

Deep-water ascidians (Tunicata: Ascidiacea) from the northern and western Pacific

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(Accepted 20 January 2006)

Abstract

Bathyal and abyssal ascidians from the northeast Pacific (Alaska Gulf and Aleutian Islands) and ultra-abyssal species from the deep-water trenches in the west Pacific (Kurile-Kamchatka, Ryukyu, Philippine, and Volcano Trenches) are discussed. Six abyssal species recorded for the first time from the north Pacific were previously known from the southern hemisphere including Antarctica, the Indian Ocean, and the Atlantic, confirming the cosmopolitan distribution of many abyssal species. Three new species are described and three previously known species are recorded at depths exceeding 7000 m.

Keywords: *Abyssal, Ascidiacea, bathyal, deep-water, new species, Pacific, Tunicata*

Introduction

The deep-water ascidian fauna of the North Pacific is poorly investigated, with fewer than 30 species being known from depths exceeding 1000 m in a huge area from the equator to the Bering Strait. This number is significantly less than in other large regions. The number of deep-water species in seas bordering Europe is two to three times more.

The first ascidian from reported depths exceeding 1000 m in this region was *Hypobythius calyptodes* Moseley (1876), a species never reported again up to the present time. Herdman (1881, 1882) redescribed Moseley's specimen, and described the second deep-water species from the North Pacific, *Culeolus murrayi* Herdman, 1881.

Seven deep-water species were described by Ritter (1907, 1913): one species, *Corynascidia herdmanni* Ritter, 1913, from the Bering Sea, and six from northern California: *Ascidia clementea* Ritter, 1907, *Benthascidia michaelensi* Ritter, 1907, *Styela milleri* Ritter, 1907, *Ciona mollis* Ritter, 1907, *Culeolus pyramidalis* Ritter, 1907, and *Bathypera ovoida* (Ritter, 1907). All except *B. michaelensi* were subsequently recorded and redescribed by other authors (Van Name 1945; Nishikawa 1981; Sanamyan 1992, 1998;

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Published 31 May 2006

ISSN 0022-2933 print/ISSN 1464-5262 online © 2006 Taylor & Francis
DOI: 10.1080/00222930600628416

Monniot 1998; Sanamyan and Sanamyan 1998). *Styela milleri* is conspecific with *S. squamosa* Herdman, 1881, Ritter's other species are now regarded as valid.

Other species known below 1000 m in the northern hemisphere along the Pacific coasts of North and Central America include four species recorded by Millar (1959, 1964, 1970): *Dicarpa simplex* Millar, 1955, *D. pacifica* Millar, 1964, *Cnemidocarpa bifurcata* Millar, 1964, and *Adagnesia bifida* Millar, 1970, and two recently described *Ascidia* species: *A. escabanae* Monniot, 1998 and *A. formella* Monniot, 1998.

Deep-water species from the northwestern Pacific were reported by Redikorzev (1941), Tokioka (1967), Nishikawa (1990), Sanamyan (1992), Sanamyan and Sanamyan (1998), and Monniot (1998). Redikorzev (1941) described three deep-water ascidians from the Sea of Okhotsk and the Japan Sea: *Agnezia orthenteron* (Redikorzev, 1941), *Culeolus ushakovii* Redikorzev, 1941 (= *C. suhmi* Herdman, 1881, see below), and *Pelonaia corrugata bursaria* Redikorzev, 1941 (a deep-water *Styela* with flat branchial sac rather than a species of *Pelonaia*).

Fauna of the Kurile-Kamchatka Trench was studied by Vinogradova (1969, 1970) who worked with the abundant material collected by several Russian expeditions focused mainly on deep-water fauna. The material contained many species, most of which remained unidentified and undescribed. Vinogradova reported only the large species from this material: *Situla pelliculosa* Vinogradova, 1969, *Culeolus longipedunculatus* Vinogradova, 1970, *C. tenuis* Vinogradova, 1970, *C. robustus* Vinogradova, 1970, *C. murrayi* and *Paraculeolus bicristatus* Vinogradova, 1970. *Culeolus murrayi* of Vinogradova (1970) is synonymized in the present work with *C. suhmi*. Only *C. tenuis* has been subsequently recorded and redescribed; other Vinogradova species are known only from the type material.

The remaining species from depths exceeding 1000 m in the northern Pacific are *C. inversus* Oka, 1928 and *C. easteri* Tokioka, 1967, both recorded in the central Pacific (north of the equator), *Apodium rhabdocormi* Nishikawa, 1990 and *Kaikoja globosa* Monniot, 1998 from the Japan Sea and Pacific coasts of Japan, *C. nadejdae* Sanamyan, 1992 from the Sea of Okhotsk, and *Adagnesia pacifica* Sanamyan and Sanamyan, 1998 and *Situla galeata* Monniot and Monniot, 1991 collected near the Commander Islands. All these species, except *S. galeata*, are known only from the original descriptions.

In the present paper we describe 13 abyssal and six bathyal species including three new species. Several abyssal species reported for the first time in the region include three from depths greater than 7000 m. Several *Culeolus* species identified and described by Vinogradova (1970) are redescribed here.

Station list

RV *Vityaz*, cruise 14: Kurile-Kamchatka Trench

St. 2120, 8330–8430 m, 46°13.9'N, 154°11.0'E (*Corynascidia* sp.).

RV *Keldish*, cruise 22: Aleutian Islands

St. 2323, 4890–4984 m, 53°05.4'N, 161°55.2'W–53°07.0'N, 161°56.12'W (*Styela squamosa*).

RV *Vityaz*, cruise 39: southwest of Kurile-Kamchatka Trench

St. 5621, 5035–5220 m, 45°18'N, 156°00'E (*Culeolus longipedunculatus*, *C. suhmi*, *C. tenuis*).

RV *Vityaz*, cruise 45: Alaska Gulf and Aleutian Islands

- St. 6089, 170 m, 58°01.7'N, 149°01.8'W (*Chelyosoma columbianum*, *Styela multi-tentaculata* sp. nov., *Halocynthia igaboja*).
 St. 6098, 200 m, 59°24.5'N, 141°53'W (*Halocynthia igaboja*, *Pyura haustor*).
 St. 6109, 3460 m, 56°12.7'N, 139°43.4'W (*Cnemidocarpa barbata*, *Styela tenuibranchia*, *Hemistyela pacifica* sp. nov.).
 St. 6111, 2880 m, 56°17.2'N, 137°51.0'W (*Cnemidocarpa barbata*).
 St. 6117, 3350–3370 m, 56°12.0'N, 139°12.1'W (*Bathystyeloides enderbyanus*, *Cnemidocarpa barbata*, *Styela tenuibranchia*).
 St. 6132, 1100–830 m, 53°46.0'N, 163°41.0'W (*Styela sigma*, *Bathypera ovoida*).
 St. 6135, 2880–2930 m, 53°32.0'N, 163°22.0'W (*Asajirus indicus*).
 St. 6142, 5000–4990 m, 52°13.5'N, 163°43.0'W (*Styela squamosa*).
 St. 6143, 4820 m, 51°34.0'N, 163°10.0'W (*Culeolus suhmi*).

RV *Vityaz*, cruise 57: Ryukyu Trench

- St. 7168, 7440–7450 m, 25°11.5'N, 128°27.8'E–25°11.4'N, 128°26.9'E (*Bathystyeloides enderbyanus*).

RV *Vityaz*, cruise 57: Philippine Trench

- St. 7206, 7880–7420 m, 10°25.1'N, 126°51.0'E–10°23.0'N, 126°48.4'E (*Bathystyeloides enderbyanus*, *Asajirus indicus*).

RV *Vityaz*, cruise 57: Volcano Trench

- St. 7391, 6330 m, 24°06'N, 143°47'E–24°07'N, 143°46'E (*Styela hadalis* sp. nov.).

Description of species

Chelyosoma columbianum Huntsman, 1912

Chelyosoma columbianum Huntsman 1912, p 124; Ritter 1913, p 486; Van Name 1945, p 208; Sanamyan 1998, p 110.

Material examined

St. 6089, 170 m, 25 specimens.

Remarks

All newly recorded specimens are identical to the one from the Commander Islands (Sanamyan 1998). They all have two central plates connected by short muscles, and 8–11 marginal plates. None of the 25 examined specimens had intermediate plates that Huntsman (1912) recorded for this species. Huntsman (1912) stated that *C. columbianum* may be readily distinguished from *C. productum* Stimpson, 1864 by the presence of short muscles connecting the two central plates. Ritter (1913) based his assignation of specimens from the Strait of Juan de Fuca to *C. columbianum* solely on this feature. However, it is possible that the muscles between the central plates have been overlooked in those specimens assigned to *C. productum* and it may not differ from *C. columbianum*. Unfortunately no specimens clearly referable to *C. productum* (with elongated body and more numerous marginal plates) were available to confirm this view. The present species cannot be confused with the other north Pacific species of *Chelyosoma*, which either have a single central plate (*C. macleayanum* Broderip and Sowerby, 1830 and *C. orientale* Redikorzev, 1911), or lack the plates on the disk (*C. inaequale* Redikorzev, 1913).

?*Corynascidia* sp.*Material examined*

St. 2120, 8330–8430 m, one specimen in poor condition and one empty test.

Remarks

This is the deepest record for the Asciidiacea. The specimens are in very poor condition and details of their morphology are obscured. The completely mutilated branchial sac seems to have spiral unciliated stigmata. The median position of the small gut loop suggests *Corynascidia*. The specimens are sessile, without a stalk. These specimens were referred by Vinogradova (1969) as probably belonging to *Situla pelliculosa* Vinogradova, 1969. The specimens, however, have two distinct siphons with numerous lobes, very different from *Situla*.

***Bathystyeloides enderbyanus* (Michaelsen, 1904)**

(Figures 1, 2A)

Bathyoncus enderbyanus Michaelsen 1904, p 226; Kott 1969, p 125.

Bathystyeloides enderbyanus: Millar 1959, p 197; 1970, p 131; Monniot and Monniot 1970, p 323 (part); 1973, p 443; 1974, p 756; 1976, p 669; 1977, p 313; 1985a, p 29; 1985b, p 292; 1985c, p 39; 1987, p 38; 1988, p 406; 1994, p 28; Monniot 1994, p 235; 1997, p 20.

?*Bathystyeloides anfractus*: Monniot and Monniot 1985c, p 39; Sanamyan and Sanamyan 1999, p 1854.

Bathystyeloides atlantica Millar 1955, p 229.

Bathystyeloides magnus Sanamyan and Sanamyan 1999, p 1855.

Material examined

St. 6117, 3350–3370 m, one specimen; St. 7168, 7440–7450 m, 15 specimens; St. 7206, 7880–7420 m, one specimen.

Description

The specimen from St. 6117 has a spherical body (8 mm diameter) with sparse, short, test hairs ventrally and a few on the sides. About 20 flat triangular tentacles are on a high branchial velum. The circular prepharyngeal band lacks any dorsal indentation and is closer to the branchial velum dorsally than ventrally. The neural ganglion is well separated from the small, round dorsal tubercle. The branchial sac has 60–75 longitudinal vessels on each side. A deep inverted fold between the dorsal lamina and the first dorsal longitudinal vessel displayed by severing the short connectives between the dorsal vessel and dorsal lamina has eight well-defined transverse rows of up to 15 longitudinal stigmata per row. The remainder of the branchial sac has only long transverse stigmata characteristic of the genus. One long immature gonad is on each side of the body. Small testis follicles are in two rows beneath the ovary. Three or four endocarps are in an unequal line on each side of the body. The stomach has eight or nine well-marked folds and a small caecum. The anal margin has about 15 distinct lobes.

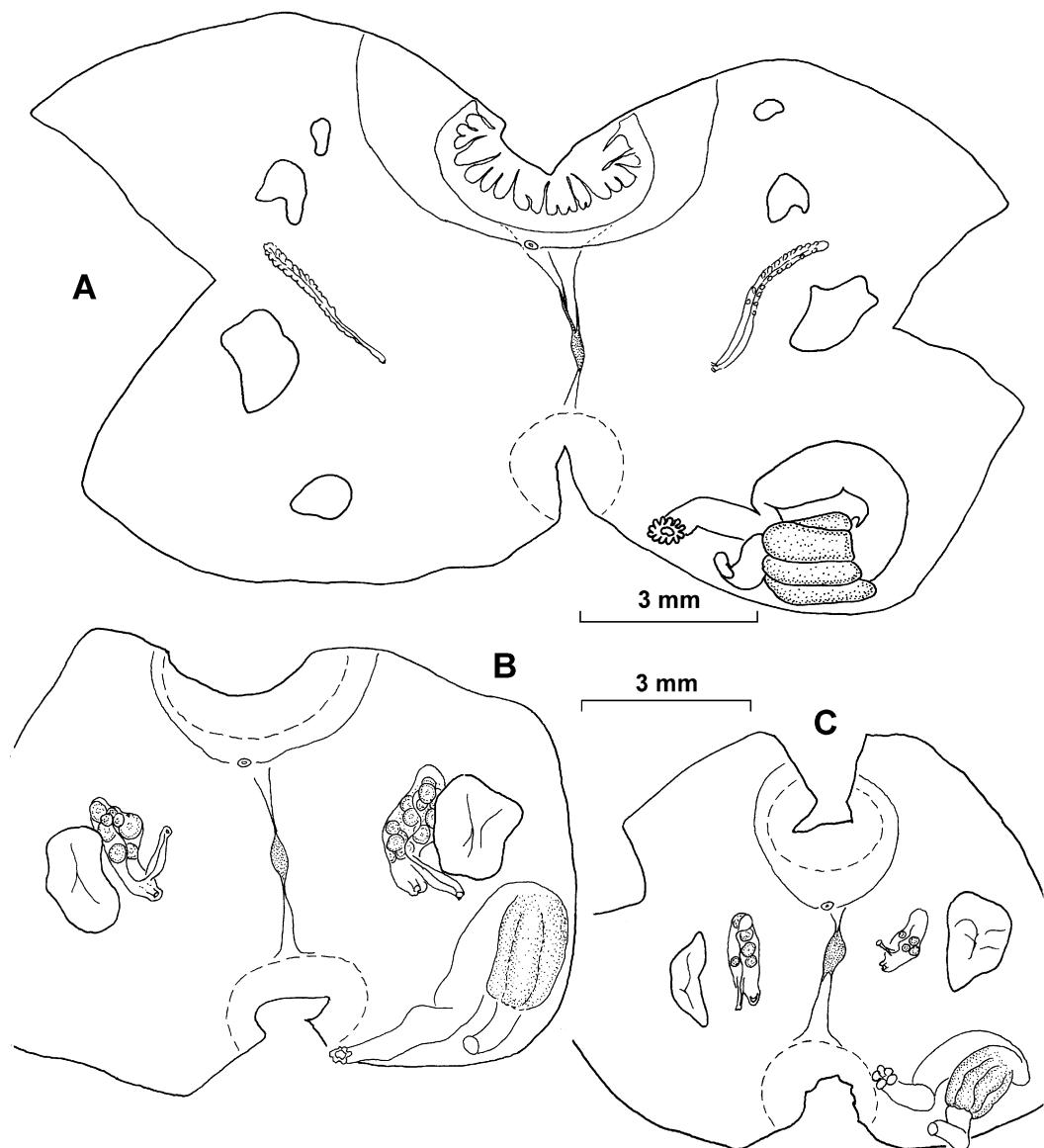


Figure 1. *Bathystyeloides enderbyanus* (Michaelsen, 1904). Specimens opened along ventral mid line; branchial sac removed. (A) Specimen from St. 6117; (B, C) specimens from St. 7168.

