CONTRIBUTIONS TO THE JAPANESE ASCIDIAN FAUNA XXVII. SOME ASCIDIANS FROM OKINAWA, WITH NOTES ON A SMALL COLLECTION FROM HONG KONG[1)]

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With Text-figures 1–40

The ascidian fauna of the waters of Okinawa Prefecture has been left nearly intact, though it is expected that many tropical species inhabiting the waters of the Philippines and Malay Archipelagoes are distributed there. The area may be interesting, too, from the distributional point of view of those species seemingly endemic to the Japanese and adjacent waters. In this paper, the following seven species are recorded from the waters of Okinawa.

Pseudodistoma kanoko n. sp.
Didemnum (*Didemnum*) *ternatanum* (Gottschaldt)
Clavelina cyclus n. sp.
Eudistoma glaucus (Sluiter)
Corella japonica Herdman
Botrylloides violaceus marginatus Tokioka
Pyura curvigona Tokioka

Of these, *Clavelina*, *Corella* and *Pyura* were collected by the last author himself, while other five were photographed (*Didemnum* and *Botrylloides*) or collected (*Pseudodistoma*, *Eudistoma* and *Clavelina*) by Mr. Shohei Shirai and submitted to the first author for identification.

A small material collected by Dr. Vrijmoed from Hong Kong and including the following four species was sent by Dr. Shizuo Mawatari, a fellow researcher of the National Science Museum, Tokyo, to the first author for identification.

Diplosoma mitsukurii Oka
Symplegma viride Herdman
Styela partita (Stimpson)
Styela plicata (Lesueur)

The authors wish to express their hearty thanks to Mr. Shirai and Dr. Mawatari

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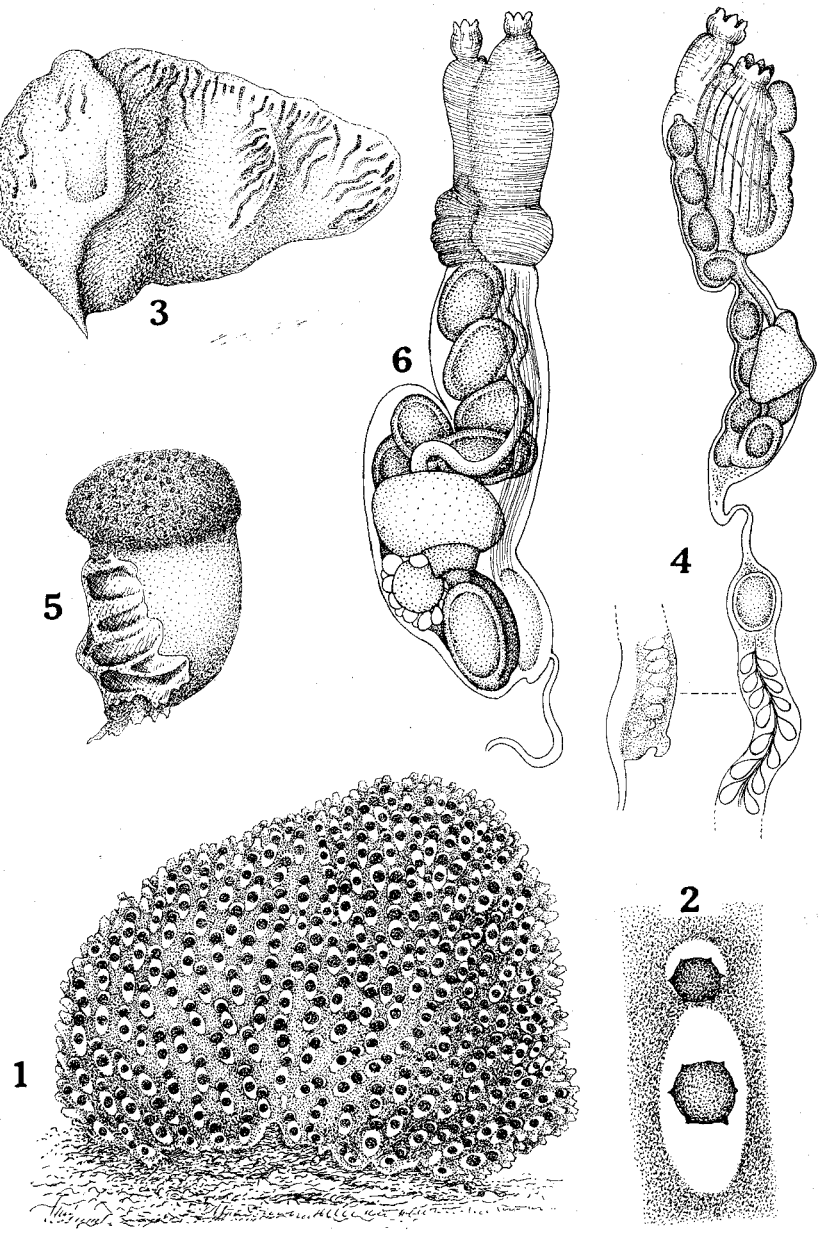
for the privilege to examine those interesting specimens. Further, the last author would like to thank Mr. Kiyoshi Kakazu, the director of the Yaeyama Branch of the Fisheries Experimental Station of Okinawa Prefecture, and other members of the station for facility for accomodations and helpful advices and also Dr. Moritaka Nishihira of the Ryukyu University for his kindness in showing actual localities of various ascidians and giving many precious advices.

1. *Pseudodistoma kanoko* n. sp.

(Figs. 1–4)

Two massive colonies collected by Mr. S. Shirai at Tinen, Okinawa; the holotype (Fig. 3) is 31 mm long, 20 mm high and 13 mm thick, while the other is 35 mm long, 23 mm high and 23 mm thick. The test is gelatinous, of a considerable hardness and translucent, with a faintly brownish tint. The surface is completely free from any foreign matters and deep reddish orange zooids distributed irregularly are seen through the test. All zooids are open directly on the upper colony surface, this feature can be seen distinctly on the photograph of a living colony, which is reproduced in Fig. 1. The colony is bright red as a whole, but with a number of small white patches distributed all over the surface. Each white patch consists of two parts: a larger elliptical part and a much smaller crescent part. The former corresponds to the anterior side of the branchial sac (elongate dorso-ventrally), surrounding the branchial aperture, while the latter embraces the dorsal side of the atrial aperture which is a little smaller than the branchial (Fig. 2). No distinct systems can be seen in the arrangement of zooids in preserved colonies. In live colonies, however, a number of vertical linear rows are definable roughly as seen in Fig. 1. Thus, the colour pattern of a live colony reminds us of a cloth piece of "kanoko-zome" that means a Japanese dyeing pattern consisting of a number of white spots on the ground colour of red.

