*Zootaxa* 1579: 55–68 (2007)
www.mapress.com/zootaxa/


ISSN 1175-5326 (print edition)
**ZOOTAXA**
ISSN 1175-5334 (online edition)

# Poorly known Ascidiacea collected in the vicinity of the Commander Islands and East Kamchatka, NW Pacific

KAREN SANAMYAN & NADYA SANAMYAN

*Kamchatka Branch of the Pacific Institute of Geography, Partizanskaya 6, Petropavlovsk-Kamchatsky, 683000, Russia.*
*E-mail: ascidiacea@sanamyan.com*

## Abstract

Deep-water *Ascidia escabanae* known previously only from Escabana Trough, NE Pacific and *Ciona pomponiae*, originally described from Galapagos Islands are recorded at abyssal and bathyal depths in the region of Commander Islands and East Kamchatka in NW Pacific. *Ciona gefesti* is a junior synonym of *C. pomponiae*. The northern Atlantic species *C. gelatinosa* Bonnevie, 1896 (previously thought to be a subspecies of *C. intestinalis* and related to the Pacific Ocean *C. mollis*) is redescribed here and shown to be a distinct species. Also discussed are several littoral and bathyal *Molgula* spp. considered previously as closely related or possibly conspecific that are shown here to be separate species readily distinguished by their gonads. *Molgula beringense* **sp.n.** is described from the vicinity of the Bering Island.

**Key words:** *Ciona*, *Ascidia*, *Molgula*, North Pacific

## Introduction

Ascidians described in this paper include shallow-water specimens we collected on the Commander Islands and Kamchatka and also deep-water specimens from the same region received from the Institute of Oceanology, Moscow. Some species recorded in the studied material have been wrongly identified previously (Sanamyan 1998, Sanamyan and Sanamyan 1998) and are redescribed here. Species of *Ciona* other than *C. intestinalis* are seldom encountered and are given some attention in this paper. The only deep-water *Ciona* other than *C. pomponiae* known to occur in the northern Pacific is *C. mollis* Ritter, 1907, which Monniot and Monniot (1989) thought may be related to *C. gelatinosa* Bonnevie, 1896, a possible subspecies of *C. intestinalis* (see Van Name 1945; Hoshino and Nishikawa 1985). As several authors have proposed relationships linking *C. mollis*, *C. intestinalis* and *C. gelatinosa*, the latter species has been redescribed to establish its identity and, in particular, its differences from *C. pomponiae*. *Ciona pomponiae* Monniot and Monniot, 1989 and *Ascidia escabanae* Monniot, 1998 are known from very few (three and nine) specimens but appear to have very wide geographic ranges, a feature commonly encountered in deep-water species. Surprisingly, many shallow-water or even intertidal species of N Pacific coast of America are less known than abyssal species. In particular very little information is published on the morphology and species characters of many small North American species of *Molgula* described about a century ago by Herdman (1898) and Huntsman (1912a, 1912b). Some were considered to be synonyms by Van Name (1945), but the real status of each species is not well understood and this group of often small, cryptic, sandy *Molgula* spp. appears to be more diverse than previously was thought.

*Accepted by P. Mather: 8 Aug. 2007; published: 10 Sept. 2007*

## Descriptions

### *Ciona pomponiae* Monniot & Monniot, 1989
(Figure 1)

*Ciona pomponiae* Monniot and Monniot, 1989: 17.
*Ciona gefesti* Sanamyan, 1998: 98.

**Material examined:** RV *Keldish*, cruise 22, st. 2328, 1814–1920m, 53°26.59'N, 160°21.00'E – 53°25.76'N, 160°21.40'E, 14 August 1990, one specimen.

**Previous records:** E Pacific, Galapagos Islands (Monniot and Monniot 1989); Bering Sea (Sanamyan, 1998).

**Description.** The laterally flattened specimen is 30mm high and 12mm wide. The test is firm (in alcohol) and translucent and colourless. Several thick branched root-like processes of the test are on both sides of the posterior end of the body. It was not possible to determine how the specimen was attached, although it appears to have been attached by more than its posterior end.