Specimens from St. 7168 and St. 7206 are smaller (about 4.5 mm diameter) and differ in having significantly longer ventral test hairs (several times longer than the body), the prepharyngeal band an equal distance from the branchial velum all around, gonads smaller with few large male follicles, and ova and only one endocarp on each side of the body (ventral side to the gonad). The branchial sac is as described above, but has fewer longitudinal vessels (about 50 on each side), and the distance between the dorsal tubercle and the ganglion is variable (see Figure 1B, C).

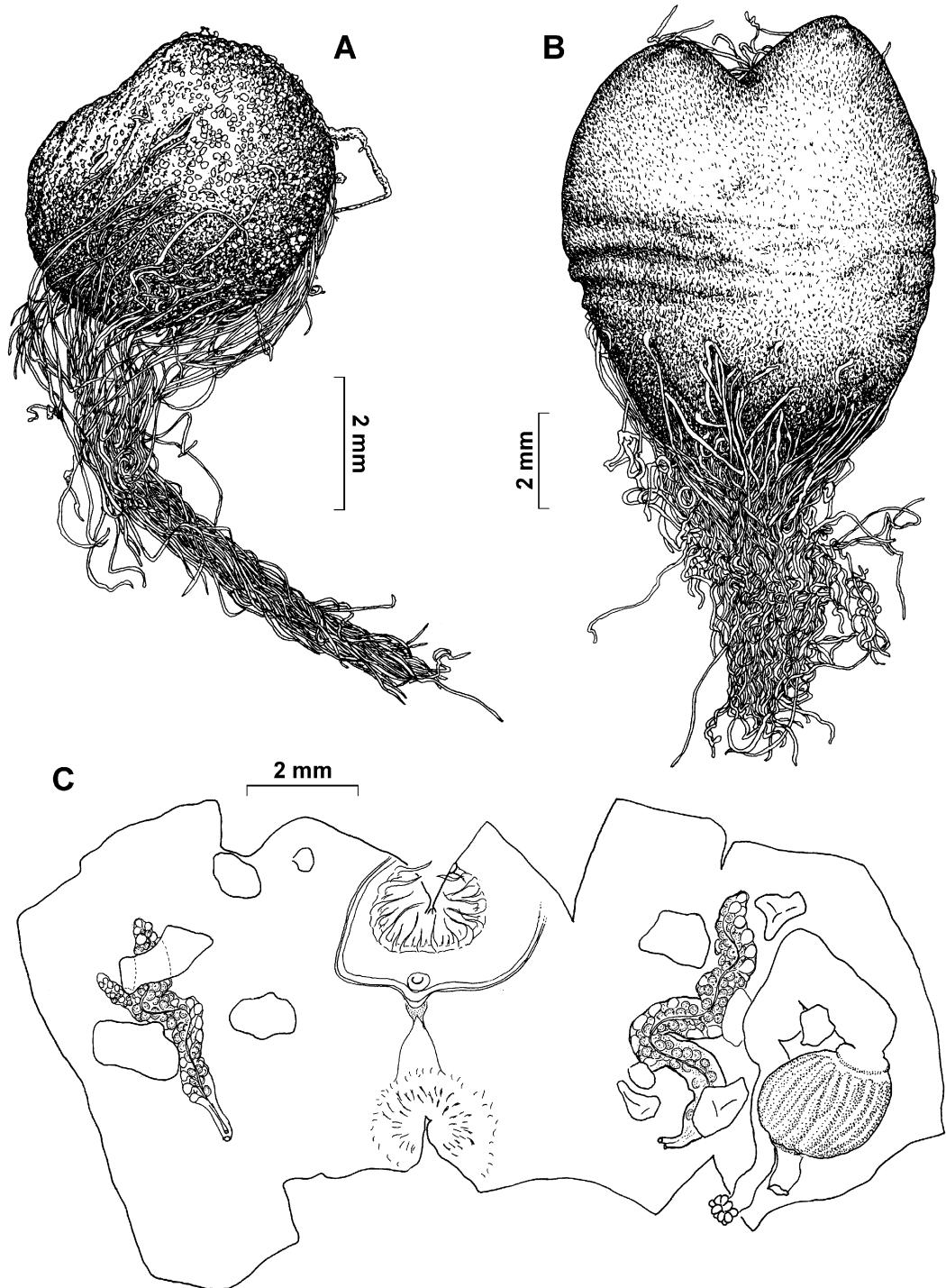


Figure 2. (A) *Bathystyeloides enderbyanus* (Michaelsen, 1904), intact specimen from St. 7168. (B, C) *Cnemidocarpa barbata* Vinogradova, 1962: (B) intact specimen; (C) specimen opened along ventral mid line; branchial sac removed.

Remarks

Bathystyeloides enderbyanus is a widely distributed, probably cosmopolitan, and an often recorded abyssal species. Although longitudinal stigmata were not reported for this species before, we believe they were overlooked by previous workers. These stigmata which are hidden in the inverted fold are not visible from the inner side of the branchial sac. We found longitudinal stigmata in every *Bathystyeloides* species examined (including numerous specimens from the Tasman Sea and from the region between Australia and Antarctica, the specimen from southwest Africa, and the present specimens from north and west Pacific). *Bathystyeloides magnus* Sanamyan and Sanamyan, 1999, distinguished from *B. enderbyanus* only by the presence of longitudinal stigmata, appears to be a junior synonym of the present species, its other characters, including the widely separated neural ganglion and dorsal tubercle and the relatively long gonads, being identical in the two taxa. *Bathystyeloides anfractus* Monniot and Monniot, 1985 also may be a synonym, differing from *B. enderbyanus* in the relative position of the ganglion and dorsal tubercle, a variable feature in *Bathystyeloides* that may depend on the size of the body.

The present record from 7440 m is the deepest record for Styelidae.

Cnemidocarpa barbata Vinogradova, 1962

(Figure 2B, C)

Cnemidocarpa barbata Vinogradova 1962, p 202; Monniot 1978, p 189; Kott 1990, p 268.

Material examined

St. 6109, 3460 m, one specimen; St. 6111, 2880 m, four specimens; St. 6117, 3350–3370 m, three specimens.

Description

The oval upright specimens are 7–10 mm high. Apertures are on the upper surface, slightly protruding in one specimen (Figure 2B), but sessile in the other. Much-branched test hairs are on the posterior end of the body, but otherwise the test is free from hairs or foreign particles and is covered by crowded minute papillae (similar to those on *Cnemidocarpa byrhia* (Herdman, 1881)). The test is thin and very difficult to separate from the body in alcohol-preserved specimens. The body musculature consists of thin but continuous layers of circular and longitudinal muscles.

About 20 large and a number of small branchial tentacles arise from a low branchial velum. A low atrial velum with a ring of atrial tentacles surrounds the inside opening of the atrial siphon. Sparse tentacle-like papillae are on the test lining inside of the atrial siphon. The prepharyngeal band composed of two lamellae, the anterior of which, about 0.3 mm high, is well separated from the branchial velum. The three poorly defined branchial folds have internal longitudinal vessels arranged more or less as in the following formulae from two of the newly recorded specimens: E5(14)(18)(12)4DL(14)6(19)4(9)7E and E10(11)15(10)10(17)12DL23(16)(16)18(11)11E. Several of the internal longitudinal vessels adjacent to the plain-edged dorsal lamina on the right side are significantly higher than the others. The dorsal lamina is removed from the closest longitudinal branchial vessel on the right, and transverse vessels connecting this vessel and the dorsal lamina are raised into laminar expansions.

One long *Cnemidocarpa*-type gonad is on each side of the body. In one specimen the left gonad is parallel and close to the gut loop and rectum (Figure 2C), in another it lies halfway between the gut and branchial siphon. Large male follicles are in two more or less regular lines between the ovary and the body wall along the whole length of the ovary projecting slightly from the sides of the ovary. The oviduct is short, and male and female openings are close to each other. The gut forms a simple short loop loosely attached to the body wall. The large globular stomach has about 20 well-defined longitudinal folds but a caecum was not detected. The anal margin has about 10 distinct rounded lobes. Five to eight large to medium-sized endocarps are on each side of the body, mainly around the gonads, and one is in the gut loop.

Remarks

Originally described from the Indian sector of Antarctica at 639 m (Vinogradova 1962), the species subsequently was recorded from the Kerguelen shelf (Monniot 1978) and from New South Wales (Australia) at 1200 m (Kott 1990). The present record from the northern Pacific is far from the previously recorded range and at a greater depth. However, we failed to find any reliable characters that could separate northern Pacific from the southern hemisphere specimens, apart from the atrial tentacles and the papillae on the whole inner surface of the atrial siphon. Such papillae are present in several deep-water Styelidae, for instance in *Cnemidocarpa bythia* (see Sanamyan and Sanamyan 2002, 2005), but they can usually be observed only after staining. They may be easily overlooked if the inner side of the atrial siphon is removed with the rest of the test. Externally, the present specimens look exactly as in the photograph of Monniot (1978, Figure 3C). Internally an outstanding character of this species is the relatively high anterior lamella of the prepharyngeal band (similar in north Pacific and Kerguelen specimens) which is higher than in other deep-water stylids. Kott (1990) noted some variations in the number of anal lobes, but she may have based that assessment on incorrect translation of the original Russian description; according to Vinogradova (1962) the anal margin has 15 small lobes (but is not bilabiate).

The newly recorded specimens are from greater depths than those previously reported for this species.

Styela hadalis sp. nov. (Figures 3, 4A)

Material examined

St. 7391, 6330 m, one specimen. Holotype KIE 1/1132.

Description

The small hemispherical specimen (about 6 mm diameter and 2.5 mm high) is attached by its wide ventral surface to a small stone. The rigid and almost naked test with only sparse sand grains and without hair-like processes expands basally to a thin flat membrane. The small sessile apertures are well spaced on the upper surface. The body wall is thin and transparent. Body muscles are confined to a few thin circular siphonal muscles. Muscles were not detected on the remainder of the body. Six short branchial tentacles arise from the

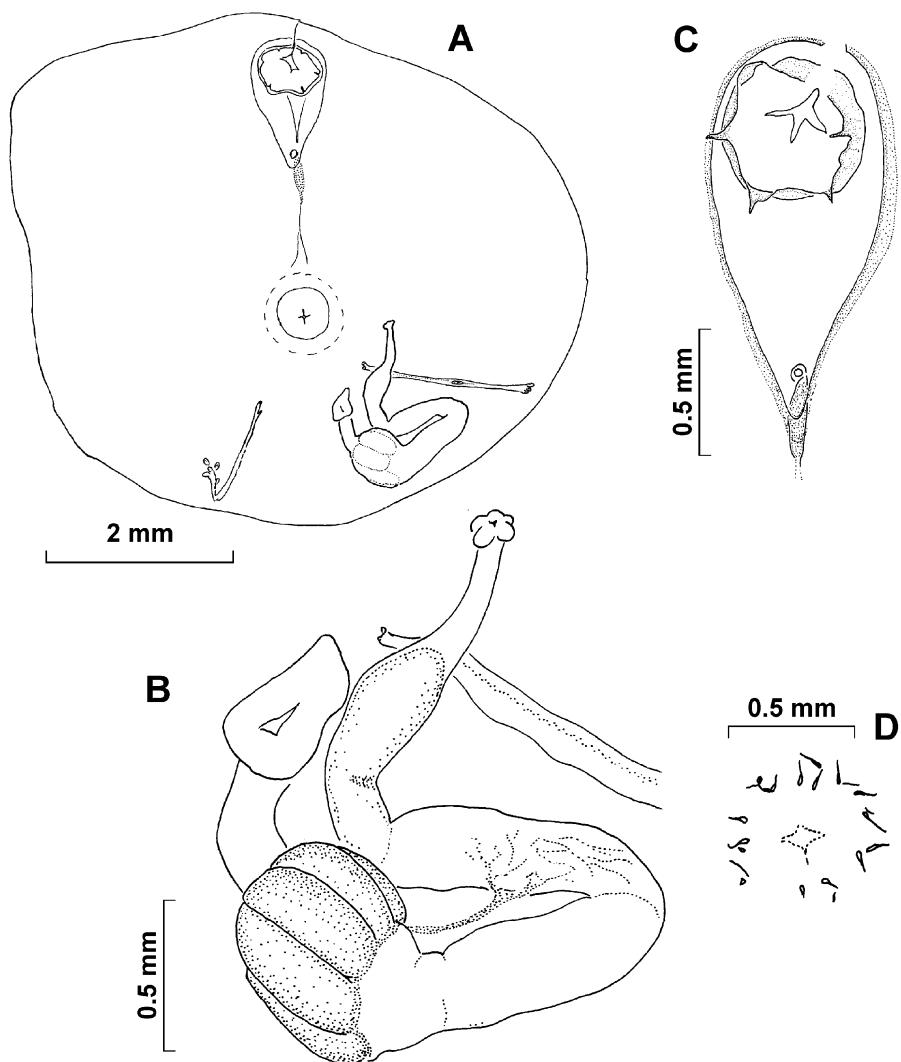


Figure 3. *Styela hadalis* sp. nov. (A) Specimen opened along ventral mid line; branchial sac removed; (B) gut loop and distal part of the left gonad; (C) branchial velum, prepharyngeal band, dorsal tubercle, and ganglion; (D) ring of atrial papillae.

margin of the high branchial velum. The prepharyngeal band is a single high lamella close to the branchial velum ventrally and making a deep, wide V dorsally. The neural ganglion is halfway between the siphons and the small round dorsal tubercle is just anterior to it. The dorsal lamina has a plain edge. The branchial sac is almost flat, with one poorly defined fold on each side. The distribution of the longitudinal vessels is: 6(5)3DL3(6)4. Longitudinal stigmata are in 10 or 11 transverse rows crossed by parastigmatic vessels (about two per mesh). Several short oblique or transverse stigmata are at the posterior end of the left side of the branchial sac.

