Herdman, 1881, 미더덕

*Styela clava* Herman, 1881, p. 70.

*Styela clava*: Drasche, 1884, p. 379, taf. 6, fig. 9-11; Herdman, 1891, p. 581; Hartmeyer, 1906, p. 158; Oka, 1935, p. 444, text-fig. 14; Kamita and Sato, 1941, p. 1; Tokioka, 1951, p. 180, pl. 11, figs. 6 and 6; Tokioka, 1953, p. 270, pl. 64, figs. 6-9, text-fig. 19; Tokioka, 1954, p. 90; Tokioka, 1959, p. 231; Tokioka, 1960, p. 202; Tokioka, 1967a, p. 190, fig. 82; Millar, 1960, p. 509, fig. 1; Millar, 1975, p. 302, fig. 81a; Monniot, 1970, p. 151, fig. 3; Rho, 1971, p. 119, pl. 6, figs. 1-4; Abbott and Johnson, 1972, p. 103, fig. 8A; Rho, 1975, p. 140; Nishikawa, 1980, p. 101, Tab. 1; Rho and Huh, 1984, p. 109; Kott, 1985, p. 115, fig. 49; Rho and Lee, 1988, p. 70; Rho and Lee, 1991, p. 202; Nishikawa, 1991, p. 114.

**Material examined.** 20 inds., Chöpto, 23 Nov. 1994, Jun-Im Song; 5 inds., Kulp'o, 25 Nov. 1994, *ibid*; 1 ind., Haedong, 25 Nov. 1994, *ibid*; 122 inds., Kümgap, 5 Nov. 1994, Rho, Lee and Won; 2 inds., Chöpto, 6 July 1994, *ibid*, (Gasado, 6 Aug. 1974).

**Remarks.** The largest specimen is 110 × 28 × 18 mm in extent including the peduncle. Both siphons are 4-lobed and situated terminal. Test leathery, thin but tough, mantle is very delicate, and yellowish white or yellowish brown in color. The inner longitudinal vessels arranged as follows:

110 mm individual:	Left	D.	4(33)	5(30)	6(29)	4(18)	3	E.
	Right	D.	8(28)	5(30)	5(30)	6(23)	3	E.
50 mm individual:	Left	D.	3(21)	4(19)	3(21)	3(15)	1	E.
	Right	D.	5(22)	3(23)	4(20)	5(15)	3	E.
45 mm individual:	Left	D.	4(20)	4(17)	4(19)	4(13)	2	E.
	Right	D.	5(23)	4(18)	4(19)	5(11)	3	E.

Six to 12 thinner vessels between a pair of the thicker ones. Parastigmatic vessels present, five to seven or seven to ten elongate stigmata in a mesh, 13 stigmata in a mesh along the endostyle. Tentacles 20-40, ciliated groove U-shaped, and with anterior ends curled in. Dorsal lamina is plain. Stomach with 30-35 longitudinal plications on the surface.

The number of gonads is very variable from 2 to 4 on the left and from 6 to 7 on the right. Most the gonads are more numerous on the right than on the left side. Testicular follicles arranged along each side of ovaries.

**Distribution.** Korea (East Sea, South Sea, Yellow Sea), Japan, Bering Sea, Okhotsk Sea, China, Australia, Californian coast, Europe, northern coast of France, Netherland, and Denmark.

#### Family Pyuridae Hartmeyer, 1908

##### 14. *Pyura lepidoderma* Tokioka, 1949 비늘가죽멍게

*Pyura lepidoderma* Tokioka, 1949, p. 10, pl. 5, figs. 1-3; Tokioka, 1953, p. 19, fig. 12; Tokioka, 1954, p. 91, fig. 5; Tokioka, 1954, p. 19, fig. 12; Tokioka, 1960, p. 215; Tokioka, 1967a, p. 198, fig. 87; Kott, 1966, p. 299; Rho, 1971, p. 121, pl. 7, figs. 1-4; Rho, 1975, p. 144; Rho and Huh, 1984, p. 110; Nishikawa, 1991, p. 132, fig. 33.

**Material examined.** one individual, Haedong, 5 Nov. 1994, Rho, Lee and Won.

**Remarks.** The specimen is small an elliptical, 20 × 10 mm in extend and 6 mm in thickness, and attached to the substratum by the wide left side and posterior end of the body. Test moderately thick, tough, and yellowish white in color, and surface divided into many scale-like polygonal areas which exceeded only surface fixed to substrate. Brachial aperture subterminal at the anterior end of the body, and atrial ones subterminal at the posterior end. The inner longitudinal vessels arranged as follows:

Left	D.	2(12)	2(8)	2(13)	2(13)	2(11)	1(5)	2	E.
Right	D.	2(9)	2(8)	2(13)	2(13)	2(12)	1(6)	2	E.

Three to four stigmata in a mesh, and seven to eight stigmata in a mesh along the endostyle, and parastigmatic vessels present. Tentacles 28, including small ones, and fine atrial tentacles arranged about 23. Ciliated groove simple, a long slit with posterior end bent to left and dorsal lamina a series of lanquets. Anus plain margin.