The body was detached from the test in preservative. Both apertures are on short obscurely lobed siphons (number of lobes cannot be counted). The branchial siphon is terminal and the atrial is in the middle of the dorsal mid-line of the body. Longitudinal muscle ribbons continue from the siphons to the posterior end of the body. On each side, three of these originate on the branchial siphon and two on the atrial. The dorsal ribbon of the branchial siphon and ventral ribbon of the atrial siphon fuse together in the middle of the body to form one muscle, so four evenly spaced longitudinal ribbons are on each side of the posterior half of the body. Transverse (circular) body muscles are thin, numerous, but well spaced, not forming a continuous layer. On the siphons they more crowded and thicker, forming definite sphincters. About 30 long curved branchial tentacles are attached to the margin of a high muscular velum. The prepharyngeal band is composed of an unusually high anterior and a low posterior lamella and is not indented dorsally. A small C-shaped dorsal tubercle is just anterior to a rather large ganglion. The neural gland is small, on the right side of the ganglion. The flat branchial sac lacks any plications. Regularly spaced lamellar transverse vessels bear longitudinally flattened, often hooked papillae. Both papillae and transverse vessels are high, and thus internal longitudinal vessels, about 30 on each side, supported by these papillae, are above the surface of the branchial sac. Tips of the papillae project out markedly beyond the longitudinal vessels. Thin parastigmatic vessels cross some (but not all) rows of stigmata. Branchial meshes are rectangular, each with about five stigmata. About 25 dorsal languets significantly increase in length from the anterior to the posterior end of the branchial sac. The endostylar appendix is absent. The retropharyngeal groove running along the posterior end of the branchial sac is narrow near the endostyle but widens significantly toward the opposite (dorsal) side (Fig. 1C). A pair of large pharyngeo-epicardiac openings is almost halfway between endostyle and oesophageal opening, somewhat closer to the latter, slightly behind the pyloric end of the stomach (Fig. 1C). The narrow primary gut loop, with short oesophagus, small globular stomach and a post-pyloric length of the intestine forms a short, narrow, horizontal loop across the left side of the posterior end of the branchial sac and the rectum extends in a straight line under the dorsal mid-line of the branchial sac. Numerous clear inner longitudinal folds are visible through the transparent stomach wall. The stomach is sharply separated from the oesophagus and the intestine. The voluminous intestine is filled with fine particles. The straight rectum ends in a clearly lobed anus. A compact ovary is in the gut loop and a C-shaped female opening is just above the anus. Male openings were not seen. Pigment spots were not detected on the genital papilla. A spherical body containing a single parasitic copepod was found in the body wall.

**Remarks.** The original description of this species is based on one specimen collected at 300–800 m near the Galapagos Islands. *Ciona gefesti* Sanamyan, 1998 from the Bering Sea is certainly conspecific, Sanamyan (1998) recognized the close affinity of his species with *C. pomponiae* but assigned it to a new species based