Zooids are generally 8–10 mm long in a contracted state; the abdomen is 1–2 mm, the thorax usually as long as or one and a half times the abdomen, though rarely shorter than the latter, and the postabdomen may attain about 4 mm at the maximum. A thin neck zone of a considerable length may be seen between the abdomen and postabdomen in some zooids. The thorax, abdomen and the mature egg at the proximal end of the postabdomen are coloured deep reddish orange, while the most part of the postabdomen occupied by testicular follicles is yellowish. Both apertures are 6-lobed, the branchial aperture is usually retracted more posteriorly than the atrial in the contracted state. Weak longitudinal muscles on each side of the thorax. About 15 tentacles, and about 10 stigmata in each of three rows (on one side); the anus opening at the level of the second transverse vessel. The stomach with a smooth surface is situated with its pyloric end at the middle of the abdomen; the hind-stomach is defined but not so distinctly, the middle intestine passes to the rectum probably at the posterior end of the abdomen. Small testicular follicles are arranged in two



Figs. 1–6. *Pseudodistoma kanoko* n. sp. (1–4): 1—A living colony. 2—Pattern of pigmentation around branchial (below) and atrial (above) apertures. 3—Holotype colony. 4—Zooid, right side. *Eudistoma glaucus* (Sluiter) (5, 6): 5—Specimen No. 1. 6—Zooid, right side.

rows, generally a single mature egg is found at the anterior end of the testis.

Remarks: Of the two species of *Pseudodistoma* known so far from the Japanese waters, *P. fragilis* Tokioka, 1958 differs clearly from the present form in the structure of both the test and zooids. Zooids of *P. antinboja* Tokioka, 1949 resemble somewhat those of the colonies here described, but the stomach is situated clearly in the posterior half and near the posterior end of the abdomen in the former. Moreover, they seem to be considerably larger, attaining 30 mm in length; this is due to their much longer postabdomen occupying 4/5 to 5/6 of the whole body length and evidently related to the shape of the colony that consists of a few to several cormidia each constructed of a remarkable corona and the peduncle of a considerable length. These differences seem to justify the establishment of a new species for the present specimens, which is named *kanoko* by the authors after its colour pattern of live colonies.

2. *Didemnum* (*Didemnum*) *ternatanum* (Gottschaldt, 1898)

This is one of the species which are identifiable exactly on photographs in natural colour. Colonies are roughly conical in shape, with a large round common cloacal aperture at the apex. The colony is whitish, dotted with branchial apertures of zooids, but faintly coloured grayish or brownish near the foot. The inside seen through the common cloacal aperture is deep green. This didemnid of a strange colony shape is distributed widely in the western tropical Pacific, and Okinawa Island is so far the northern-most locality. There, it is rather common in the coral reef areas.

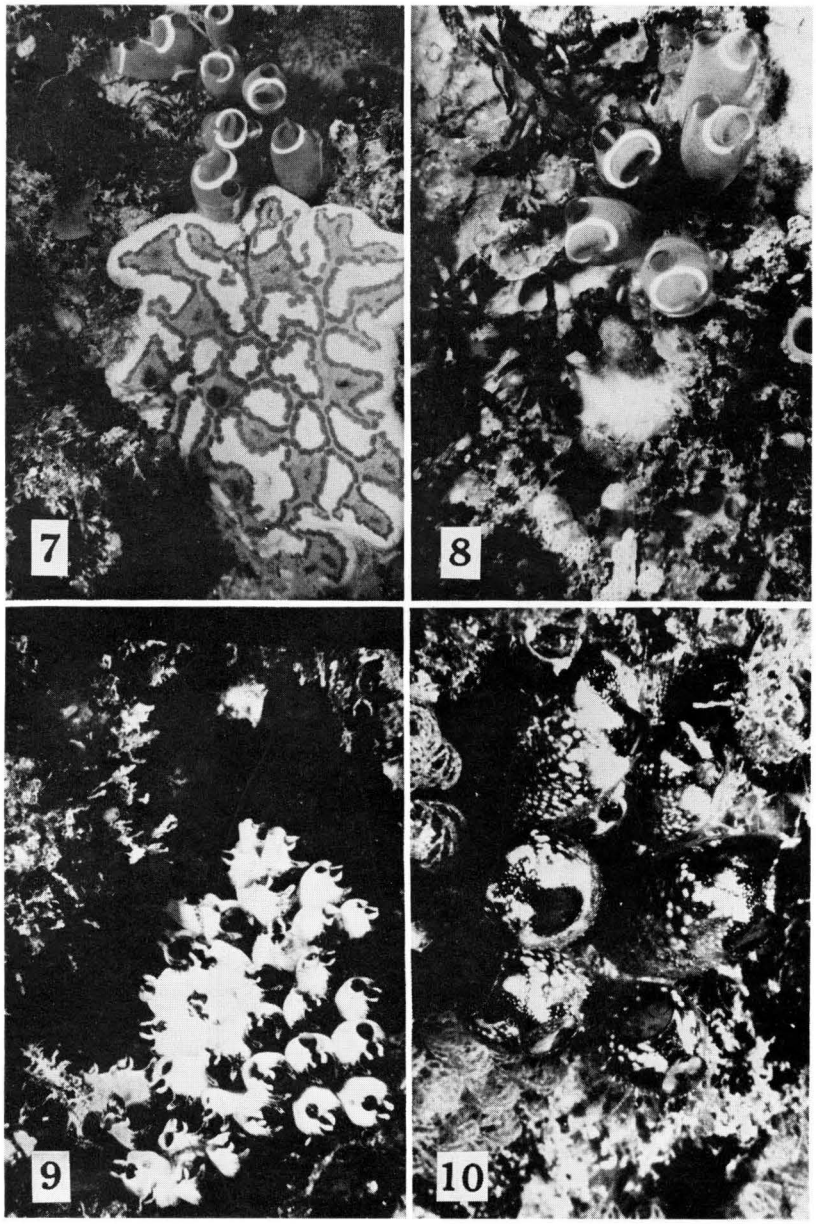
3. *Diplosoma mitsukurii* Oka, 1892

A small colony piece of this species was found covering a 10 mm long specimen of *Styela partita*, collected from Hong Kong.