The gut forms a short, narrow primary loop, and a relatively deep open secondary loop. The short stomach has six or seven well-formed longitudinal folds. There is a long gastrointestinal connective issued from the distal end of the stomach and branching into thin

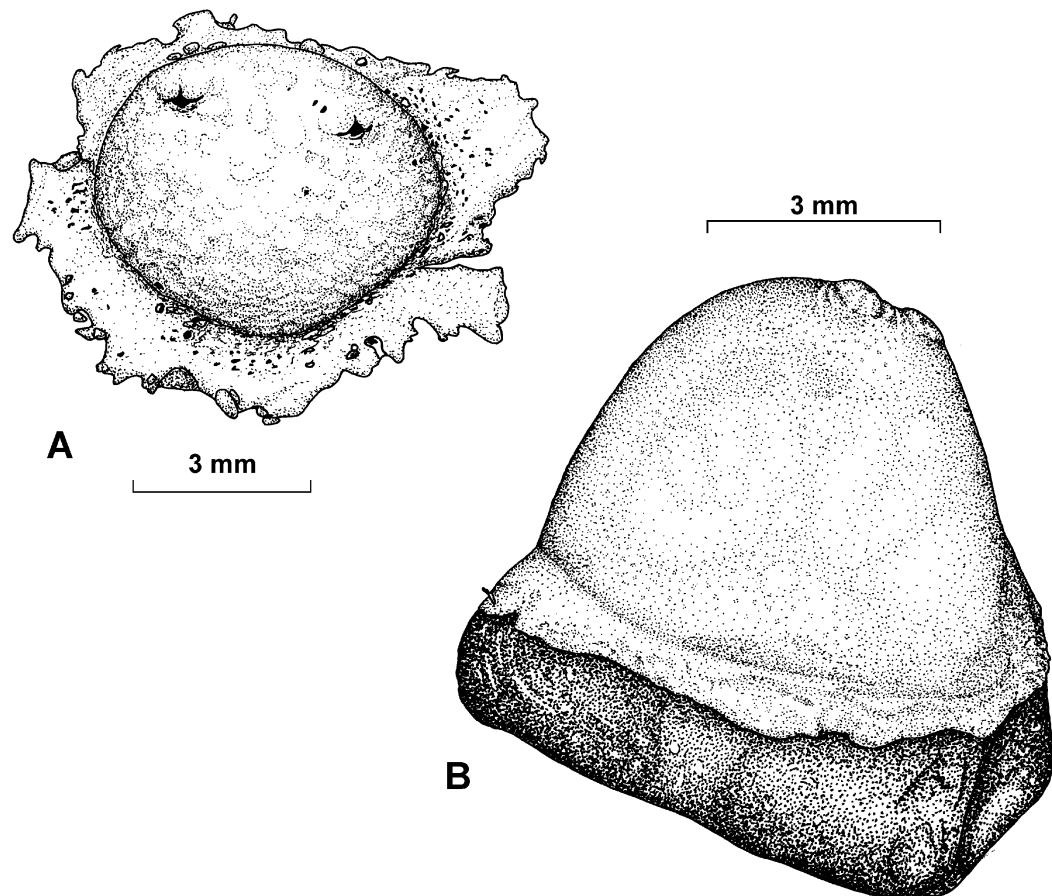


Figure 4. (A) *Styela hadalis* sp. nov.; (B) *Styela multotentaculata* sp. nov. External view.

vessels on the intestine. A gastric caecum is not present. The anal margin is divided into five distinct rounded lobes. One long narrow immature gonad is on each side of the body. Few, very small male follicles are closely applied to the proximal end of the ovary and the male duct runs along the mesial surface of the ovary to open close to the female opening. The atrial aperture is surrounded by a ring of short clavate atrial papillae, but a velum is not present. The atrial papillae are different from the atrial tentacles known in many deep-water Styelidae, and reminiscent of the papillae of *Pyurella hernia* Monniot and Monniot, 1973 (see Sanamyan and Sanamyan, 2005).

Remarks

The main distinguishing characters of the species are the absence of the endocarps, the few longitudinal vessels, only one fold on each side of the branchial sac and the body shape. In the absence of the endocarps and in the general form of gonads and gut loop, the species resembles *S. calva* Monniot, Monniot and Millar, 1976. The latter species has three or four branchial folds and more numerous vessels, smooth anal margin, hair-like processes on the test, and different branchial and atrial tentacles. *Cnemidocarpa sericata* (Herdman 1888)

also lacks endocarps, but has much more numerous branchial vessels and a different body shape. The absence of hair-like test processes and the body firmly attached by wide area to a solid object are unusual though not unique features for abyssal Styelidae, most of which are anchored in sediment by test processes. The presence and distribution of the test processes and foreign particles attached to the test, as well as the shape of the body, are remarkably stable characters in many abyssal ascidians and usually these features (often rather variable in shallow-water species) can be used safely to distinguish deep-water species. Among abyssal Styelidae *Cnemidocarpa bythia* (Herdman, 1881) and *Styela similis* Monniot, 1970 are always attached by a wide ventral area, but they have large endocarps.

This is the deepest known record of a *Styela* spp. Only two other Styelidae species are recorded at depths exceeding 6000 m: *C. bythia* recorded by Millar (1959) at 7000 m and *Bathystyeloides enderbyanus* recorded in the present work at 7450 m.

***Styela multotentaculata* sp. nov.**

(Figures 4B, 5)

Material examined

St. 6089, 170 m, one specimen. Holotype KIE 1/1133.

Description

A small dome-shaped specimen (about 5 mm high and 6 mm diameter at the base) is firmly fixed to a small stone by a wide flat ventral surface. The cloudy, translucent, thin but firm test spreads into a short membrane around the area of attachment. It has no hair-like outgrows and the surface is smooth and clear, without foreign particles. Small sessile apertures are close to each other, the branchial aperture terminal and the atrial aperture slightly displaced dorsally.

The body wall is thin, almost transparent and contains sparse stellate spicules about 0.02 mm in diameter. The muscles are weak and form a thin continuous layer. The branchial velum is wide but low. About 25 crowded branchial tentacles, short and rather thick, especially at their bases. The prepharyngeal band is a single lamella that runs close to the ring of tentacles and lacks a dorsal V. The large round dorsal tubercle has a simple transverse slit. The large oval neural ganglion is posterior and close to the dorsal tubercle halfway between the siphons. The high dorsal lamina has an uneven, slightly toothed margin (Figure 5C). The branchial sac has four pronounced folds with closely set inner longitudinal vessels. The interspaces between the folds are narrow and contain no more than two inner longitudinal vessels and it is difficult to decide if these vessels are in the interspaces or belong to the adjacent folds. The branchial formula is: 1(11)2(12)2(9)2(13)2DL0(9)2(6)2(11)0(11)0.

The gut forms a simple, narrow U-shaped loop. The oesophagus is relatively long and curved. The short, rectangular stomach has 16 well-defined longitudinal folds and a long curved caecum. The long intestine ends in an anus with the rim divided into several distinct lobes. Gonads are well developed, one on each side of the body. Ovaries are thick deeply undulating tubes of moderate length, ending in short oviducts in a distance from the atrial orifice. Numerous large, deeply subdivided male follicles form a compact voluminous mass behind the proximal end of the ovary. As seen from the outside (Figure 5B), the male

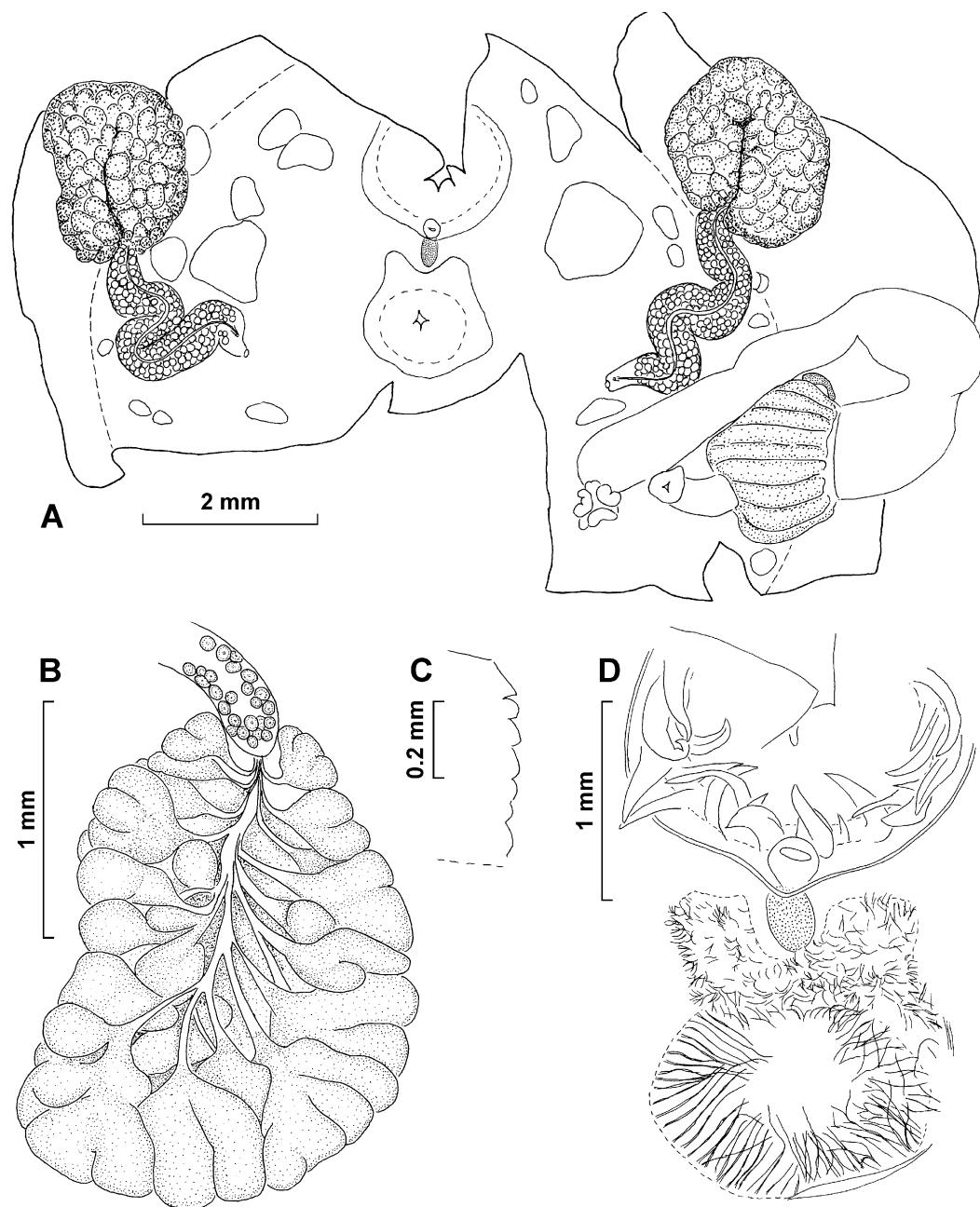


Figure 5. *Styela multotentaculata* sp. nov. (A) Specimen opened along ventral mid line; branchial sac removed; (B) proximal part of the right gonad, external view through the transparent body wall (male follicles and the proximal end of the ovary); (C) part of the dorsal lamina; (D) internal view of the dorsal area (branchial and atrial tentacles, prepharyngeal groove, dorsal tubercle, and ganglion).

follicles are completely posterior to the ovary and do not overlap it. They join to single thick duct running between the male gonad and body wall and then along the mesial surface of the ovary. The male opening is almost sessile, on a short inconspicuous papilla near the

oviductal opening. One large and several smaller endocarps are on each side of the body but not in the gut loop. The atrial tentacles are peculiar: they are unusually long (longer than the branchial tentacles), filiform and extremely numerous, arranged in a perfect circle around the atrial aperture and are crowded on two anterior lamellar expansions of the body wall, on the sides of the neural ganglion (Figure 5D).

Remarks

The present species has some resemblance to the small hemispherical specimens identified (by Lutzen 1959) as young specimens of *Styela gelatinosa* Traustedt, 1886. Individuals of *Styela gelatinosa*, however, are large reaching 84 mm high. The present specimen, 5 mm high, with its voluminous mature gonads, cannot be a young specimen of *S. gelatinosa*. Another similar species, *S. squamosa* Herdman, 1881 (described below), is also significantly larger than *S. multotentaculata* sp. nov., has the plain-edged dorsal lamina, and its male follicles are spread around or overlap the posterior end of the ovary rather than forming the compact mass behind the ovary as in the present species. *Styela coriacea* (Alder and Hancock, 1848) has a similar body shape, but the gonads are different, the male follicles being distributed along the side of the ovary.

Styela multotentaculata sp. nov. has significantly longer and more numerous atrial tentacles than the other ascidians we have the opportunity to examine. The stellate spicules in the body wall also may be characteristic of the species rather than an artefact of fixation as they are not present in the other ascidians from the same station kept for many years in the same bottle. This, however, needs to be confirmed on more material.

Styela sigma Hartmeyer, 1906 (Figure 6)

Styela sigma Hartmeyer 1906, p 12; Nishikawa 1991, p 123; Sanamyan 2000, p 70.

Not *Styela sigma* Monniot and Monniot 2003, p 715.

Styela atlantica: Tokioka 1953, p 264; 1967, p 191; Tokioka and Nishikawa 1977, p 23.

Material examined

St. 6132, 1100–830 m, one specimen.

Description

The specimen, about 1.5 cm diameter, is attached by the wide ventral surface to a hexactinellid sponge. The apertures are close together on the upper surface, on short diverging siphons. The test is hard and rigid, opaque, roughly wrinkled and has firmly attached, fine, sparse sand grains. About 25 short tentacles of two size orders are on a low branchial velum. The prepharyngeal band has a shallow dorsal V around the large dorsal tubercle, which has a U-shaped slit. The high dorsal lamina is plain edged. The branchial sac has four prominent folds. The branchial formula is: 4(8)7(13)3(14)3(18)4DL3(10)6(13)4(13)4(7)3.

The gut forms a narrow, almost straight loop with a large voluminous stomach, thick intestine and long rectum. The stomach has about 20 conspicuous internal longitudinal folds and a small caecum. The anal margin has a number of small rounded lobes.

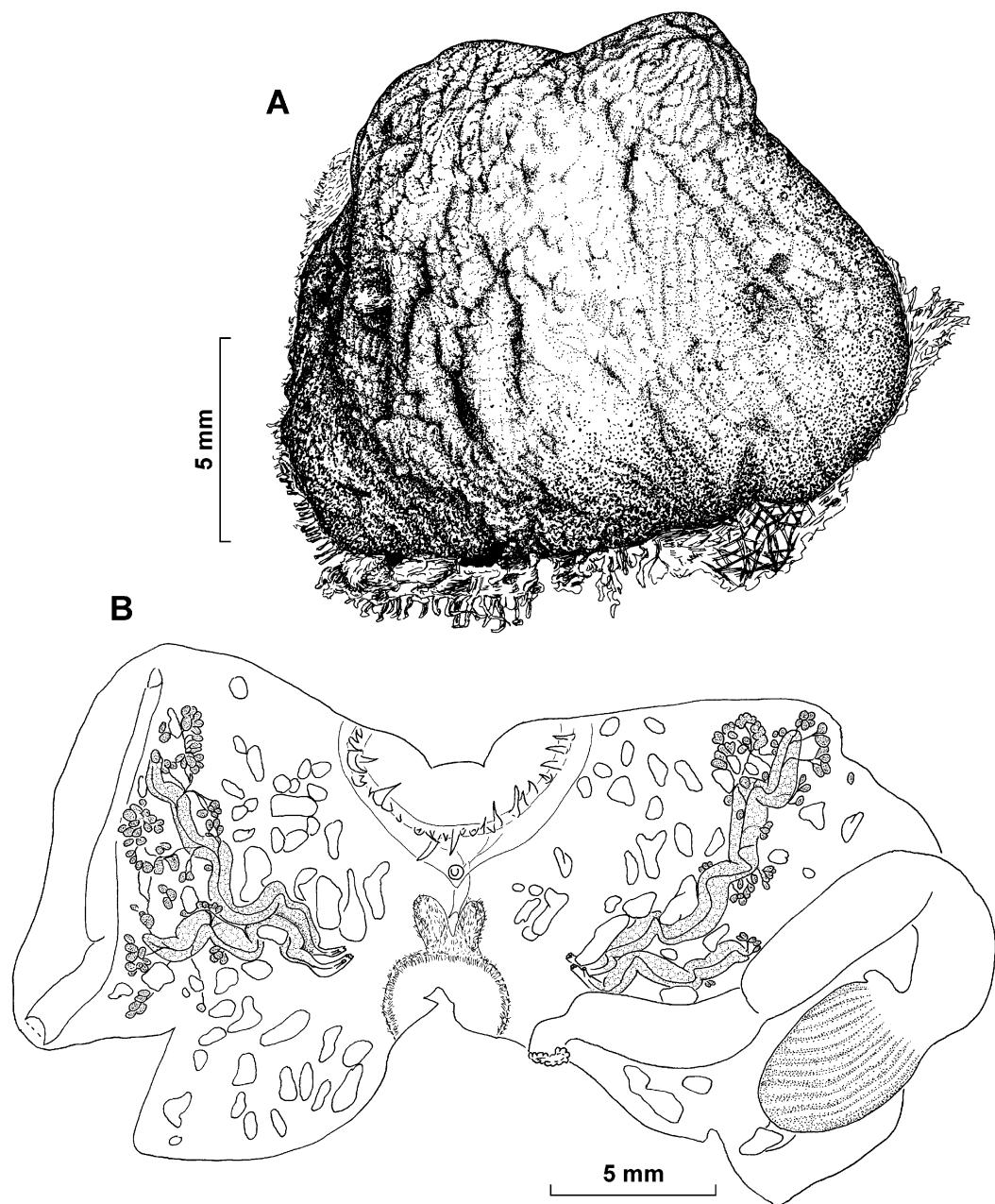


Figure 6. *Styela sigma* Hartmeyer, 1906. (A) External view; (B) specimen opened along ventral mid line; branchial sac removed.