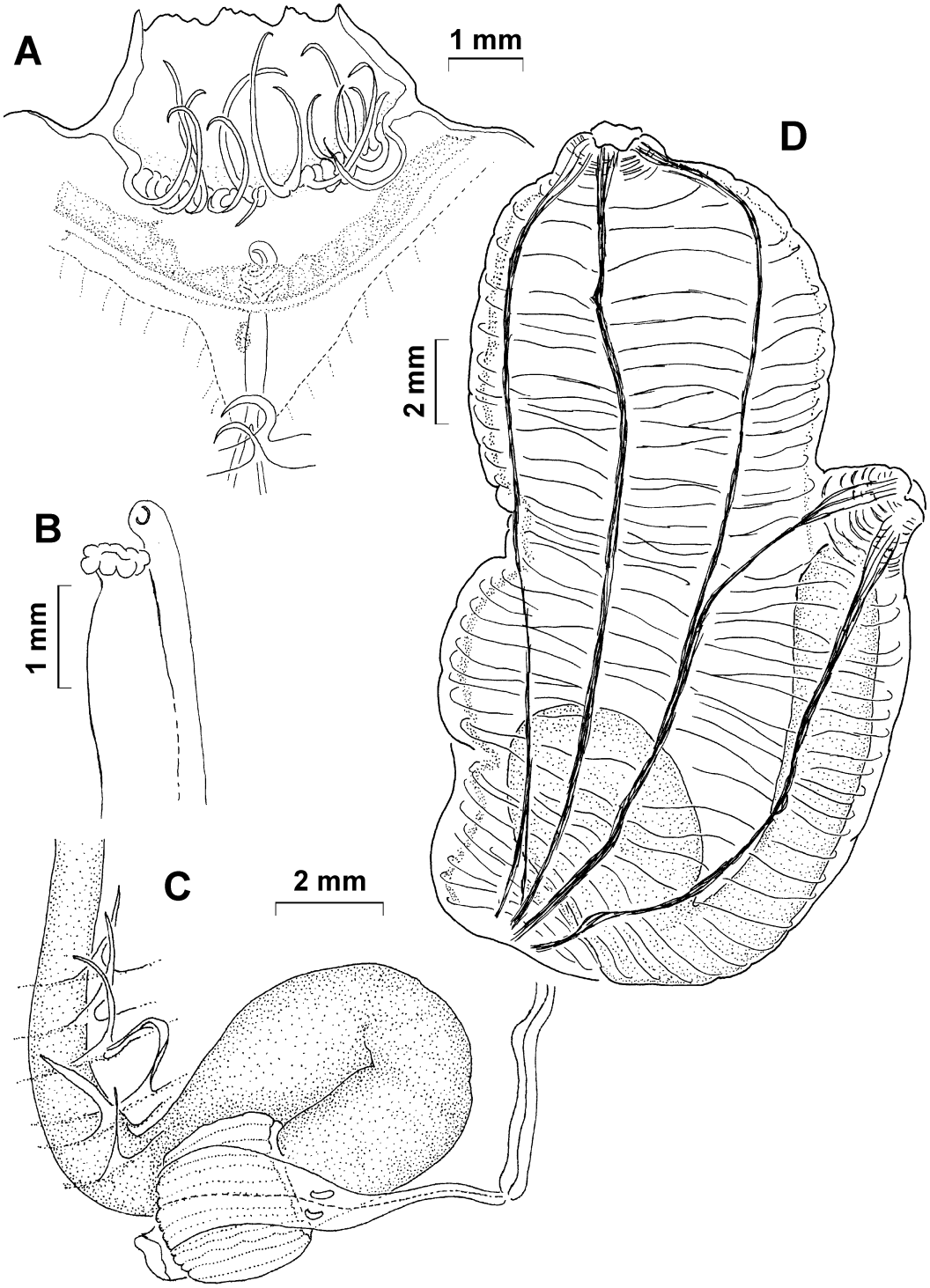


**FIGURE 1.** *Ciona pomponiae*. A, internal view of antero-dorsal midline (branchial tentacles, prepharyngeal groove, dorsal tubercle, ganglion and anterior part of dorsal lamina); B, rectum and genital papilla; C, gut loop, pharyngeo-epicardiac openings in retropharyngeal groove, dorsal languets; D, body removed from the test.

on the great geographical distance from the location of *C. pomponiae* and supported by a number of minor features, including the presence of clear stomach folds and lobed anus in *C. gefesti*. The present specimen, from East Kamchatka, is smaller, but in most features identical with the type specimen of *C. gefesti*. The only difference between North Pacific specimens and the original description of *C. pomponiae* is the shape of the anus, smooth in the Galapagos specimen described by Monniot and Monniot (1989) and lobed in both North

Pacific specimens. However, anal lobes are not prominent and the anus may appear smooth, especially if the specimen is contracted or not in a good condition. The structure of the stomach wall also is not a reliable feature separating these specimens and although the stomach appears as almost smooth on Monniots' figure (Monniot and Monniot, 1989, Fig.1 E,G) it is described as having internal plications visible through the stomach wall as in the present specimen. The number of longitudinal muscle bands, four in the posterior half of the body, is identical in all three known specimens and may be considered a stable distinguishing feature of this species.

*Ciona mollis* Ritter, 1907 is the only other deep-water species of this genus known from the northern Pacific. It differs from *C. pomponiae* in the unusual structure of the branchial sac with doubled longitudinal vessels (see Monniot, 1998), absence of transverse body muscles (reported by Ritter, 1907 and confirmed by Monniot, 1998), and several less prominent features. Monniot and Monniot (1989) proposed a relationship between *C. mollis* and *C. gelatinosa* Bonnevie, 1896, but several features distinguish these species (see *C. gelatinosa* below).