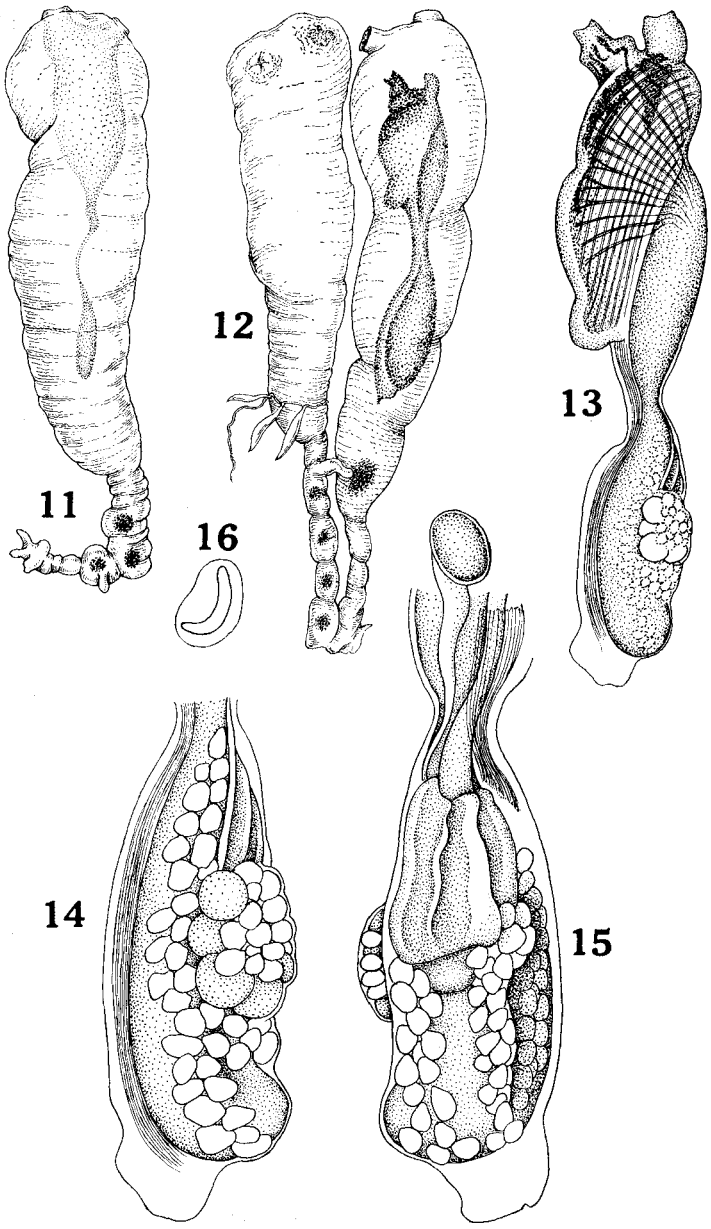
4. *Clavelina cyclus* n. sp.

(Figs. 7–20)

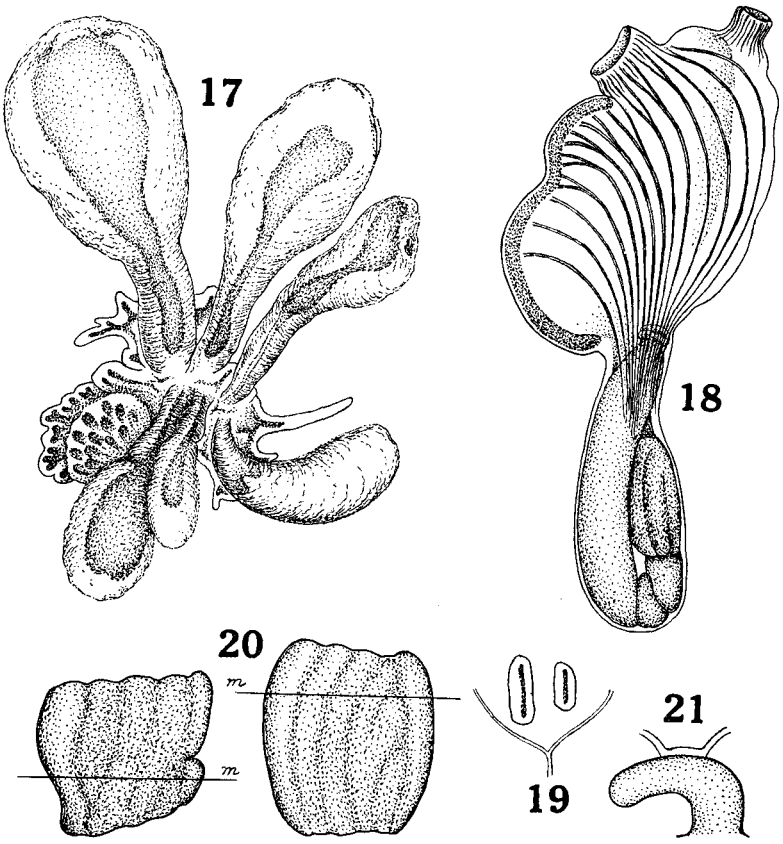
Four individuals were collected by Mr. Shirai at Tinen, Okinawa in 1975 and preserved in formalin, but two of them were emptied. Two individuals are isolated, while the other two, empty and solid ones, are found in close contact with each other at the proximal end of zooids; the solid individual of the latter is designated as the holotype. In these, the mantle body consists of strongly contracted thorax and much less contracted abdomen with matured gonad. These specimens are seemingly in the reproductive phase. In addition, there is a colony collected by the last author at Kabira, Okinawa on June 24, 1975, which consists of 6 zooids, 2 empty and 4 solid ones. Zooids are up to 20 mm in length, all attached to a common basement test issuing a number of purplish stolon buds from the periphery; and their mantle



Figs. 7–10. *Clavelina cyclus* n. sp. 7, 8—Individuals of typical colour pattern, a large colony of *Botrylloides violaceus marginatus* Tokioka is shown below in 7. 9—Individuals with white pigmentation covering the whole anterior half of branchial sac. 10—Individuals with many small white pigment patches over the same body part.



Figs. 11–16. *Clavelina cyclus* n. sp. 11—Holotype. 12—Another individual. 13—Holotype zooid, left side. 14—Abdomen of the same zooid, left side. 15—The same, right side. 16—Ciliated groove.



Figs. 17–21. *Clavelina cyclus* n. sp. (17–20): 17—Paratype colony. 18—Zooid from paratype colony, left side. 19—Unusual ciliated groove. 20—Surface of strongly contracted stomachs, *m* showing the middle level of abdomen. *Symplegma viride* Herdman (21): Pyloric coecum.

body consists of the thorax in a rather extended state and strongly contracted abdomen with only the rudimentary gonad. This colony evidently in the vegetative phase is designated as the paratype.