Two gonads are present on each side of the body. The ovaries are long and thick, their distal halves converging. On the left side the anterior ovary almost reaches mid-ventral line above the pole of the gut loop, the ventral (proximal) end of the posterior ovary (which is less than half the length) is in the middle of the secondary gut loop. On the right, both have their proximal ends against the thick tubular heart. Small, pear-shaped male follicles are in

bunches around and some distance from the proximal halves of the ovaries. Many medium-sized endocarps are spread over the inner body wall. Numerous atrial tentacles form a wide band encircling the atrial siphon and are crowded on two anterior lamellar expansions of the body (Figure 6B).

Remarks

We follow Nishikawa (1991) in referring at least Pacific records of *S. atlantica* (Van Name, 1912) to this species. The large specimen from the Philippines described by Monniot and Monniot (2003) has a very long rectum and differs from all other Pacific specimens (see synonymy) in the relative length of the ascending and descending limbs of the gut loop. The male part of the gonad, consisting of a few entire male follicles arranged in a row around the proximal end of each ovary, also differs from north Pacific specimens. The Philippine specimen belongs to another species. The other records of this species include Japan, East Kamchatka, and the Aleutian Islands.

Styela squamosa Herdman, 1881

(Figures 7–9)

Styela squamosa Herdman 1881, p 66; Monniot and Monniot 1982, p 113; 1983, p 77; 1994, p 33; 2003, p 717; Monniot 1993, p 356; Millar 1988, p 1430.

Styela oblonga Herdman 1881, p 65.

Tethyum tholiforme Sluiter 1912, p 455.

Styela milleri Ritter 1907, p 21; Van Name 1945, p 308; Millar 1964, p 62; 1969, p 91.

Styela gracilocarpa Millar 1982, p 80.

Styela maculata Sanamyan 1992, p 192.

Material examined

St. 6142, 5000–4990 m, one specimen; St. 2323, 4890–4984, one specimen.

Description

Upright, cylindrical, or oval specimens, the largest (St. 6142) 3 cm high and 1.5 cm diameter, firmly attached to small stones by the whole basal surface and with a tuft of rhizoids spreading over the stone. The test is hard and thin and its surface is warty, densely wrinkled and dirty grey-brown. Two small inconspicuous sessile apertures are on opposite ends of the upper surface.

The body wall is thick and muscular. About 30 thick and long branchial tentacles are on a low velum. The prepharyngeal band is a single thick lamella and has a V-shaped notch around the round dorsal tubercle, which is halfway between the siphons and has a U-shaped slit. The large neural ganglion is close to the dorsal tubercle, displaced slightly to the left. Extending from it are a pair of branched anterior nerves, and a pair of unusually thick posterior nerves running to the atrial siphon. The high dorsal lamina has a plain, but folded margin. The branchial sac is thick and has four low folds and crowded internal longitudinal vessels. The branchial formula for the largest specimen is: 4(10)7(17)7(18)6(20)2DL4(15)4(20)7(11)10(8)2. Stigmata are long and often are crossed by parastigmatic

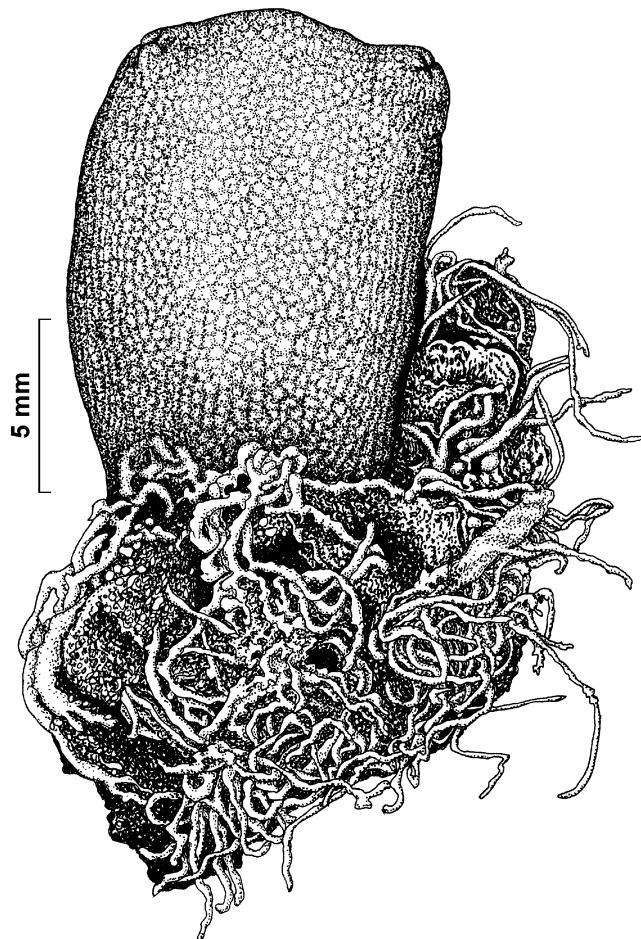


Figure 7. *Styela squamosa* Herdman, 1881. Specimen from St. 2323, external view.

vessels. Up to nine stigmata per mesh are between the folds, but in most places are fewer, and on the folds the longitudinal vessels are set very close to each other.

The small stomach has about 20 distinct longitudinal folds and a small caecum. The shape of the gut loop is slightly different in the two specimens and probably depends on the shape of the body. The larger specimen (St. 6142, Figure 8) has an almost straight, vertical, narrow J-shaped loop and an almost straight intestine, the smaller specimen (St. 2323, Figure 9A) has a narrow, closed primary loop and widely opened secondary loop. The anal opening, bordered by many small lobes, is just below the atrial orifice.

One long gonad is on each side of the body; the left is almost straight and the right with its the posterior end turned slightly ventrally. Numerous small male follicles form a compact mass around the posterior end of each ovary. Many medium-sized endocarps are spread over the inner body wall. Numerous thin and short atrial tentacles are on a short velum with two prominent anterior horns (Figure 8A).

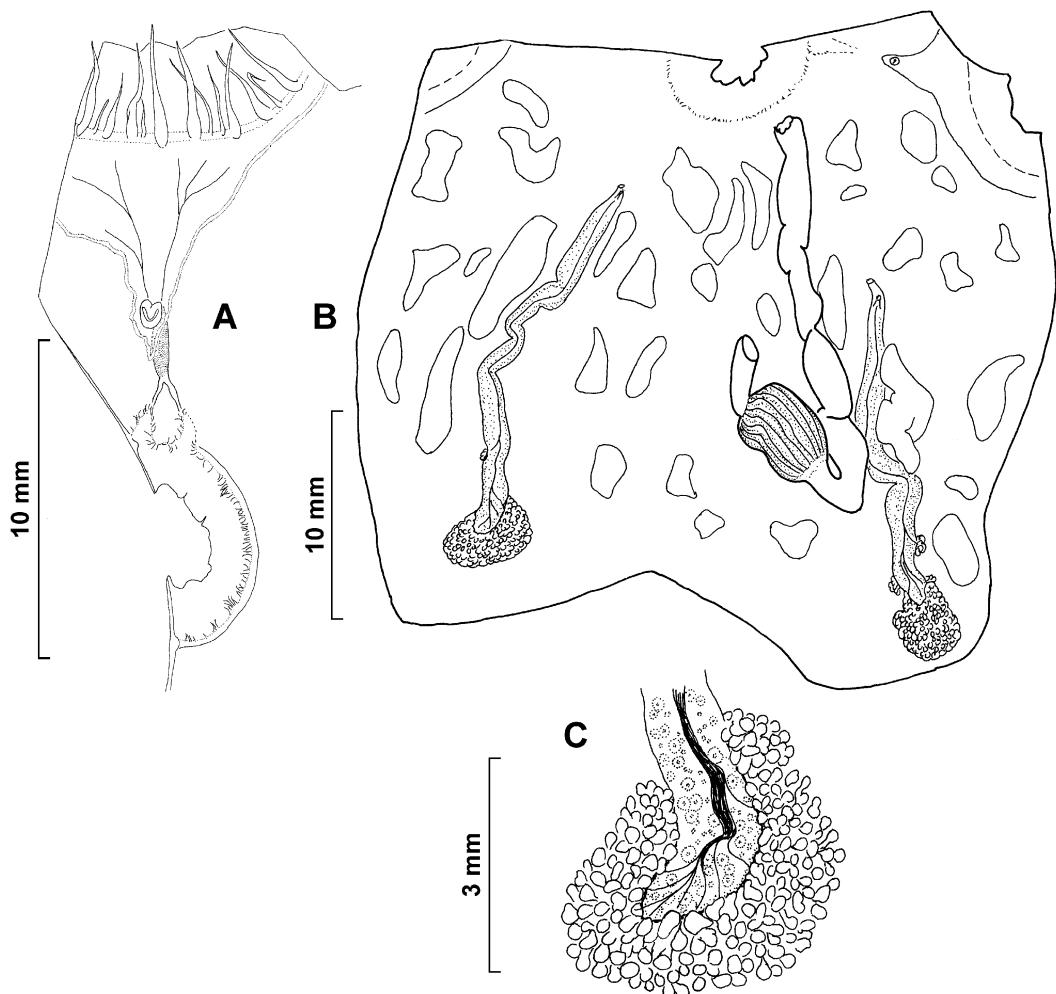


Figure 8. *Styela squamosa* Herdman, 1881. Specimen from St. 6142. (A) Internal view of the intersiphonal area (branchial and atrial tentacles, prepharyngeal groove, dorsal tubercle and neural ganglion); (B) specimen opened along ventral mid line; branchial sac removed; (C) proximal part of the right gonad.

Remarks

Monniot and Monniot (1982, 1983) re-examined types of *S. squamosa*, *S. oblonga*, and *Tethyum tholiforme* and synonymized these species. Although *S. oblonga* has page priority, *S. squamosa* was chosen as the valid name.

Monniot (1993) listed *S. milleri* and *S. gracilocarpa* as probable synonyms of *S. squamosa* and this opinion is adopted here. According to the original description, *S. milleri* has 18 or 20 longitudinal vessels on each face of the largest folds, giving 36–40 vessels per fold (Ritter 1907). This number is twice that in all other recorded specimens and it is likely that the specimen had 18–20 vessels on the entire fold (rather than on each face). Millar (1982, p 80) distinguished his *S. gracilocarpa* (with 20 longitudinal vessels on the largest fold) from *S. milleri* only by “many fewer longitudinal branchial bars in animals of similar size”, although previously he (Millar 1959) identified a specimen having only 11 vessels as *S.*

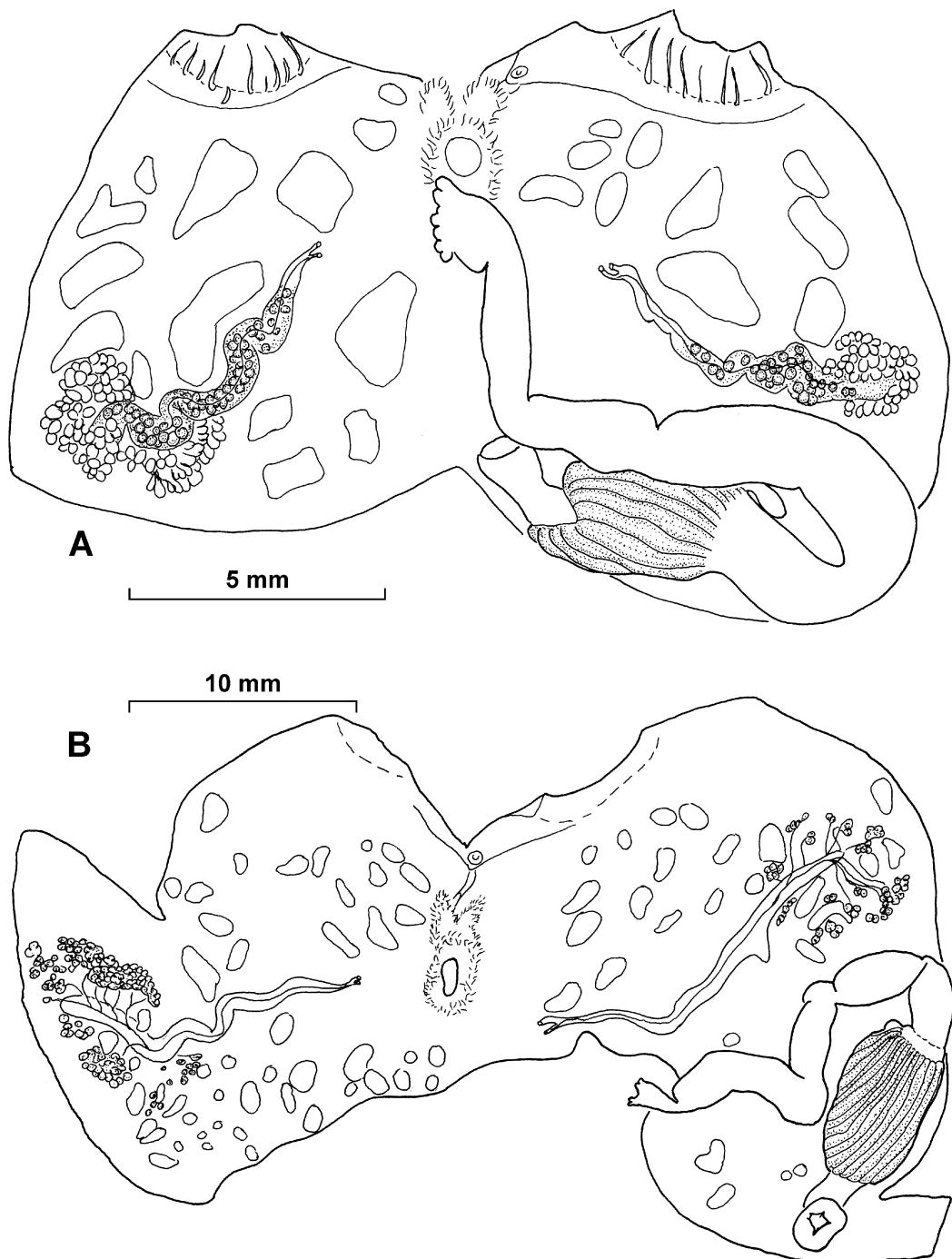


Figure 9. *Styela squamosa* Herdman, 1881, specimens opened along ventral mid line; branchial sac removed. (A) Specimen from St. 2323; (B) paratype of *S. maculata* Sanamyan, 1992.

milleri. An abnormal specimen with numerous male openings recorded by Millar (1964) as *S. milleri* also certainly belongs to *S. squamata*. We examined the similar specimen from New Zealand (at 1600 m), and found a single male opening on the left gonad, but four male papillae on the right.