### *Ciona gelatinosa* Bonnevie, 1896

(Figure 2)

*Ciona gelatinosa* Bonnevie, 1896: 3. Not Monniot, 1969a: 1133.
*Ciona intestinalis* form *gelatinosa*: Van Name, 1945: 163 (synonymy).
*Ciona intestinalis gelatinosa*: Hoshino and Nishikawa, 1985: 68.

Although this species is not recorded in the Pacific, it is described here to establish its separate identity and relationships to other *Ciona* species including *C. pomponiae*.

**Material examined:** Canada, Baffin Island, Frobisher Bay, 63°42.657'N, 68°35.335'W, muddy bottom, about 33 m, 23 September 2003, one specimen. Collector T. Siferd. KBPIG 1127/1. The collector noted the species to be fairly common at this location but that currents and bottom type may exclude it from depths less than about 25m.

**Previous records:** Arctic and North Atlantic (Van Name 1945, Hoshino and Nishikawa 1985).

**Description.** According to the collector the living specimens are quite flexible and gelatinous with about 15–20 cm of the body above the substrate and another approximately 6–8cm below the surface anchoring the animal to the soft bottom. Although Van Name (1945, p.163) said that "there is no pedicel", the cylindrical body narrows posteriorly to a stalk which usually is not visible as it is below the surface of the sediment. Occasionally individuals are raised above the bottom on this narrow stalk (T. Siferd, *pers. comm*). Underwater photographs show that the stalk is bent in a right angle so that the body lies parallel to the bottom (Fig. 2C) and oriented along the water current. Both apertures are on well marked siphons at the anterior end of the body. The branchial siphon is the largest and is curved posteriorly so the aperture faces the water current.

A preserved specimen is about 20 cm long, with soft, thick and translucent test. Short thick branched root-like processes are at the posterior end, otherwise the surface is smooth, without outgrowths. The whole length of the posterior abdominal extension is hollow and contains an extension of the body wall. The contracted body removed from the test is only 10 cm long. Seven longitudinal muscle bands are on each side of the body, four originating on the branchial siphon and three on the atrial. Adjacent bands sometimes fuse (Fig. 2A). They all reach the posterior end of the post-abdominal extension where they are wider and less crowded, although individual muscle fibers in the muscle band are thicker. Thin circular transverse muscle fibers form a continuous coat in the anterior contracted third of the specimen. These are less crowded in the middle of the body and are completely absent from the post-abdominal extension.

About 40 branchial tentacles are on a high muscular velum. A small dorsal tubercle has a C-shaped slit with the open interval to the right. The neural gland and ganglion form a compact, thick, almost spherical

body protruding from the outside of the body wall between the siphons (Fig. 2A). The branchial sac is thick and resembles *Ciona intestinalis*, with numerous (more than 80) dorsal languets and about 40 internal longitudinal vessels on each side. These are not significantly raised on papillae but are close to the surface of the branchial sac. An endostylar appendix is absent and a pair of pharyngeo-epicardiac openings is close to the endostyle. The gut forms a horizontal loop behind the branchial sac. The short stomach has internal longitudinal plications but is not clearly differentiated from the intestine. The straight rectum ends in a lobed anus. The ovary is a compact pear-shaped mass in the gut loop and numerous small male follicles spread over the gut loop. Genital apertures are situated anterior to the anus. Numerous male papillae are on a swollen end of the male duct (Fig. 2B). There are no pigment spots around male papillae or on other parts of the body (including siphons of living specimens).