Zooids in the reproductive phase are 24 to 26 mm long, club-shaped, and provided with the peduncle 5 to 8 mm in length. The body proper is gently narrowed posteriorly and continues to the much thinner peduncle that bears some constrictions and contains a few to several whitish spherules inside. Although several to considerable numbers of zooids have been observed aggregated in the photographs (Figs. 7–10), it is not yet known exactly whether they are still connected with one another by stolon or mostly isolated. In contrast with these, zooids in the vegatative phase are all attached directly to the basement test by the proximal end of the body proper, devoid of the peduncular portion mentioned above, and connected one another by stolons through the basement. The thoracic part is oval, while the abdominal portion is narrowed, peduncle-shaped and nearly as long as the thoracic portion in smaller ones but may be about only half as long as the latter in larger ones.

The test is very thin, gelatinous, rather stiff in the holotype but soft in the paratype, and quite transparent; the posterior portion of the body proper, where the abdomen is buried, is slightly harder than the anterior half and may be transversely creased in the holotype, but the internal structure is extremely loose and soft. The peduncle, possibly the old stolon, is much more rigid; small pieces of some creeping alga or a slight amount of mud may be found attached to or settled on the surface of the posterior half of the body proper, otherwise the test surface is nearly smooth and wholly free from foreign materials. Both apertures terminal and open each on a low elevation; the branchial is slightly bent ventralwards.

The mantle body of zooids may attain 22 mm in length in the preserved state. That of the holotype is 14 mm in length, 6 mm for thorax and 8 mm for abdomen, while in that of the paratype the thorax is evidently longer than the abdomen. In the living state, the thorax will extend two times as long as in the preserved state to fill wholly the large space inside the anterior part of the test body. The branchial siphon and the anterior part of the branchial sac are provided with some dark red pigmentation, but this does not seem to show any remnant of the colouration of the living specimen, because the live specimens are generally opaque grayish blue as a whole and typically provided with a white or yellowish circle around the base of the branchial siphon. This circle is cut on the mid-ventral line. In addition, there may be a longitudinal white line along the dorso-median line or the atrial aperture may be fringed with white pigmentation on both lateral sides. Further, in some aggregations, the white circle around the branchial siphon may extend to cover the whole anterior portion of the branchial sac, inclusive of the branchial siphon (Fig. 9), or may be dispersed into a number of small white spots distributed irregularly over the anterior half of the branchial sac (Fig. 10). The thoracic mantle of the paratype is still retaining a purplish tint in formalin in the end of July. Up to 15 oblique muscles are running from the antero-ventral to the postero-dorsal side of the thorax, of these antero-dorsal 6–7 are converging to the branchial siphon, but posterior 5–6 to 9 are ending anteriorly along and towards the endostyle (Fig. 18). By strong contraction of these muscles, the branchial sac will be contracted much more markedly on the dorsal than the ventral side supported by the endostyle so that plications on the thoracic mantle, which are formed in parallel with stigmatal rows, are running obliquely from the dorso-anterior to the postero-ventral side (Fig. 13). Both apertures are round, the branchial siphon is bent a little ventralwards. Usually 15 to 18 stigmatal rows are counted, but they may be as many as 22 at the maximum. Transverse vessels are supported each by a prominent membrane. Possibly 20 or a little more stigmata in respective rows. Tentacles about two dozens, partly arranged in the order of large-small-large. The ciliated groove is typically a longitudinal slit. The anus is bilobed and opens at the dorso-posterior corner of the thorax.

The stomach in the holotype occupies the posterior two thirds of the anterior half of the abdomen, with its pyloric end around the middle of this body part, and is furnished with 4 distinct and 1 indistinct longitudinal plications on the exposed surface. In more strongly contracted abdomen of the paratype, the stomach is

situated more posteriorly, the middle of the abdomen may be at the level near the cardiac end of the stomach (Fig. 18) and the surface plications may look somewhat differently (Fig. 20). The hind-stomach is distinctly constricted off from the stomach. The gonad is spreading over the left side of the loop of the alimentary canal, the ovary including several large ova is found at the centre, being surrounded and partly covered by many testicular follicles which are extending to some marginal portions of the posterior half of the loop on the right side. A dark yellow mature egg is found at the dorso-posterior part of the thorax on the right side in the holotype.

Remarks: As seen clearly between the holo and paratypes, the superficial appearance of the thorax will differ greatly according to the degree of contraction. The contraction degree of the abdomen will differ with the maturation stage of the gonad and this will affect the situation and the surface feature of the stomach. Therefore, for the present form, the colour pattern, especially of the typical one, may be the best characteristic defining the species. The pattern is very unique and this evidently justifies the establishment of a new species for this form. Probably the ground colour of opaque grayish blue of the body may be very significant, too, for this new species. However, such pigmentation and colour pattern belong to the mantle of the zooid, which may be much contracted in the present new species provided with an oblique thoracic musculature and will fade or be turned into other hues in preservatives. Therefore, at the present level of knowledges of the taxonomy of *Clavelina* from the Pacific, it will be rather difficult to make exact identification of this new species on only preserved specimens but without any notes showing the colouration in a living state.

5. *Eudistoma glaucus* (Sluiter, 1909)

(Figs. 5–6)

Polycitor glaucus: Sluiter (1909); Siboga-Exped. Monogr. 56b, pp. 12–13; Pl. I, fig. 10.

Two colonies in the material, collected by Mr. Shirai at Tinen, Okinawa in 1975, together with some transparencies in natural colour. Colonies are massive, the one (Fig. 5) is 21 mm high and consists of a dark grayish green (in formalin) corona, 13 mm wide and 6 mm thick, and the dark grayish peduncle. The other colony is 21 mm high, 13 mm wide, and 8 mm thick and consists of two cormidia, each differentiated into a dark greenish corona and the dark grayish peduncle.

The test is gelatinous, rather rigid, translucent and quite free from any foreign matters, though the peduncle is partly encrusted with shell fragments and other pieces. Living colonies are coloured deep green. This colouration is due to the pigmentation of the test itself, while the zooids are nearly colourless in the preserved state, but only the stomach that is coloured yellowish gray.