The specimens described as *S. maculata* by Sanamyan (1992) are similar to the present specimens, but have slightly different gonads: the male follicles are attached to the body wall some distance from the ovary (Figure 9B). Although all known specimens of *S. maculata* (nine specimens from the Sea of Okhotsk, 1500 m) have the same gonads, suggesting the stability of this feature, it hardly seems a sufficient character to distinguish the two species and *S. maculata* is synonymized here with *S. squamosa*.

These are the greatest depths so far recorded for the species.

***Styela tenuibranchia* Monniot, Monniot and Millar, 1976**
(Figure 10)

Styela tenuibranchia Monniot et al. 1976, p 1193; Monniot and Monniot 1985b, p 297;
Sanamyan and Sanamyan 1999, p 1850.

Material examined

St. 6109, 3460 m, five specimens; St. 6117, 3350–4990 m, one damaged specimen.

Description

Oval specimens 5–8 mm diameter, all of similar appearance. The body is covered with short, not very crowded hairs with a naked area only around and between the siphons. The hairs may be sparser laterally and ventrally. Sparse minute sand grains are attached to the test and its hairs. About 14 short, flattened branchial tentacles are present. The prepharyngeal band makes a circular line without a dorsal indentation. The branchial sac is flat, without any trace of folds. The number of the internal longitudinal vessels on each side appears to be about 50–60 (although in the preserved specimens the right and left sides of the branchial sac adhered strongly to each other and obscured the exact number of vessels). The shape and position of the gonads and endocarps, the gut loop with the short folded stomach and conspicuous caecum, and a smooth anus (Figure 10B) are as described for the specimens from the Coral Sea (Sanamyan and Sanamyan 1999).

Remarks

The present record of this species from the Gulf of Alaska is far from all the previous records (Indian Ocean near Sri Lanka, Tasman Sea, and Coral Sea). The present specimens are smaller and have less numerous longitudinal branchial vessels than recorded for southern hemisphere specimens, Monniot et al. (1976) recorded more than 100 and Sanamyan and Sanamyan (1999) recorded 95–100 vessels on each side of the branchial sac.

***Bathypera ovoida* (Ritter, 1907)**

Halomolgula ovoida Ritter 1907, p 3.

Bathypera ovoida: Van Name 1945, p 369; Nishikawa 1981, p 187; Sanamyan 1992, p 188; 1996, p 205; Monniot 1998, p 552.

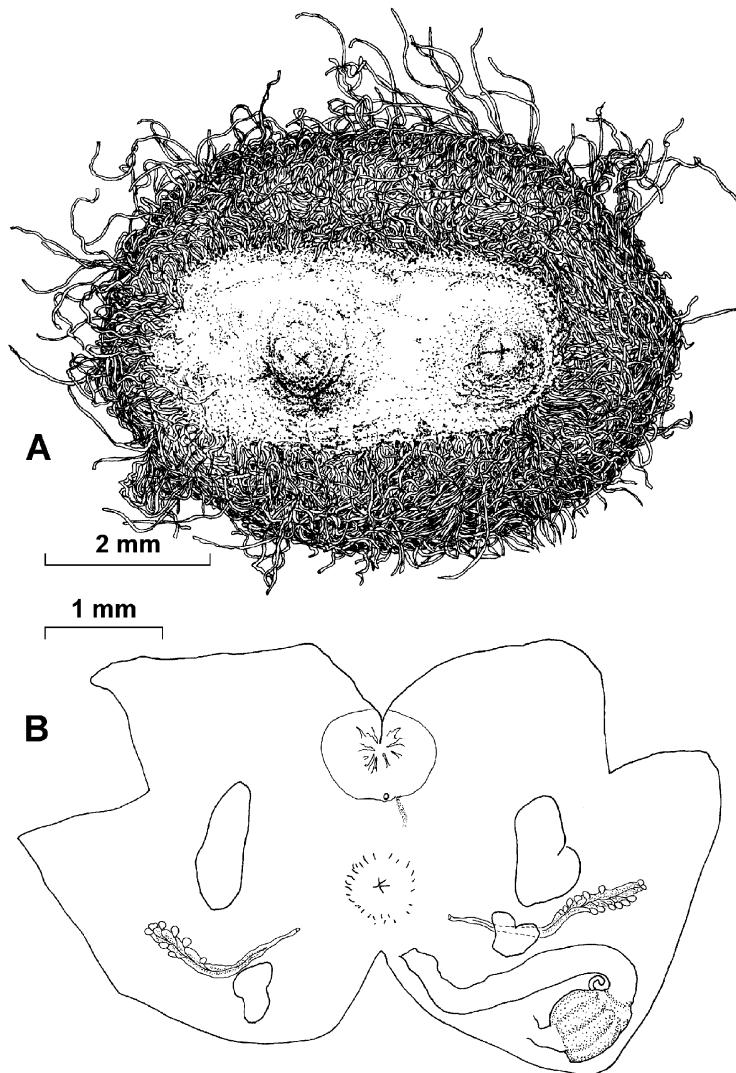


Figure 10. *Styela tenuibranchia* Monniot et al., 1976. (A) Intact specimen; (B) specimen opened along ventral midline; branchial sac removed.

Material examined

St. 6132, 1100–830 m, one specimen.

Remarks

This easily recognizable species has a wide range in the North Pacific. Monniot (1998) erroneously reported the species from 40°45.5'S, the correct locality is 40°45.5'N.

Genus *Culeolus* Herdman, 1881

Vinogradova (1970) reported on four *Culeolus* and one *Paraculeolus* species from the Kurile-Kamchatka Trench. Part of her material has been re-examined. The brief redescriptions of

the four *Culeolus* species (below) complement Vinogradova's detailed accounts, especially in regards to some details of internal structure, including the disposition of the gonads.

***Culeolus longipedunculatus* Vinogradova, 1970**

(Figure 11)

Culeolus longipedunculatus Vinogradova 1970, p 503.

Material examined

St. 5621, 5035–5220 m. One intact specimen marked by Vinogradova as "Paratype 1".

Description

The body length is 65 mm, the peduncle is long but not complete, an entire peduncle being 132.5 cm long (Vinogradova 1970). The peduncle is much thinner than in other *Culeolus* species, being 0.4–0.5 mm in diameter along its whole length. The thin, translucent, whitish test is covered with small hemispherical papillae, some of which have an opaque central granula. The T-shaped postero-ventral crest consists of soft high lamellae. A shorter mid-ventral branch and longer branches extend obliquely along each side from the postero-ventral point, and end halfway along the body (far from the atrial siphon). Branchial and atrial orifices are large.

The body wall is thin and translucent except for a thickened area around the branchial and atrial siphons. The body muscles, composed of circular and radial ribbons, form a rather regular network. The circular muscles are crowded around the siphons and form a sphincter under the ring of tentacles, which projects slightly from the body wall. Thin, short and weakly branched branchial tentacles do not protrude outside of the branchial aperture. They are sparse and not numerous, about 15 larger tentacles belonging to the first and the second size orders, with numerous minute slender tentacles irregularly distributed between them. A thick and high prepharyngeal band runs close to the ring of tentacles ventrally and laterally and makes a wide dorsal V around the large dorsal tubercle. The branchial sac has six folds on each side with wide flat intervals between them. The branchial formula is: 2(4)3(8)4(9)5(11)4(10)5(9)2DL3(10)4(9)5(6)4(6)4(7)3(3)2.

Two thick, elongate-oval gonads are on each side of the body. They are not divided into lobes and each is completely covered by a large endocarp. The gonads are in the anterior half of the body, and are parallel to each other and to the longitudinal axis of the body. On the left both gonads are outside of and removed from the open gut loop. The leaf-like lobulated hepatic diverticulae are in two series, one along each side of the stomach. The anus has a slightly undulating margin, but without distinct lobes.

Remarks

The type material consists of three large specimens from one station in the Kurile-Kamchatka Trench. The main distinguishing features are the large body, very long and thin peduncle, T-shaped postero-ventral crest consisting of plain high lamellae, and the two compact gonads on each side of the body with those on the left all outside the gut loop. *Culeolus likae* is a similar species, but has three gonads on each side, one of which is in the gut loop. The small test papillae, and a two or three times thinner peduncle also may

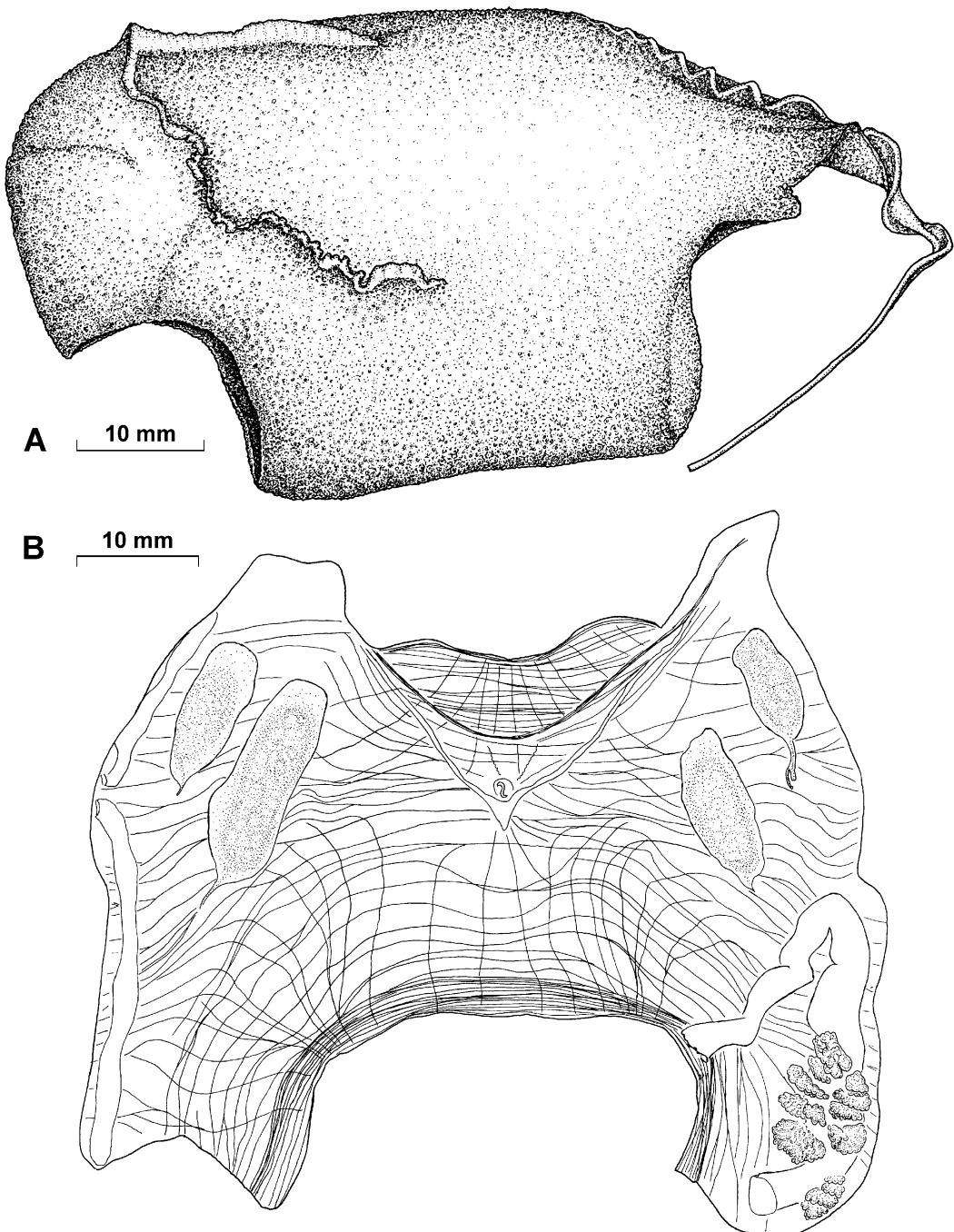


Figure 11. *Culeolus longipedunculatus* Vinogradova, 1970. (A) Intact specimen (whole stalk not shown); (B) specimen opened along ventral mid line; branchial sac removed to show gut, gonads, and muscles.

distinguish *C. longipedunculatus* from *C. likae*, but the stability of these features needs to be confirmed.

***Culeolus tenuis* Vinogradova, 1970**

(Figure 12)

Culeolus tenuis Vinogradova 1970, p 941; Sanamyan and Sanamyan 1998, p 214.

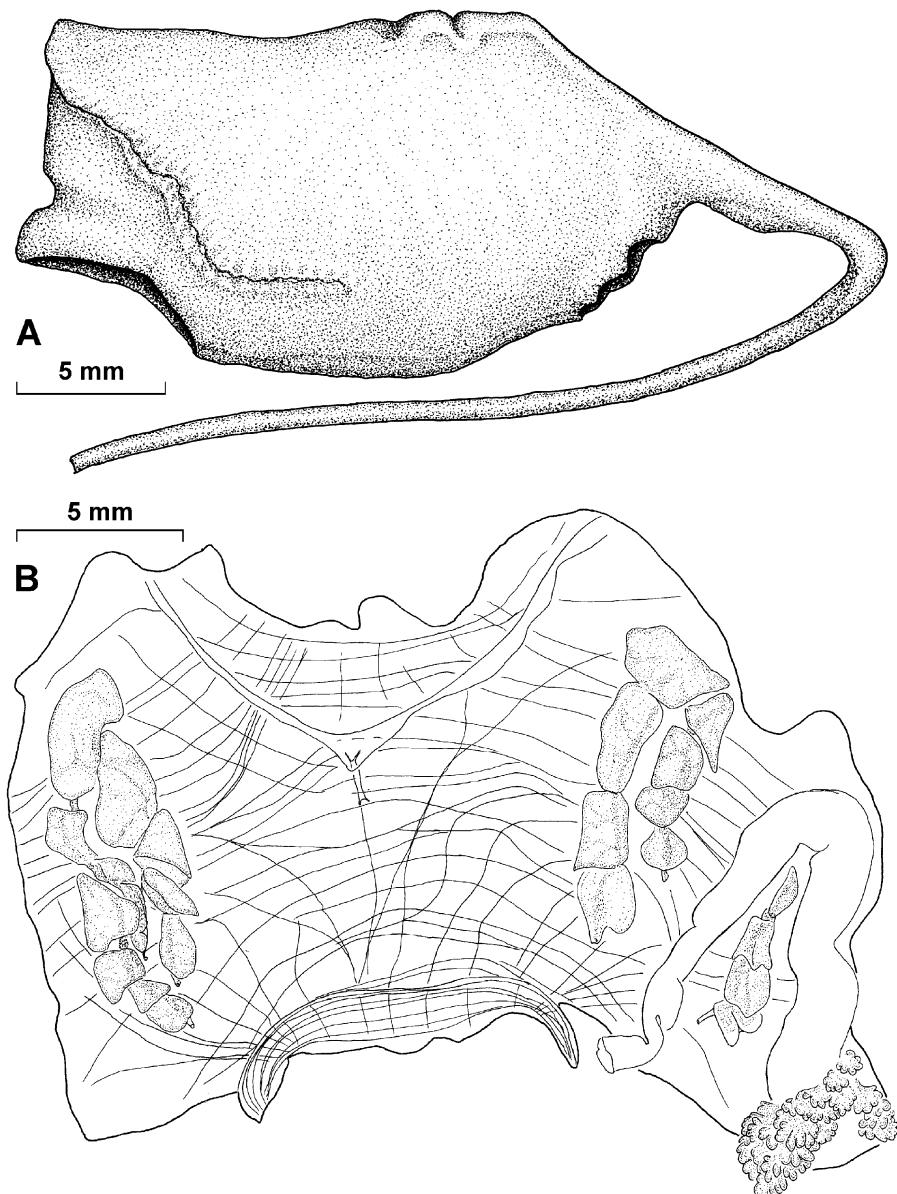


Figure 12. *Culeolus tenuis* Vinogradova, 1970. (A) Intact specimen (whole stalk not shown); (B) specimen opened along ventral mid line; branchial sac removed to show gut, gonads, and muscles.