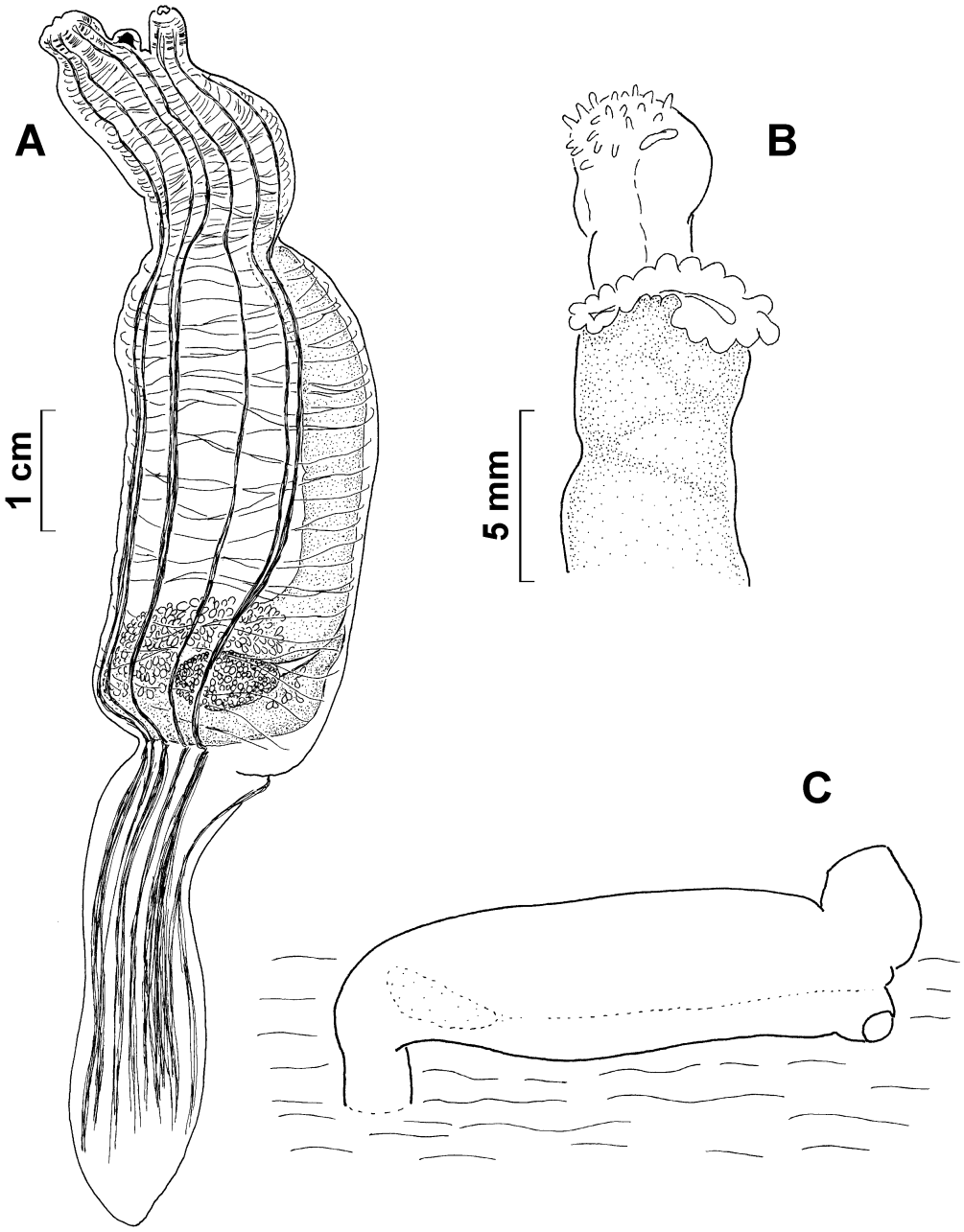


**FIGURE 2.** *Ciona gelatinosa* (KBPIG 1127/1). A, body removed from the test; B, rectum and genital papilla; C, position of the specimen on the sea floor (from a photo).

**Remarks.** The branchial sac of this species is robust, with crowded vessels and is closer to shallow-water *C. intestinalis* (Linnaeus, 1767) and *C. savignyi* Herdman, 1882 than to the deep-water *C. pomponiae* and *C. mollis*. The species is characterized by its large muscular post-abdominal extension of the body wall allowing easy identification. For many years it was regarded as a form or subspecies of *C. intestinalis* (see Hoshino and Nishikawa 1985: 68). However, unlike the latter species, its endostylar appendage is either very indistinct or is absent altogether as in the newly examined material; and living specimens have no pigment spots on either genital aperture or between the siphonal lobes. The whole habitus of living specimens with curved branchial siphon and long peduncle is quite different from *C. intestinalis*. *Ciona intestinalis* may occur on soft bottom but never develops a peduncle containing a post-abdominal extension of the body.