Zooids are up to 4.5 mm in length in a contracted state; the thorax is usually less than a half of the total body length and the abdomen is as long as or up to one and a half times the thorax. The thorax is furnished with a thickly developed musculature, superficially consisting of many transverse muscles. Both apertures are 6-lobed,

tentacles may be up to 15, the ciliated groove is an oval orifice. About 10 stigmata in each of three rows, the anus opens at the level of the second transverse vessel. The stomach is globular and situated in the posterior half of the abdomen, with its cardiac end at the middle of the abdomen. Both the hind-stomach and middle-intestine are distinct, the latter passes to the rectum at the posterior end of the abdomen. A strong curve of the rectum occurs as usual in the genus *Eudistoma* around the level of the cardiac end of the stomach. The gonadal mass occupies the left side of the loop of the alimentary canal, posterior to the pyloric end of the stomach.

Remarks: At a glance, the green colouration of live colonies reminds us of colonies of the same colour of *Eudistoma viridis* Tokioka, 1955 occurring commonly in Palao, however in *E. viridis* the colouration is due to the pigmentation of the mantle of zooids. *Eudistoma rigida* Tokioka, 1955 which was reported from Palao, too, forms also dark greenish colonies; in this species the colouration is due to the pigmentation of the test itself and zooids are yellowish brown when alive. In this species, however, the rectum is extended straight but never showing any sharp curve that is seen generally in many other species of the genus inclusive of the present form. The present form seems to show a close resemblance to *Polycitor glaucus* Sluiter, 1909 collected by the Siboga Expedition from the Flores Sea (8°19'S, 117°41'E); the size of zooids (4 mm: 1.5 mm for thorax and 2.5 mm for abdomen), number of stigmata in each row (8–10), and the existence of a remarkable curve of the rectum at the cardiac level of the stomach (Pl. I, Fig. 10) in *P. glaucus* agree nearly perfectly with the corresponding features of the present form. Sluiter's colony was grayish blue in alcohol; 12 tentacles are recorded and developed thoracic muscles are arranged in the general way in his species. In spite of the existence of such minor differences and somewhat uncertain point, the present colonies may be safely identified with *P. glaucus* for the resemblance in more essential features mentioned above. *Eudistoma angolanus* (Michaelsen, 1914) resembles the present form in having developed transverse muscles (together with longitudinal ones) on the thorax and dark bluish pigmentation in the preserved colony test. However, the rectum is not curved in the zooid and the test is impregnated with sand grains in the abdominal and bottom layers of the colony in the former.

Only, a question still remains. This concerns the possibility that *Eudistoma tokarae* Tokioka, 1954 described from the Tokara Islands north of Okinawa Island might be the young colonies of the present form. The existence of some weak longitudinal muscles on the thorax in *tokarae* may easily become obscure when much better developed transverse muscles are contracted strongly. If the colony shape of *E. tokarae* is representing only a young stage of somewhat massive colony, the relation between *glaucus* and *tokarae* should be examined again more closely.

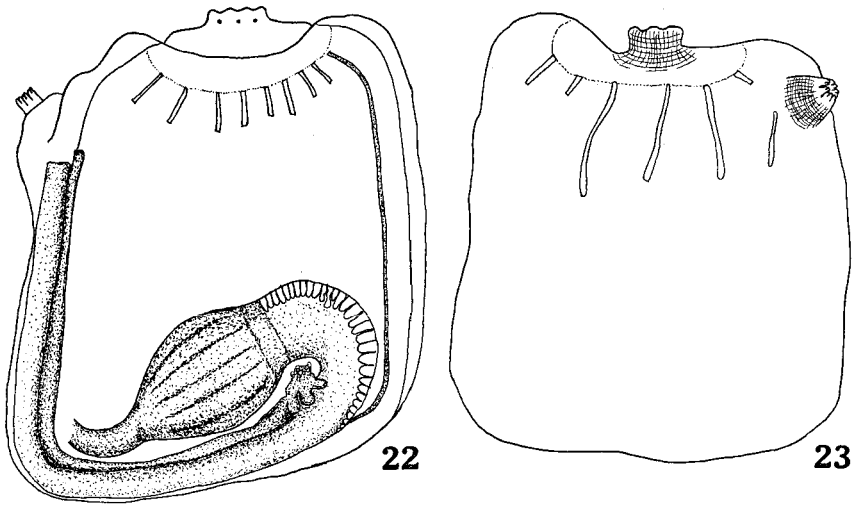
6. *Corella japonica* Herdman, 1880

(Figs. 22–23)

A single 16.1 mm long and 12.4 mm wide specimen from the underside of a

dead coral mass in the shallow (about 1 m deep) lagoon in Kabira Bay, Okinawa on April 1, 1975. The test colourless and transparent, the surface without any foreign matters, smooth but with minute papillae scattered over it, and the dark yellowish visceral mass seen through the test when alive. Both apertures are 6–lobed as indicated distinctly by 6 ocelli, these of the branchial aperture are each accompanied basally with a smaller brownish spot; and respective lobes, especially of the atrial aperture, are subdivided into a pair of lobules.

The mantle is very thin, transparent and furnished on each side with only a poor musculature surrounding the base of the branchial siphon. The musculature consists of 8 short muscles on the right, while 3 of such muscles and 4 pieces on the left side. Tentacles 22, arranged partially as large-small-large; the ciliated groove is an oval slit, elongate transversely and faintly pinkish in a fresh state. Stigmatal spirals on the wall of the branchial sac are arranged in about 20 transverse and the



Figs. 22–23. *Corella japonica* Herdman. Mantle body, right side (22) and left side (23).

same number of longitudinal rows on each side; internal longitudinal vessels 26–27 on each side, the dorsal-most one is running very closely along the series of dorsal languets and the ventral-most one is limited to the anterior half of the sac. The anterior end of the intestinal loop does not reach the level of the atrial siphon. About a dozen of longitudinal plications on the globular stomach. The anal margin plain. The ovary is already emptied, but testicular follicles are found on the intestine along the periphery of the loop and the vas deferens is full of sperms.

Remarks: The poor musculature of this specimen reminds us of *C. minuta* Traustedt, 1882 from the West Indies and a dwarf form of *C. japonica* Herdman, 1880 reported by Tokioka (1953) from Sagami Bay. However, as the body size and the structure of the branchial sac and alimentary canal in this specimen agree well with those features of typical *japonica*, the specimen cannot be referrable to the species of

the West Indies. Further, the specimen is as large as typical individuals of *japonica* and provided with more longitudinal and transverse vessels than the dwarf form of *japonica* from Sagami Bay, therefore it can never be a dwarf form.