Material examined

St. 5621, 5030–5031 m, two intact specimens identified as *Culeolus tenuis* by Vinogradova.

Description

The body length of the examined specimen is 22 mm, the entire peduncle is 126 mm long and 0.7–0.9 mm diameter. The surface of the pale yellowish test is almost smooth, without papillae. The postero-ventral crest consists of a low thick lamella crossing the mid-ventral line in the postero-ventral point of the body and continuing obliquely along each side to end halfway between the siphons, not reaching the dorsum.

The body wall is thicker and less transparent than in *C. longipedunculatus*. The inner surface is uneven, raised in places into low, cushion-like elevations filled with sparse, opaque yellowish granules. Body muscles form a regular network with more or less rectangular meshes. The circular muscles are crowded around the siphons. Branchial tentacles number about 18, the dorsal ones appreciably larger than the others. The mid-dorsal tentacle reaches the bottom of the branchial sac. The prepharyngeal band, just behind the ring of tentacles, makes a wide but shallow dorsal V around the almost flat and inconspicuous dorsal tubercle. The branchial sac has six well-defined folds with wide flat intervals between them. The branchial formula is: 6(4)2(6)3(7)3(7)3(8)3(7)2DL2(8)3(6)3(5)5(6)4(7)3(6)3.

Three gonads each of four or five lobes are on each side of the body. On the left side one gonad is inside the gut loop; on the right, the three gonads are close and parallel, forming a compact group. The anal margin is undivided.

A cluster of large zooids of Hydrozoa of the family Calycopsidae (identified by Dr. O. Sheiko) was found in the branchial sac, one was attached to a branchial tentacle.

Remarks

The specimens described by Vinogradova (1970) (Kurile-Kamchatka Trench) and Sanamyan and Sanamyan (1998) (Aleutian Trench) have abundant spicules in all tissues, while the present specimen lacks spicules confirming that this feature cannot be used as a species-specific character. According to Vinogradova (1970), *C. tenuis* is abundant in the Kurile-Kamchatka Trench, 40 specimens of this species being found at six stations at 5035–6282 m. Sanamyan and Sanamyan (1998) recorded a larger (body length 10 cm) specimen in the western point of the Aleutian Trench, 6074–5300 m. Despite its larger size the latter specimen had the same number of gonads (two on the left, and three on the right) and each gonad has the same number of lobes. The distribution of the gonads is also similar, two left gonads being above and one inside the gut loop.

This species was regarded as a probable synonym of *C. sluiteri* Ritter, 1913 (see Monniot and Monniot 1991, p 421), but they certainly are not conspecific. *Culeolus sluiteri* has large papillae on the test and a different postero-ventral crest. The number of gonads is similar, *C. sluiteri* having three gonads on the right and one on the left, the latter inside the gut loop. Ritter (1913) stated that the presence of only five branchial folds is one of the significant distinguishing features of his species. The number of the branchial folds appears to be relatively stable in *Culeolus* (the other species which consistently has five folds is *C. anomalous*).

Another related species, *C. nadejdae* Sanamyan, 1992, has up to five gonads on the left, all of which, unlike *C. tenuis*, are in the gut loop. *Culeolus nadejdae* appears to be more

closely related to *C. sluiteri* than to *C. tenuis*; differing from *C. sluiteri* only in the number of gonads in the gut loop, and in having six branchial folds.

***Culeolus suhmi* Herdman, 1881**

(Figure 13)

Culeolus suhmi Herdman 1881, p 86; Sanamyan and Sanamyan, 2002, p 350 (synonymy); 2005, p 15.

Culeolus ushakovi Redikorzev 1941, p 183.

Culeolus murrayi: Vinogradova 1970, p 498.

?*Culeolus murrayi* Herdman 1881, p 83; 1882, p 91; Monniot and Monniot 1982, p 117.

Material examined

St. 5621, 5035–5220 m, nine specimens (identified by Vinogradova 1970 as *C. murrayi*); St. 6143, 4820 m, two specimens.

Description

The specimens from St. 5621 are too mutilated and the description is based on a 24 mm long specimen from St. 6143 (Figure 13). The surface is covered by crowded small, hemispherical or sometimes pointed vesicles, many of which have opaque granulae inside. A complete ring of long crowded papillae encircles the posterior end of the body with the atrial aperture in the centre of this ring. The ventral papillae are noticeably longer than on the sides of the body and they are covered by the same minute warts as on the remainder of the test. Similar large papillae are in short transverse rows running from each corner of the branchial aperture to the base of the peduncle at the antero-ventral point of the body. A few separate and relatively long papillae are on the mid-ventral line, but they do not form a distinct mid-ventral crest.

The body wall is thick and opaque. The radial and circular muscles form a regular meshwork as in *C. tenuis* but muscle bands appear to be much thicker. The tentacles are few and not much branched: the longest dorsal tentacles have only few short, sparse, primary branches, while the smaller branchial tentacles may be simple (not branching). The specimen has two gonads on each side. On the right the anterior gonad is composed of three large lobes, the posterior gonad is shorter and not divided. On the left, one gonad is in the gut loop and has two masses of male follicles covered by a single large endocarp, and another small undivided gonad is outside the loop, halfway along its descending limb, close to the intestine. The anal margin has about 10 distinct lobes. Spicules are present in all organs.

Remarks

The specimen described above, from the northeast Pacific, is identical with the specimens from the Kurile-Kamchatka Trench identified by Vinogradova (1970) as *C. murrayi*. Vinogradova did not describe their internal structure, concentrating instead on a detailed description of the external appearance, relative length of the body and its peduncle, and variations in the shape of the dorsal tubercle. It is clear that her identification is based mainly on the external resemblance of her specimens and the specimen of *C. murrayi*.

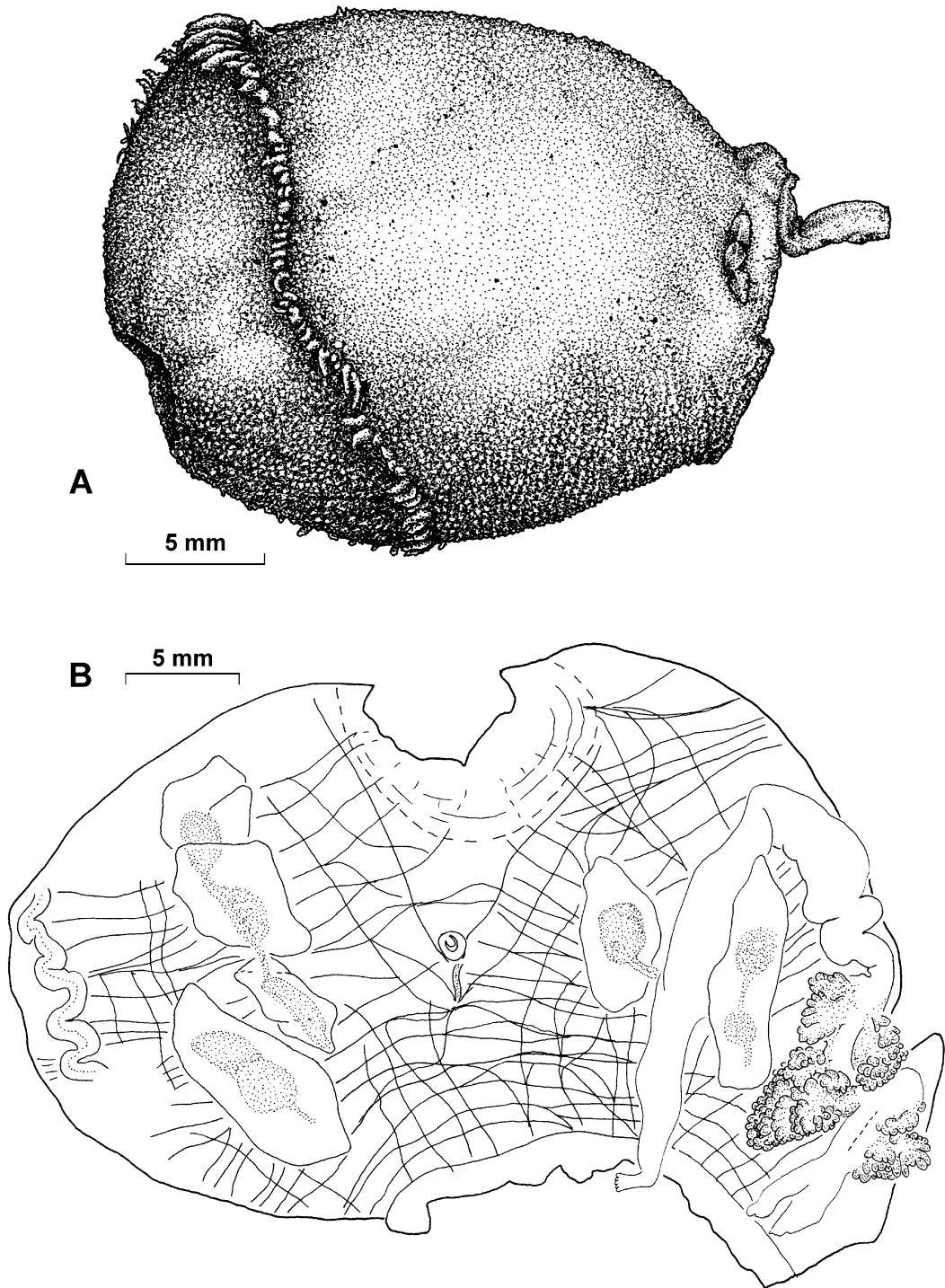


Figure 13. *Culeolus suhmi* Herdman, 1881. (A) Intact specimen (whole stalk not shown); (B) specimen opened along ventral mid line; branchial sac removed to show gut, gonads, and muscles.

figured by Herdman (1882): the specimens have similar body shape, papillated test, and a complete ring of crowded papillae encircling the posterior end of the body. All these features are also characteristic for the north Atlantic specimens of *C. suhmi* we had the opportunity to examine (Sanamyan and Sanamyan 2005). The north Atlantic specimens of *C. suhmi* have exactly the same branched papillae on the mid-ventral crest as the north Pacific specimens, although this feature was previously regarded as a species-specific feature for *C. murrayi*.

A small part of the material identified by Vinogradova as *C. murrayi* (nine specimens from St. 5621, see Vinogradova 1970, Figures 5, 6) was placed at our disposal. Most of these specimens, including a group of several specimens she figured (Vinogradova 1970, Figure 6) are mutilated (by lateral or dorsal dissections without removing the test), in the extent that even the number of gonads was obscured. The single intact medium-sized specimen was, however, in perfect condition. It has two gonads on each side, the right ones consisting of three and five large lobes, respectively; on the left, one gonad is inside and the other outside the gut loop and both have five lobes. We failed to find any reliable feature distinguishing this specimen from *C. suhmi* and all specimens of *C. murrayi* of Vinogradova (1970) are here considered conspecific with *C. suhmi*.

Culeolus ushakovi also apparently is conspecific with *C. suhmi*. According to Redikorzev (1941), it has a complete ring of papillae around the posterior end of the body and two gonads on each side, anterior ones with three lobes and the posterior ones with two lobes.

The type specimen of *C. murrayi* has three short gonads on each side (Monniot and Monniot 1982), while the present specimens (as well as *C. ushakovi*), have two. Although some specimens of *C. suhmi* also may have three gonads on the right side, their position appears to be different from the gonad in *C. murrayi* and at this stage the species do not appear to be conspecific.

Culeolus robustus Vinogradova, 1970 is also similar to *C. suhmi*. There are 15 known specimens (all from the Kurile-Kamchatka Trench, St. 5608). It is not clear which features were used by Vinogradova to distinguish her species from other *Culeolus* species. We dissected the intact paratype of this species (Figure 14). It has two gonads on each side, the anterior one having two lobes, the posterior one being entire. One gonad on the left is inside, the other is outside the gut loop. Internally this specimen is indistinguishable from the specimen of *C. suhmi* described above (compare Figures 13B and 14B). The body of *C. robustus* is slightly more elongated than in *C. suhmi*. The only apparent difference is the shape of the postero-ventral crest, closed in *C. suhmi* and opened dorsally in *C. robustus*. In the larger specimens of *C. robustus* the papillae are more or less united into a thick membrane, while they are separate in the smaller specimens. At this stage, the shape of the postero-ventral crest separates the species. Although this probably is a stable feature in many *Culeolus* spp., it could vary in others. *Culeolus anomalous* is another species similar to *C. suhmi* but with the crest open dorsally (Sanamyan and Sanamyan 2002). The present material from St. 6143 contains two specimens very similar to the above-described *C. suhmi*, but with the postero-ventral crest opened dorsally. One of these specimens has two short gonads on the left and no gonads on the right; the other specimen has one gonad on each side in the gut loop. We are not sure if these specimens may be considered as abnormal specimens of *C. suhmi* or belong to another species.

Halocynthia igaboja Oka, 1906

Halocynthia igaboja Oka 1906, p 45; Van Name 1945, p 362 (synonymy); Lambert and Sanamyan, 2001, p 1776.