Single long gonad on each side of the body, the left gonad consisting of 22 genital capsules, while the right ones of 20 capsules, and ovary situated the side of attachment of each capsules.

**Distribution.** Korea (South Sea), Japan, and northern Australia.

15. *Pyura vittata* (Stimpson, 1852) 끈멍게

*Cynthia vittata* Stimpson, 1852, p. 231; Oka, 1935, p. 439.

*Pyura vittata*: Oka, 1932, p. 259; Van Name, 1945, p. 321, pl. 16, fig. 5; Pérès, 1948, p. 93; Pérès, 1951, p. 1060; Tokioka, 1953, p. 136, pl. figs. 3-4, pl. 66, figs. 1-5; Tokioka, 1960, p. 213, pl. 28, figs. 27-34, pl. 29, figs. 35-37; Tokioka, 1967a, p. 202, fig. 90; Millar, 1960, p. 126; Kott, 1964, p. 142; Kott, 1966, p. 300; Kott, 1972, p. 37; Rho, 1967, p. 367, fig. 3; Rho, 1968, p. 97; Rho, 1971, p. 121; Rho, 1975, p. 143; Rho and Huh, 1984, p. 110; Rho and Lee, 1989, p. 71; 1991, p. 205; Nishikawa, 1991, p. 129.

**Material examined.** None, (Chōpto, 6 Aug., 1974).

**Remarks.** This species has been collected by the author from Chōpto (= Jupdo) in 1974 and already reported by the author (Rho, 1975).

16. *Boltenia transversaria* (Sluiter, 1904) 가로줄멍게

*Halocynthia transversaria* Sluiter, 1904, p. 48, taf. 11, figs. 1-4.

*Boltenia transversaria*: Tokioka, 1960, p. 217, pl. 29, fig. 44, pl. 30, figs. 48-52; Rho, 1975, p. 149, pl. 10, figs. 6-9.

**Material examined.** None, (Chōpto, 6 Aug. 1974).

**Remarks.** This species have been collected by the author from Chōpto (= Jupdo) in 1974, and already reported by the author (Rho, 1975).

## DISCUSSION

The present study on the classification of the Chindo Islands ascidians was conducted by collecting a total 106 colonies and 612 individuals from 5 area (Haedong, Kunp'o, Kūmgap, Chōpto and Pojōn) during he period from July to November, 1994 and including the previous records (four areas: Chōpto, Gahag, Gasado and Nogjin, in 1974).

A total 718 specimens of ascidians were classified into 2 orders, 3 suborders, 7 families, 11 genera and 16 species and 9 species were newly added species in the present work. And the compound ascidians are 8 species and the others are all the solitary forms.

The following table shows the water forms and the ascidian species found in Chindo Islands waters which belong to each water form. From this table it is clear that lots of Chindo Island ascidian species are temperate water form, and the temperate-tropical species are more abundant than the tropical species. It is interesting that the boreal and the boreal-temperate species were not found, but one tropical species are found from Chindo Islands waters. This is quite reasonable because Chindo Islands waters are influenced by the branch of Kuroshio Warm Current.



Table 1. Water forms and the species of Chindo Islands ascidians.

Water forms	Species	Total no. of species	Percent (%)
Temperate water form	<i>Amaroucium pliciferum</i> ; <i>Ciona intestinalis</i> ; <i>Botryllus schrosseri</i> ; <i>Botrylloides magnicoecum</i> ; <i>Botrylloides violaceus</i> ; <i>Symplegma connectans</i> ; <i>Styela plicata</i> ; <i>Pyura lepidoderma</i>	8	50
Temperate-tropical water form	<i>Didemnum (Didemnum) moseleyi</i> ; <i>Ascidia sydneyensis divisa</i> ; <i>Styela partita</i> ; <i>Styela clava clava</i> ; <i>Pyura vittata</i> ; <i>Boltenia transversaria</i>	7	44
Tropical water form	<i>Amaroucium multiplicatum</i>	1	6

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## 珍島産 海鞘類(Ascidians)의 分類

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### 요 약

진도산 해초류의 분류학적 연구를 위하여 1994년 7월과 11월에 진도의 5개 지역(접도, 보전, 군포, 해동, 금갑)에서 채집된 재료들을 정리한 결과 13종과 1974년 8월에 진도의 4개 지역(가학, 녹진, 접도, 가사도)에서 채집하여 이미 보고된 7종을 합하면 모두 7과 11속 16종이다. 이들 모두는 한국산 해초류에 보고된 종들이나 이 중 7과 9종은 진도산 해초류로서 처음 밝혀지는 종들이다. 이들 16종에 대한 수성별 구성은 온수역종이 8종(50%), 그 다음이 온-열대수역종으로서 7종(44%), 열대수역종은 1종(6%)이었다. 그러나 한수역 및 한-온수역종은 전연 나타나지 않았다. 이러한 사실은 진도가 우리나라 황해 남단에 위치하고 있어 남쪽에서 올라오는 쿠로시오난류의 지류에 영향 받는다는 사실과 부합한다.