In comparison with *japonica*, *eumyota* Traustedt, 1882 and *willmeriana* Herdman, 1898 which are furnished with a strong musculature, *aequabilis* Sluiter, 1904, *borealis* Traustedt, 1882, *parallelogramma* Müller, 1776, *larvaeformis* Hancock, 1870 and *ovata* Hancock, 1870 are provided rather with less developed musculature that consists, however, of muscles arranged similarly in some "radiating" manner. This feature in the latter group seems to differ considerably from that of the present specimen. Taking all these together, the specimen may be treated here as an individual near the margin of a wide variation range of the musculature in *japonica*. Differences found in the test appearance (smooth and exposed in the present specimen) and the number of tentacles (fewer in the present specimen) are probably of minor significance.

Only, it is suspected at present that the reduction of body size is possible in the waters of higher temperatures as there they may reach the maturity much earlier and that the reduction of musculature may occur with the decrease in body size. Rather, however, the existence of the individual of usual body size but with a poor musculature in the waters of Okinawa, together with common occurrences of much larger variety *asamusi* Oka of *C. japonica*, that is furnished with much stronger musculature, in the northern waters of Japan, seems to allude the possibility that the reduction of musculature occurs with raising water temperature. Anyhow, this problem requires further crucial studies on much more specimens from many different localities.

7. *Botrylloides violaceus marginatus* Tokioka, 1967

(Fig. 7)

U.S. Nat. Mus. Bull. 251, 1967, p. 160, fig. 64.
Publ. Seto Mar. Biol. Lab., 16 (2), 1968, pp. 141–145, fig. 1.
Publ. Seto Mar. Biol. Lab., 18 (1), 1970, pp. 57–58.

This botryllid can be identified easily, too, on the coloured picture, because its colour pattern is quite unique. The occurrence of this beautiful species in Okinawa waters was confirmed by an underwater picture in natural colour taken by Mr. Shirai.

8. *Symplegma* sp. aff. *viride* Herdman, 1886

(Fig. 21)

Two colonies from Hong Kong, 20 mm × 20 mm and 20 mm × 30 mm in extent respectively and 1.5 mm in thickness. The test is transparent. Zooids are 2–3 mm in length and faintly pinkish gray in colouration; the branchial aperture subterminal and the atrial at about the middle of the body. In some zooids keeping somewhat standing posture in some part of the colony, the branchial aperture is terminal and the atrial in the anterior half of the body. The stigmatal rows on the left and 9(+)

rows on the right side. The anterior edge of the intestinal loop reaches the 5th transverse vessel. Stigmata are distributed in the anterior half as:

Left side	D 5.5.4.8 V
Right side	D 5.3.3.8 V.

The first (dorsal-most) vessel on the left side is much shorter than others, reaching the dorsal lamina at the middle of the branchial sac. The stomach is half as long as the visceral mass and furnished with 11 plications on the surface; the pyloric coecum is very prominent, strongly curved, and issues two vessels from near the middle of the convex margin. The anus is open at the level of the 5th transverse vessel. The gonad is extending from the 3rd to 5th stigmatal row on the right side and with the ovary on the 4th row, while from the middle of the 2nd to the middle of the 4th row on the left side and with the ovary near the posterior margin of the 3rd row.

Remarks: This is a provisional identification. As the morphological range through the recorded individuals of *S. viride* is seemingly too large, the future revision will be inevitable as to this species.

9. *Styela partita* (Stimpson, 1852)

(Figs. 24–36)

Records from the Pacific:

Yokohama: Proc. Imp. Acad., 10 (3), 1934, pp. 184–186.
Sagami Bay: Ascidians of Sagami Bay, 1953, pp. 123–125, 262–263.
Sado Island: Publ. Seto Mar. Biol. Lab., 10 (1), 1962, p. 17.
Osaka Bay: Publ. Seto Mar. Biol. Lab., 1 (4), 1951, pp. 175–177.
Inland Sea of Japan: Publ. Seto Mar. Biol. Lab., 3 (1), 1953, pp. 16–17.
Ariake Sea: Publ. Seto Mar. Biol. Lab., 8 (1), 1960, pp. 213–215.
Tokara Islands: Publ. Seto Mar. Biol. Lab., 3 (3), 1954, pp. 262–263.
Arafura Sea: Publ. Seto Mar. Biol. Lab., 4 (2/3), 1955, pp. 56–57.
New Caledonia: Publ. Seto Mar. Biol. Lab., 9 (1), 1961, pp. 128–132.
Panama Bay: Bull. American Mus. Nat. Hist., 84, 1945, p. 293.
Costa Rica: Publ. Seto Mar. Biol. Lab., 19 (6), 1972, pp. 398–399.

About 20 individuals from Hong Kong, up to 16 mm in length, including smaller ones only 1–6 mm in length. Of these, 5 specimens, 6–16 mm long, were dissected for identification. Their test is leathery, yellowish white (smaller individuals) to yellowish brown and whitish on the inner surface. Both apertures are sessile and 4-lobed, the branchial subterminal and the atrial usually with the posterior edge near the middle of the dorsal side; they are coloured dark red and furnished with thin white lines up to 12 in number or with a number of minute white patches radially arranged. Dissected animals are all fully mature and the inner surface of the mantle is filled with testicular follicles of two gonads on each side except the 6 mm and 10 mm long individuals, in the former only a single gonad is found on the left side and in the latter only a single gonad on each side. The mantle is salmon pink on the dorsal side and extremely thin on the ventral side. The stomach is very elongate, occupying most

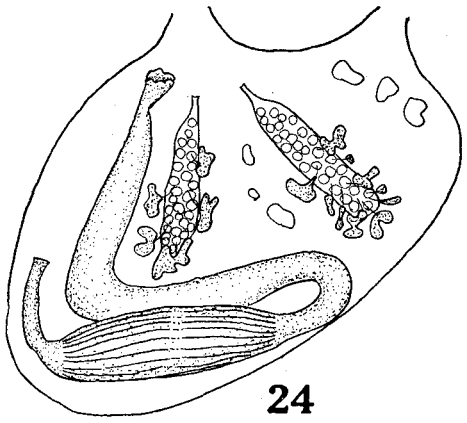


Fig. 24. *Styela partita* (Stimpson). Left half of mantle body of a 13 mm long specimen from Seto, inner surface.

Body length	Number of gonads	
	Left side	Right side
6 mm	1	2
10	1	1
12	2	2
15	2	2
16	2	2

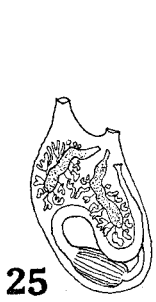
part of the ventral branch of the first intestinal loop. In this respect the specimens from Hong Kong are related closely to those from the Tokara Islands (Fig. 32), the Arafura Sea (Fig. 33) and New Caledonia (Figs. 34–35), but differ somewhat from those recorded from Yokohama (Fig. 26) and Sagami Bay (Fig. 27), that have a short oval stomach. Recently, this point was checked again by the last author on the specimens from the vicinity of the Seto Marine Biological Laboratory. A number of specimens, 9.5 mm to 34 mm in length, were collected from the vicinity as follows:

Off the north shore of the Seto Marine Biological Laboratory, a cluster of specimens from a buoy on Aug. 8, 1974 and some specimens from the surface of *Polycarpa cryptocarpa* var. *kroboja* (Oka) (coll. by Mr. T. Kuwamura) on Jan. 29, 1975.