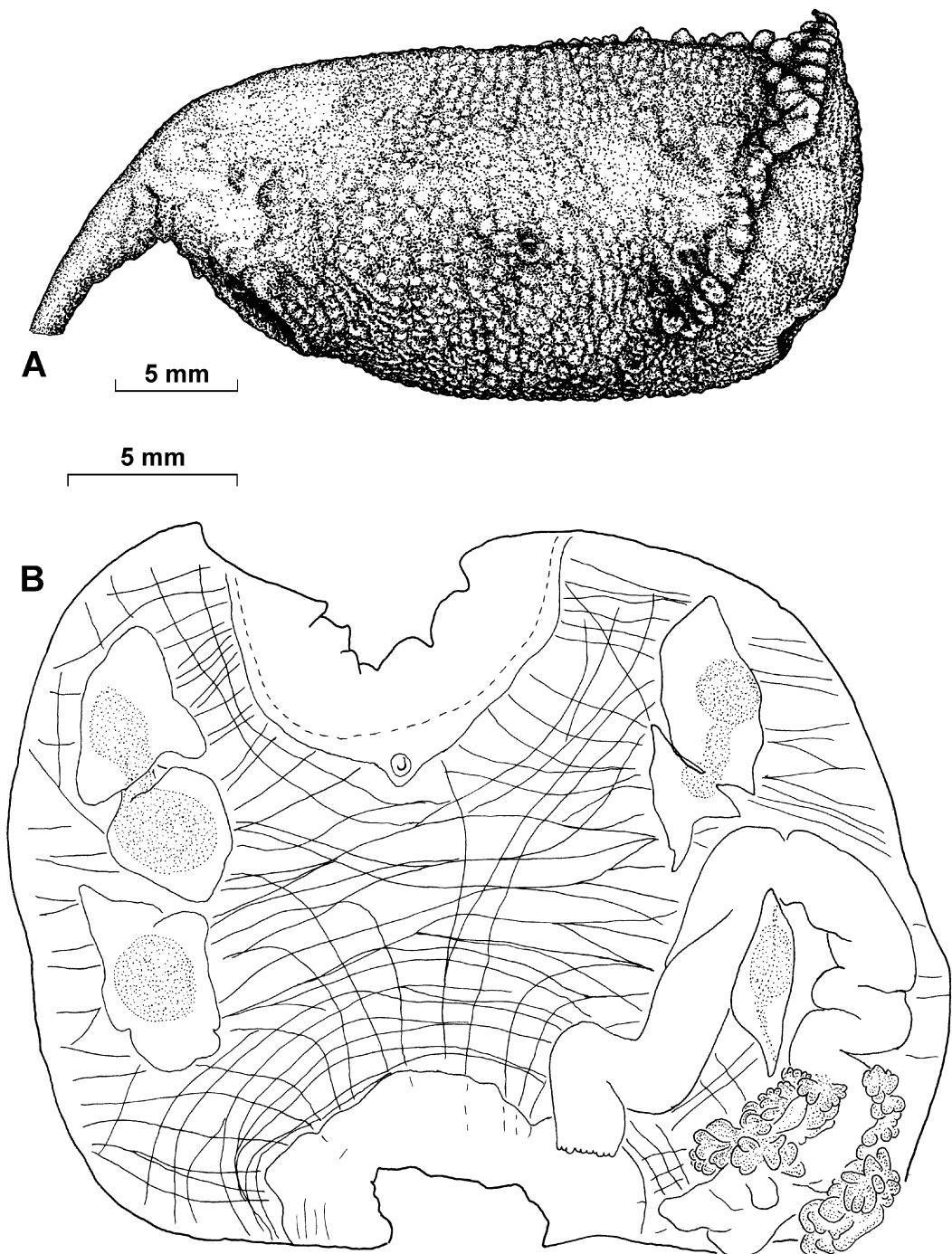


Figure 14. *Culeolus robustus* Vinogradova, 1970. (A) Intact specimen (whole stalk not shown); (B) specimen opened along ventral mid line; branchial sac removed to show gut, gonads, and muscles.

Material examined

St. 6089, 170 m, four specimens; St. 6098, 200 m, three specimens.

Remarks

This species belongs to a group of several similar species which differ from each other mainly in external appearance, length of siphons, and shape and distribution of the spines on the test. The group includes several species described from Japan: *H. hilgendorfi* (Traustedt, 1885), *H. owstoni* Oka, 1906, *H. ritteri* Oka, 1906, *H. igaboja* Oka, 1906, *H. cactus* Oka, 1932, and the east Pacific species *H. okai* Ritter, 1907. Although these species have been discussed by almost all ascidian taxonomists it is not clear if they are synonyms or a group of sibling species. Only one species has a recorded range from Alaska to California, but several are sympatric from northern Japan to the Korea Strait (Lambert and Sanamyan, 2001). Huntsman (1912) synonymized *H. okai* with *H. igaboja* and the latter name is applied to the east Pacific specimens (Van Name 1945; Lambert and Sanamyan 2001). East and west Pacific populations appear to be separated: the species is abundant in Alaska Bay and the eastern Aleutian Islands (we found it in dredged material collected by every expedition to that region), but not recorded in the west Pacific north of Japan and appears to be absent in Russian waters. Therefore, although *H. okai* may be distinct from *H. igaboja*, the question can be resolved only by comparison of further material.

***Hemistyela pacifica* sp. nov.**

(Figures 15, 16A)

Material examined

St. 6109, 3460 m, two specimens. Holotype: KIE 1/1130. Paratype: KIE 2/1131.

Description

Rounded specimens are 6 mm (holotype) and 5 mm diameter. Sparse, unbranched, and relatively long, hair-like test processes mainly on the proximal (ventral) half of the body, are less crowded on the sides, and the almost whole anterior half of the body, including a wide area between and around the siphons, is bare. The test and the test processes are almost smooth or have sparse sediment attached. Apertures are widely separated on the upper surface.

Body musculature consists of an external layer of regularly spaced bands of circular muscles around the whole body (especially crowded around the siphons) and an internal layer of longitudinal muscles radiating from the siphons. Fifteen short, flattened, simple branchial tentacles arise from the margin of the short branchial velum. The prepharyngeal band of two lamellae makes deep undulations (associated with the branchial folds as in *Molguloides*) and has a long narrow dorsal indentation. A long neural ganglion, about 1 mm in the holotype, is on the right side of the dorsal V. A short, thick neural duct extends transversely from the gland at the anterior end of the neural ganglion to a small round opening at the top of the peritubercular V-shaped area (Figure 15B). The dorsal lamina is represented by at least 10 long triangular languets. The branchial sac has four folds on the left, and (apparently) five on the right. A group of the most dorsal vessels on the right may

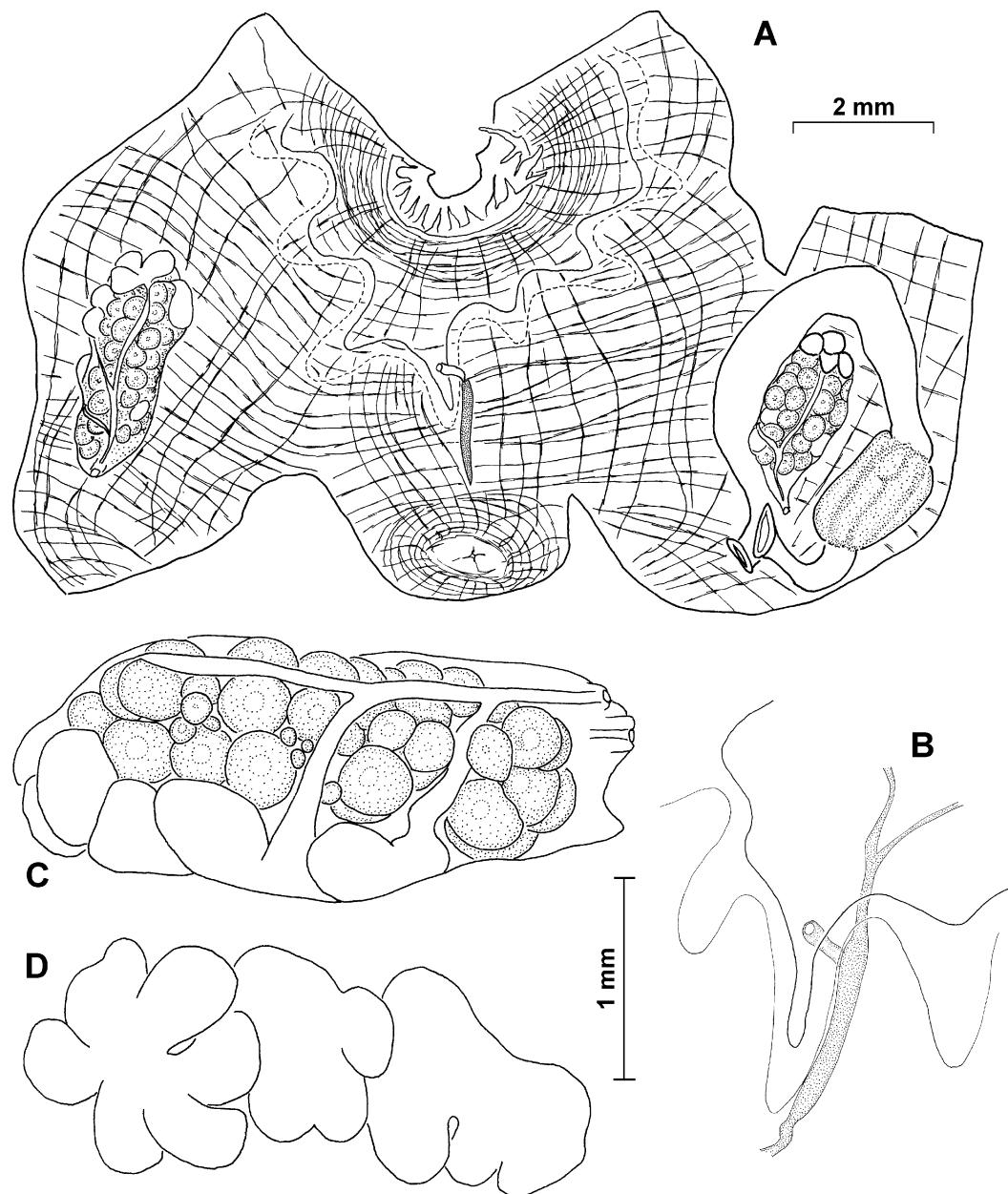


Figure 15. *Hemistyela pacifica* sp. nov. (A) Specimens opened along ventral mid line; branchial sac removed; (B) internal view of intersiphonal area (prepharyngeal groove, undulating line of the anterior margin of the branchial sac, ganglion, and dorsal tubercle; (C) right gonad, lateral view; (D) right gonad, external view through the transparent body wall (male follicles).

constitute one fold or two. The formula for the anterior part of the branchial sac is: (6)(10)(12)(4)(6)DL(11)(8)(10)(12). The middle longitudinal vessels on each fold do not reach the bottom of the branchial sac and the number of longitudinal vessels significantly decreases toward the posterior end of the branchial sac. Only transverse stigmata are

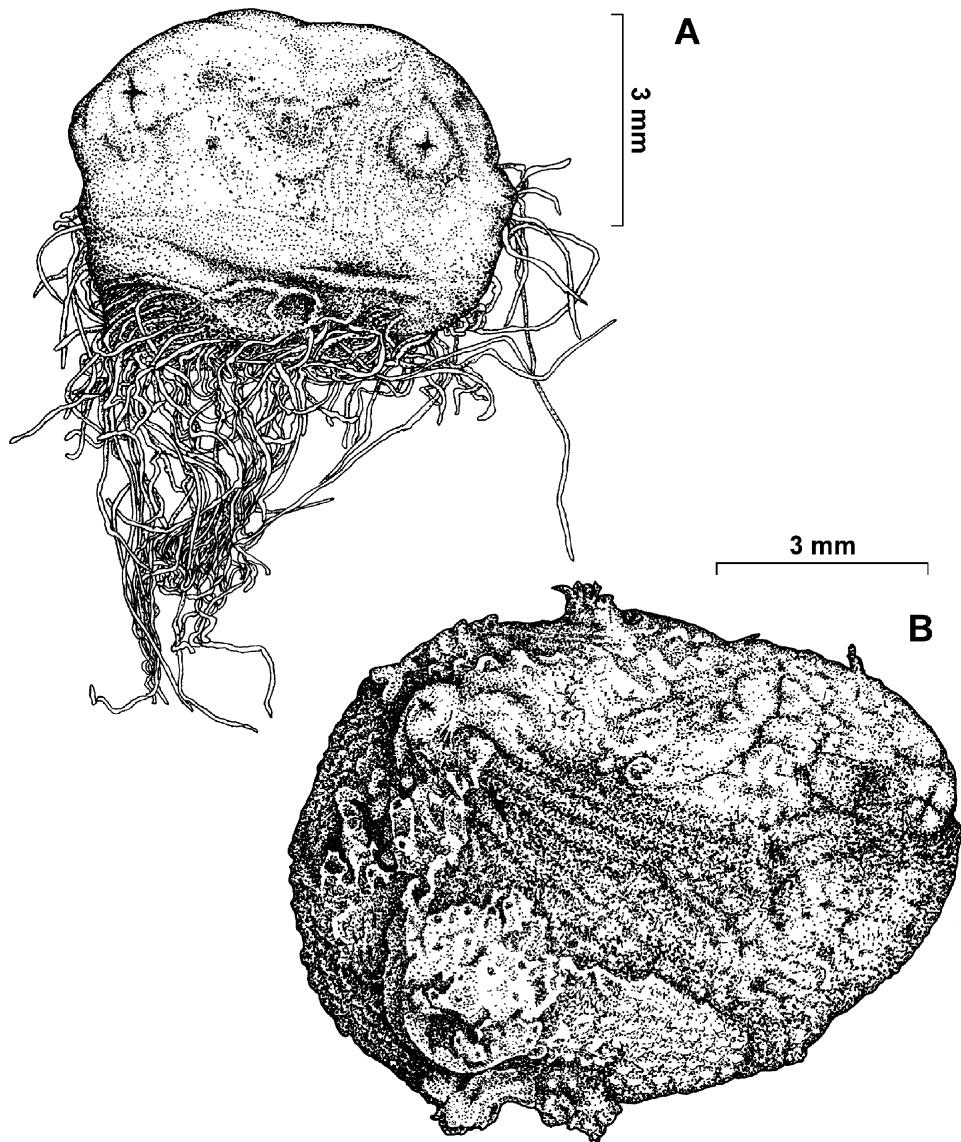


Figure 16. (A) *Hemistyela pacifica* sp. nov.; (B) *Pyura haustor* (Stimpson, 1864). External view.

present, the stigmata under the branchial folds are longer than the stigmata on the sides of the folds (as in *H. hirta* and *H. pilosa*, see Monniot and Monniot 1974, Figure 16B; 1977, Figure 6E, F).

One thick gonad is on each side, the left one completely enclosed in the gut loop and the right some distance from, and parallel to, the endostyle. Two or three large, lobed testis follicles are between the ovary and the body wall, their rounded lobes projecting slightly from the sides and posterior end of the ovary. The male duct runs along the mesial surface of the ovary from the posterior testis follicles terminates near the almost sessile oviductal opening. One or two lateral branches join it along its length. The gut forms a wide, closed loop. A long oesophagus is clearly demarcated from the short cylindrical stomach. The

stomach has five or six deep longitudinal folds but a gastric caecum was not detected. The anal border is smooth. Endocarps are not present.

Remarks

This is the first record of the genus in the north Pacific. Although very similar to the two already known *Hemistyela* species, the present one appears to be distinct from both. The type specimen of *H. hirta* (Monniot and Monniot, 1974) has several male openings on each gonad. Originally described from the south Indian Ocean, *H. hirta* was subsequently recorded in the Weddell Sea and from New Caledonia, but these specimens have not been described and it is not known if they also have multiple male openings. *Hemistyela hirta* has about 50 branchial tentacles (many more than the present species) and a characteristic flattened pouch on the ventral side of the intestine (similar to those of *Pyurella*) that is not present in *H. pacifica* sp. nov. *Hemistyela pilosa* Millar, 1955 a species known from several specimens from the North and Central Atlantic, and one dubious record from West Indian Ocean appears to have different body muscles (see Monniot and Monniot 1974).