***Ascidia escabanae* Monniot, 1998**
(Figure 3)

*Ascidia escabanae* Monniot, 1998: 544.
*Ascidia clementea*: Sanamyan and Sanamyan, 1998: 212. Not Ritter, 1907: 32.

**Material examined:** RV *Keldish*, cruise 22, st. 2316, 4294–4200m, 55°36.8'N, 167°23.04'E – 55°35.0'N, 167°24.4'E, 5–6 August 1990, one specimen.

**Previous records:** NE Pacific, Bering Sea, Escabana Trough of the southern Gorda Ridge (Monniot 1998, Sanamyan and Sanamyan 1998)

**Description.** The specimen is flattened laterally, oval in outline, 3.5 cm high. The colourless, translucent and almost smooth test, with minute sparse conical papillae in places, is thicker on the left side. It contains blood vessels, which are, however, not as conspicuous as originally described for this species and do not differ much from those found in other *Ascidia* spp. Apertures are on low siphons, the branchial siphon is terminal and the atrial halfway along the dorsal mid-line. The contracted body removed from the test is 2 cm long. Body musculature consists of weak circular siphonal muscles and a network of thin fibers on the right which terminate in a band of parallel transverse fibers along the ventral region. Muscles are not present on the left. A branchial velum is not present. About 25 long, thin tentacles are attached directly to the body wall. The prepharyngeal band of two thin lamellae is in a circle just behind the ring of tentacles. It is not indented dorsally. Papillae were not detected on the body wall between the tentacles and prepharyngeal band. A large, more than 1 mm long, ganglion is just behind a small simple dorsal tubercle. The dorsal lamina has two blades anteriorly which fuse near the middle of the ganglion, and continue posteriorly as a rather high single lamella with minute spaced indentations on the margin (Fig. 3A). The branchial sac is thin and delicate with much reduced tissue. It has more than 60 transverse vessels, and about 50 thread-like internal longitudinal vessels on each side supported on short papillae. Minute intermediate papillae are invariably present on internal longitudinal vessels. Parastigmatic vessels have not been detected in any part of the branchial sac. The stigmata are large, two to four per mesh. The gut forms a simple open, more or less J-shaped arc, its proximal limb shorter than the distal limb. The small stomach has shallow internal longitudinal plications and the border between its wider pyloric end and the intestine is obscure. The junction between the stomach and intestine is in the curve of the J, the stomach occupying a large part of the proximal limb. The rectum opens at the atrial opening in a smooth-rimmed anus. The ovary is spread over the intestine as a set of branched tubules. Male gonads and gonoducts were not detected. The whole gut loop excepting distal end of the rectum is embedded in a mass of renal vesicles, which are, however, transparent and may be easily overlooked.

**Remarks.** The only previous records of this species are from one location in the NE Pacific (see above). The general shape of the body, position of siphons, shape of the gut loop, branched tubular ovary on but not inside the gut loop, absence of the branchial velum, and large neural ganglion are all as originally described for the species (see Monniot, 1998). However, papillae were not detected in the prebranchial region, two

blades of dorsal lamina in Escabana specimens fuse far behind the ganglion (at the level of the ganglion in the present specimen), and the present specimen is smaller and has only about 50 internal longitudinal vessels (80 in the original description). Several other specimens from the same station have been wrongly identified by Sanamyan and Sanamyan (1998) as *Ascidia clementea*. They are larger than the present specimen and have more (up to 70) internal longitudinal vessels. *Ascidia clementea* appears to be a closely related but distinct species, the main differences are the shape of the gut loop and position of the ovary within the gut loop. Further, the branchial sac of *A. escabanae* appears to be much thinner in comparison to that figured for *A. clementea* by Ritter (1907, Plate 4, Fig. 34) and Monniot and Monniot (1989, Fig. 2C) although this might be only a subjective impression.