From the west coast of Hatakezima Island, some specimens from the surface of *Styela plicata* on Oct. 14, 1974 and from the underside of a boulder near the low water mark on May 13, 1975.

The test is reddish brown, the inner surface of both siphons are dark red and with 8 white lines, 4 thicker and 4 thinner ones alternating regularly. Inner longitudinal

Figs. 25–36. *Styela partita* (Stimpson), inner surface of left half of mantle body, showing the relative size of stomach in specimens from different localities in the Pacific. 25—17 mm long specimen (after Van Name, 1945). 26—Specimen from Yokohama, 22 mm long (after Oka, 1934). 27—Sagami Bay, 22 mm (Tokioka, 1953a). 28—Sado Island, 15 mm (Tokioka, 1962). 29—Osaka Bay, 22 mm (Tokioka, 1951). 30—Inland Sea of Japan, 22 mm (Tokioka, 1953b). 31—Ariake Sea, 15 mm (Tokioka, 1960). 32—Tokara Islands, 9 mm (Tokioka, 1954). 33—Arafura Sea, 9 mm (Tokioka, 1955a). 34, 35—New Caledonia, both 13 mm (Tokioka, 1961). 36—Pacific coast of Costa Rica, 10 mm (Tokioka, 1972).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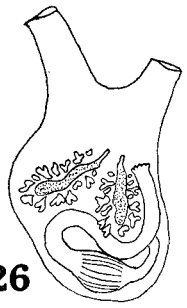
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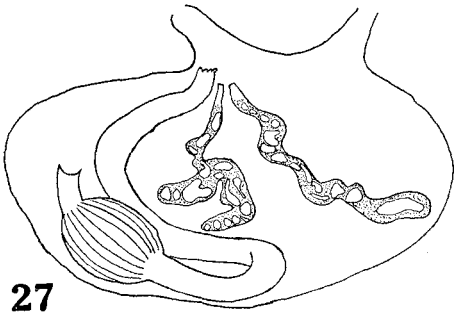
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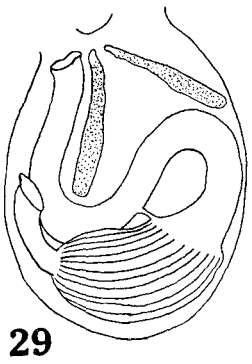
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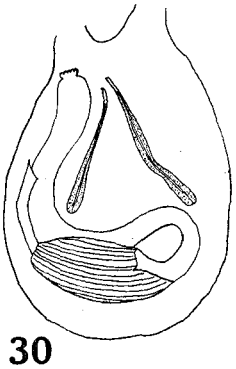
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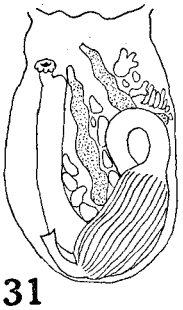
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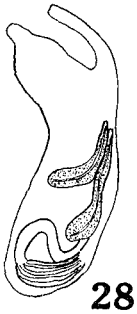
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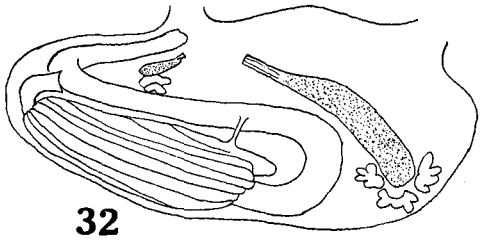
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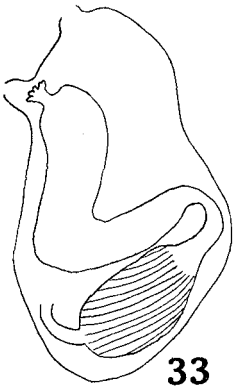
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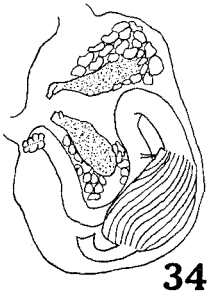
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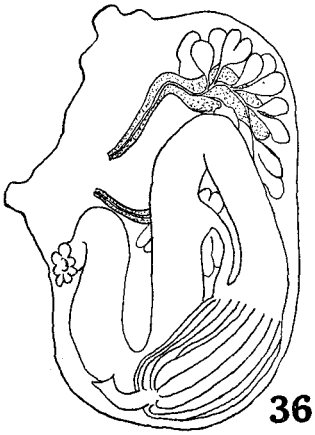
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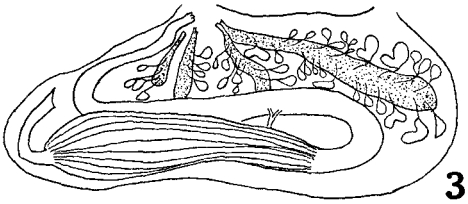
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vessels are arranged in a 13 mm long specimen as follows:

Left	D. 2 (11) 4 (10) 3 (10) 3 (7) 2 V.
Right	D. 4 (10) 3 (9) 4 (9) 3 (6) 2 V.

The stomach occupies more than two thirds of the ventral branch of the first intestinal loop. The axis of the wide second intestinal loop passes through the cardiac end of the stomach (Fig. 24). As every material includes some fully mature individuals, the species seems to attain the maturity almost throughout the year in Tanabe Bay. Two gonads on each side; testicular follicles surrounding the posterior half to two thirds of respective ovaries. The posterior gonad on the left side, rarely the anterior one, too, is located in the second intestinal loop.

Evidently, the specimens from the vicinity of the laboratory conform perfectly with the specimens from Hong Kong in having the stomach with markedly larger relative length. Comparing these with the specimens from northern localities in Japan, which are provided with much smaller (relatively) stomach and seemingly reach the maturity at much larger body size, it is supposed that there is a trend of decreasing the body size of mature individuals and increasing the relative size of the stomach towards the localities in the tropical waters in the north-western Pacific; specimens from Sado Island (Fig. 28), the Inland Sea of Japan (Fig. 30) and the Ariake Sea (Fig. 31) seemingly showing some intermediate features. The original features of *partita* may be seen most exactly in the description given by Van Name (1945) as the observations on the specimens collected from or near the type locality must be included in it. Basing on this description and many other published ones, it seems very difficult to draw any distinct boundary in the variation range seen throughout the descriptions made as to *partita*. Probably the reduction of the body size of matured individuals is related closely with the raise of the water temperature and the increase of the relative size of the stomach is related with the size reduction of the body, and the reduction of the gonad may occur in correlation with the reduction of the body size, too.