Originally described by Millar (1955) as a genus belonging to Styelidae, *Hemistyela* was synonymized with the genus *Boltenia* by Monniot and Monniot (1974). Although certainly belonging to Pyuridae, *Hemistyela* cannot be congeneric with *Boltenia*, all species of which (even very small specimens) have the branched tentacles.

Pyura haustor (Stimpson, 1864)

(Figures 16B, 17)

Cynthia haustor Stimpson 1864, p 159.

Pyura haustor: Van Name 1945, p 338 (synonymy). Sanamyan 1996, p 200; Lambert and Sanamyan, 2001, p 1777.

Material examined

St. 6098, 200 m, three specimens.

Description

Most of the small (less than 1 cm long) specimens are attached by the wide ventral surface to the larger specimens of *Halocynthia igaboja* and are often completely hidden by the test spines of that species. The siphons on the preserved specimens are short, sometimes almost sessile, but sometimes protruding suggesting that these variations in length may be affected by contraction and that they may be longer in living specimens. The test is hard, but lacks the ridges characteristic of larger specimens. The test around and inside the siphons is covered by relatively sparse, long narrow spines, 0.07–0.12 mm in length. Internally the specimens agree with the previous accounts. The gonads, immature in examined specimens, are long, consisting of numerous, sometimes more than 30, small, widely spaced polycarp sacs. Liver diverticula are in several separated bunches, they do not form one compact mass as was erroneously figured by Sanamyan (1996). Endocarps are not present.

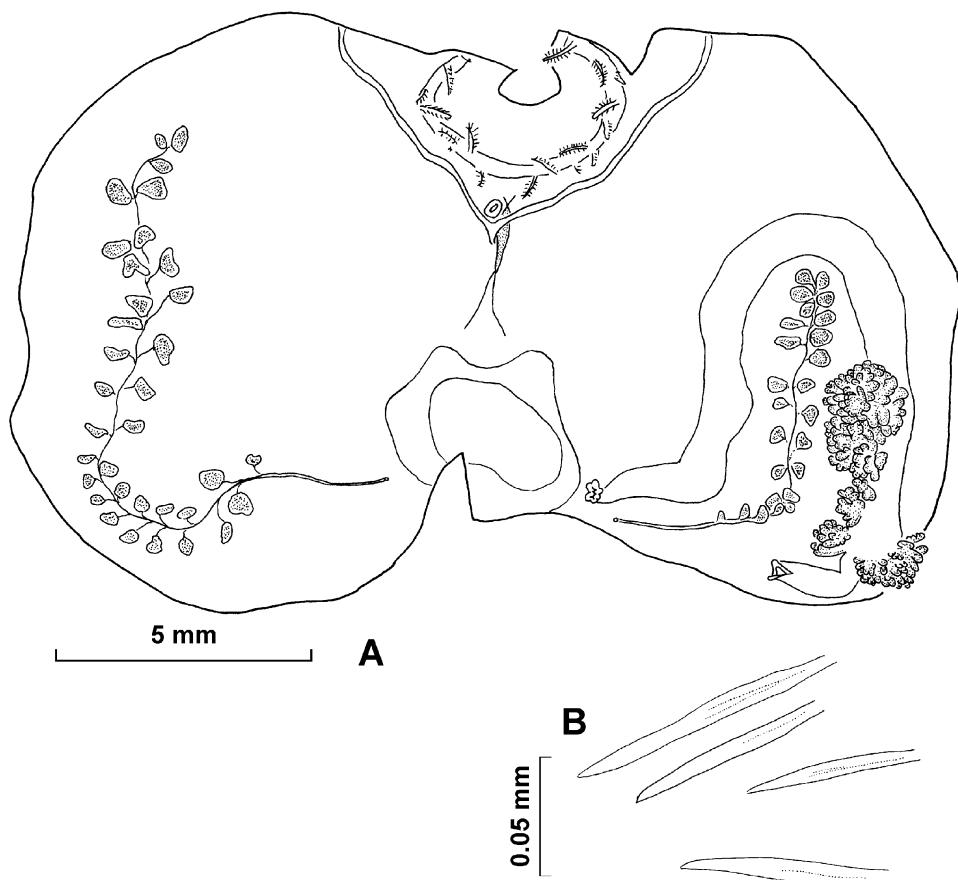


Figure 17. *Pyura haustor* (Stimpson, 1864). (A) Specimens opened along ventral mid line; branchial sac removed; (B) siphonal spines.

Remarks

According to Van Name (1945) the endocarps in this species are poorly developed or may be absent. Larger specimens collected in the same region (Sanamyan 1996) have endocarps on the free edges of the polycarps and a few small endocarps are on the gut loop. These specimens have larger (0.12–0.18 mm long) siphonal spines of similar shape. All these differences are obviously connected with the size of the specimens. The species is distributed from Alaska to California. The range extends to the eastern Aleutian Islands, where it appears to be common at depths of 75–200 m. It was not recorded further to the west.

Asajirus indicus (Oka, 1913) (Figures 18, 19)

Hexacroblylus indicus Oka 1913, p 6.

Asajirus indicus: Kott 1989, p 521; 1992, p 648 (synonymy); Sanamyan and Sanamyan 1999, p 1873.

Hexadactylus indicus: Monniot and Monniot 1990, p 271.

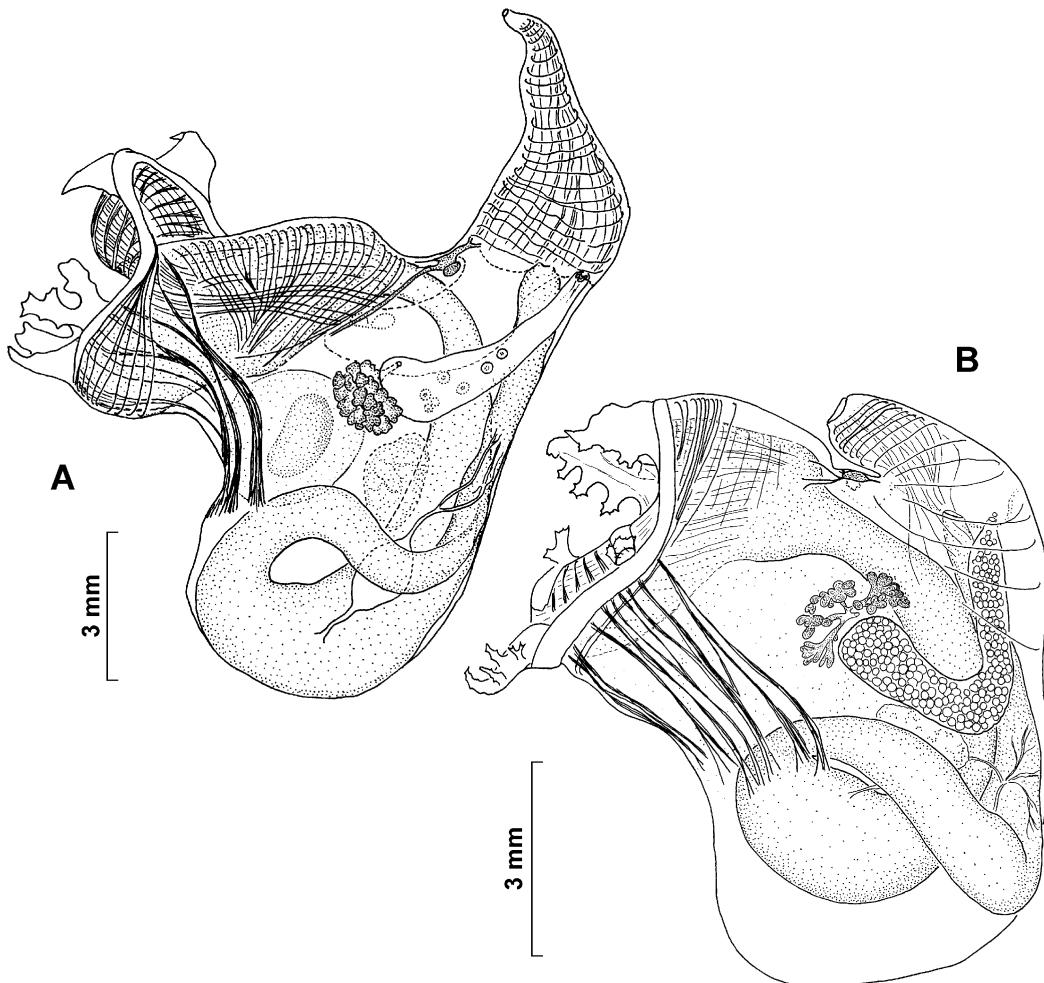


Figure 18. *Asajirus indicus* (Oka, 1913). Specimens opened along ventral mid line; branchial sac removed. (A) Specimen from St. 7207; (B) specimen from St. 6135.

Material examined

St. 7206, 7880–7420 m, one specimen; St. 6135, 2880–2930 m, two specimens.

Description

The description is based on the specimen from the Philippine Trench (St. 7206). The specimen is 20 mm high (the body with the test removed is 15 mm), densely covered by thin short hairs which are longer posteriorly. In the intact specimen the oral lobes are clearly divided into two groups: two dorsal lobes, with free edges directed down and four ventral, with free edges directed up; this is not so evident on the body wall after the test is removed. Both siphons are long, covered by crowded circular and longitudinal muscles; the atrial siphon is slightly shorter than the oral (measured from the ganglion to the edge of the siphons). Longitudinal ventral muscles grouped into about seven thick crowded bands,

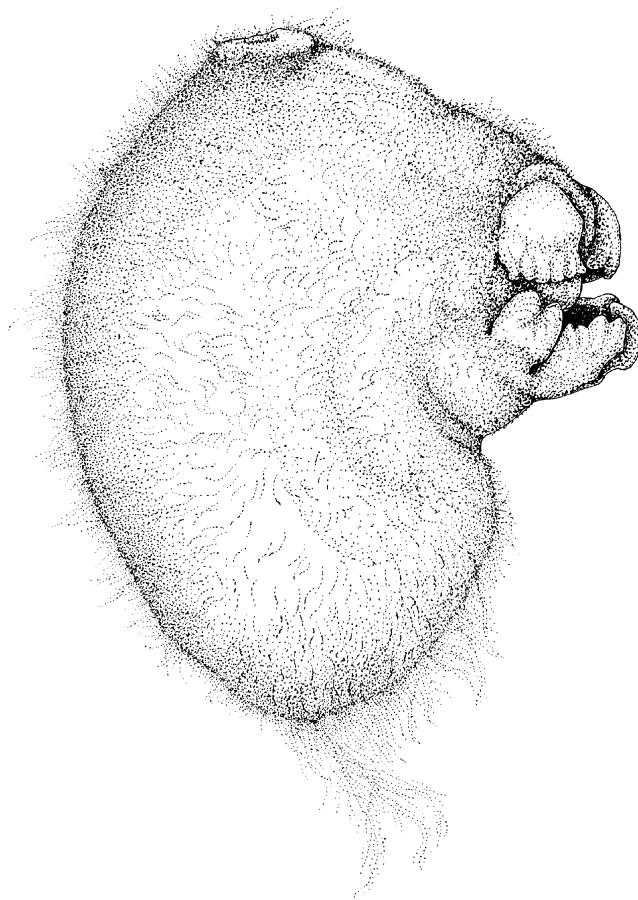


Figure 19. *Asajirus indicus* (Oka, 1913). Intact specimen from St. 7206.

sometimes intercrossing and branched, and terminating on one line in the middle of the body, below the posterior edge of the renal sac. The ganglion has two anterior pairs of nerves and a thick posterior nerve dividing into two. The pharynx is connected with the lateral pockets of the atrial cavity through the two pharyngeal chambers. The anterior chamber is thick walled and opens to the atrial cavity through a small slit-like stigmatum; the thin-walled posterior chamber opens through a large horseshoe-shaped opening. The large pyloric vesicle is connected with the middle of the stomach through a relatively thick duct, and another duct arises from the opposite side, divides into two and forms a net of anastomosing vessels over the intestine. Long and slightly curved ovaries containing only a few small oocytes open close together at the base of the atrial siphon, dorsal to the anus. The round, compact male gonad consists of numerous short follicles and has a short sperm duct that opens to the lateral horn of the atrial cavity opposite the two stigmata described above.

The two specimens from the Aleutian Islands (St. 6135, Figure 18B) are smaller, about 12 mm in height. They have a shorter atrial siphon, and six anterior nerves.

Remarks

The specimen from the Philippine Trench agrees closely with the existing accounts, especially with the description and figures made by Monniot and Monniot (1990). Kott (1989, 1992) described two ventral longitudinal muscle bands, one on each side of the mid-ventral line, and in her figure (Kott 1989, Figure 1) these bands are much longer than in the present specimen, reaching the posterior end of the body, but in another specimen (Kott 1992) they are described as short.

In the shape of the testis and the six anterior nerves the specimens from the Aleutian Islands resemble *A. seeligeri* (Monniot and Monniot, 1990), and the short atrial siphon is similar to that in *A. millari* (Monniot and Monniot, 1990). According to Monniot and Monniot (1990), *A. seeligeri* differs from *A. indicus* in shorter oral lobes, six oral nerves, a different shape of the gut, and a different position of the female papillae. In the figures, however, the shape of the gut is quite similar, and there seem to be more differences in the shape of the gut between the two figured specimens of *A. indicus* than between *A. indicus* and *A. seeligeri* (compare Monniot and Monniot 1990, Figure 21A and Figure 16A, D). We agree with Kott (1989, 1992), who synonymized *A. seeligeri* and *A. millari*, and also *A. arcticus* (Hartmeyer, 1923), *A. eunuchus* (Monniot and Monniot, 1976), *A. antarcticus* (Monniot and Monniot, 1990) and *A. longitestis* (Monniot and Monniot, 1990) with *A. indicus*. Many features used by these authors to distinguish these species, such as the shape of the dorsal oral lobes (in *A. millari*), slight differences in the position of female papillae in relation to the intestine and the anus (*A. seeligeri*, *A. millari*), the shape of the intestine, the distance between the ventral longitudinal muscles (in *A. eunuchus*), the number of the anterior nerves, etc., cannot justify specific separation. The differences in the shape of the ventral longitudinal muscles (grouped into bundles, regularly spaced, short or long) also seem to be related to their contraction and growth rather than species differences. For example, these muscles seem to be similar in *A. antarcticus* and *A. arcticus* (compare Monniot and Monniot 1990, Figure 9G and Figure 11B) although described as grouped in the former and spaced in the latter. It is evident that in the larger specimens, and in contraction, ventral muscles of *A. arcticus* may look exactly as in *A. antarcticus*.

We support Kott (1989) in assigning Hexacrobylidae to the class Ascidiacea.

The present record in the Philippine Trench is the deepest record for the family Hexacrobylidae. The record near the Aleutian Island is the first record of the family in the north Pacific.

Acknowledgements

The authors are grateful to Dr. A. N. Mironov (Institute of Oceanology, Moscow) for the material provided.

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