However, it is very noteworthy that a small specimen from the Pacific coast of Costa Rica (Fig. 36) is provided with rather short stomach as in the typical form figured by Van Name (Fig. 25). This seems to show that there is still a possibility that this species in the north-western Pacific might have been differentiated into the northern and southern races and the vicinity of Seto might be the northern limit of the range for the southern race.

10. *Styela plicata* (Lesueur, 1823)

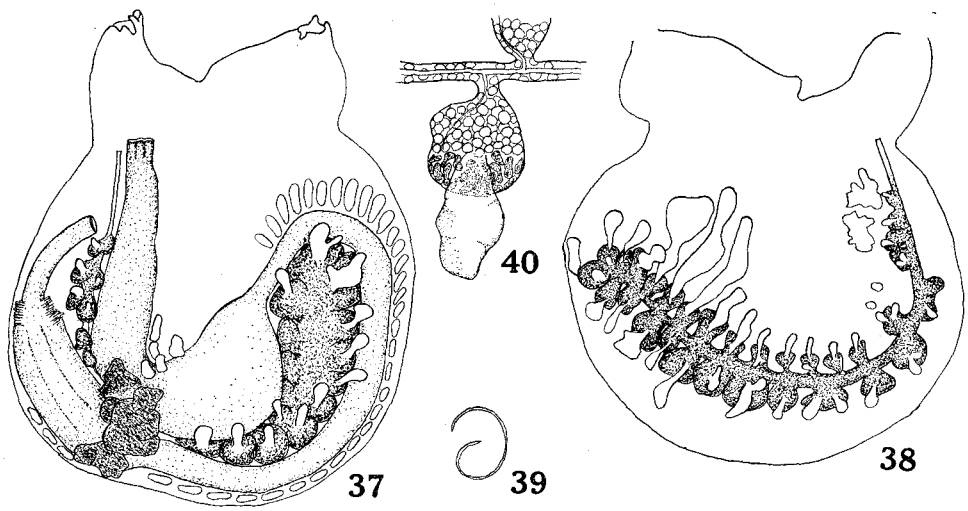
A single 10 mm long individual from Hong Kong. The test is yellowish white and hard cartilaginous. No gonads are developed yet. However, the feature of the alimentary canal, with long oesophagus, ascending stomach and deep second intestinal loop, seems clearly to justify the present identification.

11. *Pyura curvigona* Tokioka, 1950

(Figs. 37–40)

Pyura curvigona—Tokioka, 1950: p. 147, fig. 22; pl. 10, figs. 4–6. 1967: pp. 199–202, figs. 88–89.

A single 34.2 mm long specimen was found attached by the right side of the body to the surface of a dead coral mass in the lagoon at Kabira, Okinawa in April, 1974. The body is roughly oval in outline, with both apertures subterminal and each opening on a low elevation. The test is thin, leathery, irregularly wrinkled, very coarse and allowing encrusting of some didemnids on the surface; chocholate brown on the surface in both living and preserved states and whitish on the internal surface. There are many small prominences surrounding the apertures, which are covered with spinules as well as the inner surface of the distal portion of siphons; the spinules are up to 30 μ in length and give the test surface a kind of iridescence. When alive, the inner surface of siphons is deep brown and with about 20 darker striations.



Figs. 37–40. *Pyura curvigona* Tokioka. 37—Left half of mantle body, inner surface. 38—Right half of mantle body, inner surface. 39—Ciliated groove. 40—A genital capsule.

The mantle is thick and reddish orange in the anterior siphonal area, but thin, translucent and whitish in other parts of the body. Intervals between the lobes of branchial and atrial apertures are each pigmented heavily in deep red. The musculature well developed, consisting of about 20 thick longitudinal muscles converging into both siphons and a number of thinner transverse ones crossing regularly the longitudinal ones all over the mantle. Tentacles about 30 inclusive of minute ones, branched in 2 orders but branches less developed, and arranged as large minute small minute large—. The ciliated groove is rather small, C-shaped and open to the left (Fig. 39). Six plications on each side of the branchial sac which is coloured orange in a fresh state. The inner longitudinal vessels are arranged as:

Left	D. 7 (18) 0 (25) 0 (26) 8 (18) 10 (14) 6 (11) 8 V.
Right	D. 5 (17) 2 (22) 3 (23) 6 (18) 8 (17) 8 (13) 7 V.

Five to 6 thinner transverse vessels between each pair of thicker ones, parastigmatic vessels present partially, 5–6 stigmata in a mesh.

The loop of the alimentary canal occupies nearly two thirds of the left half of the mantle body. Both the first and second loops are very deep, the axis of the second loop passes across the pyloric end of the gastric region and the rectum is swollen along this loop. A series of endocarps along the outer margin of the first loop. The anal margin is folded indistinctly into 5–6 lobules, deep yellowish and with two white longitudinal bands on the free surface. The liver is divided into the smaller anterior and much larger posterior portions far apart from each other. The former is found at the cardiac end of the gastric region, pale greenish yellow and consists of finger-shaped lobules, while the latter is situated at the pyloric portion, dark yellow, and consists of about a dozen of hepatic lobes each constructed of many minute lobules. A U-shaped gonad on each side, the left gonad with about 20 and the right one with about 30 genital capsules. Each capsule contains pale orange testicular follicles in the distal one third and whitish eggs in the proximal two thirds and is furnished with one or two elongate endocarps on the surface; these endocarps are larger on ventral capsules in the left gonad but on dorsal ones in the right gonad.

Remarks: The feature of the strongly curved gonad, with endocarps on respective genital capsules, and of the alimentary canal, with the swollen rectum and the liver distinctly differentiated into the anterior and posterior parts, and the existence of iridescent spinules over the test around siphons are the remarkable characteristics of this species and all are shared with the present specimen. The arrangement of eggs (proximal) and testicular follicles (distal) in the genital capsule in the present specimen differs a little from that shown by Tokioka (1967), in which eggs occupy the attachment side while testicular follicles the free side. Probably the difference is due to the stage or degree of the development of respective genital glands in the capsule.

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