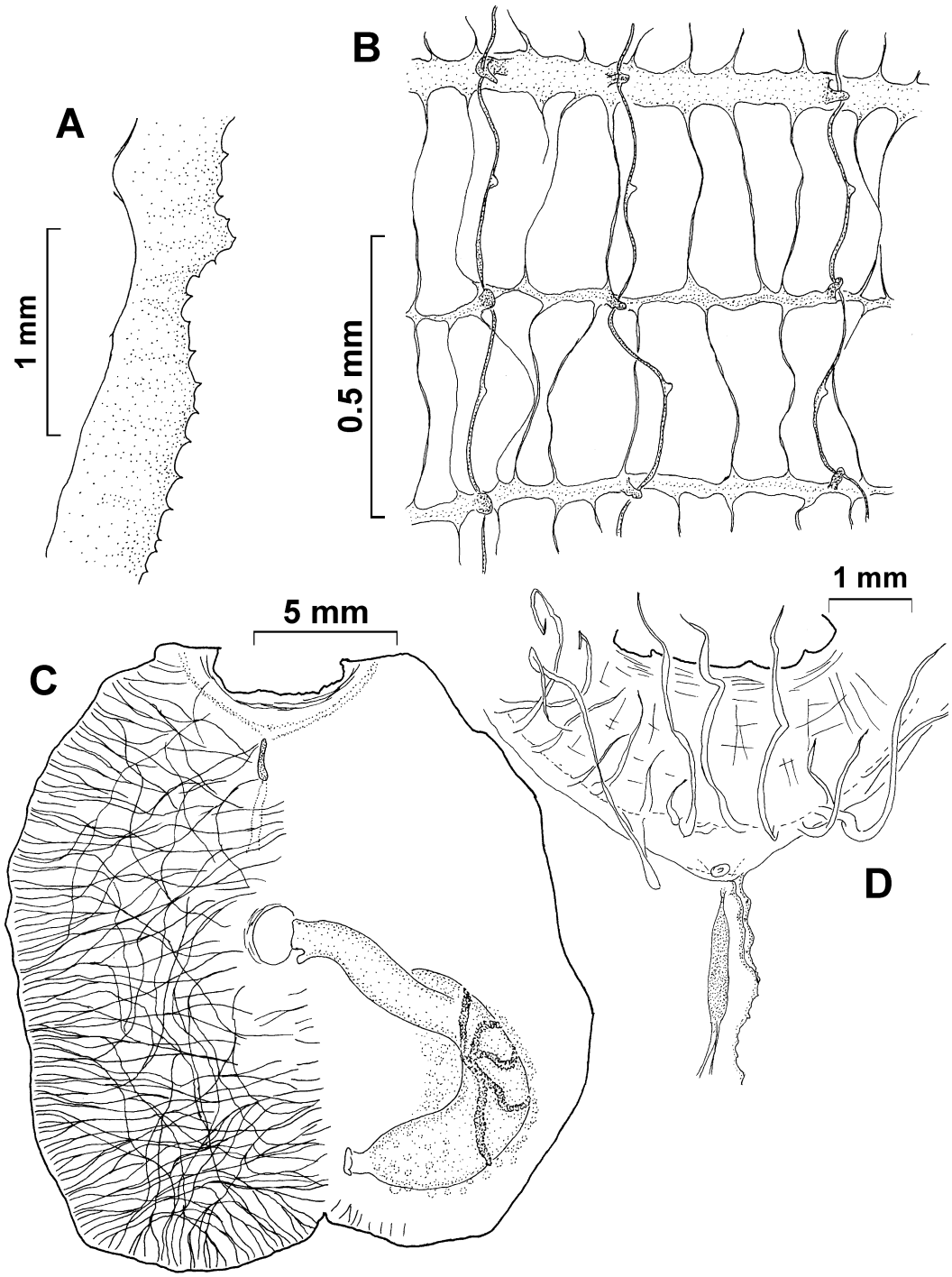


**FIGURE 3.** *Ascidia escabanae*. A, dorsal lamina; B, detail of the branchial sac; C, specimen opened along ventral midline, branchial sac removed; D, internal view of antero-dorsal region.

***Molgula cooperi* (Huntsman, 1912)**
(Figure 4)

*Caesira cooperi* Huntsman, 1912b: 134; 1912a: 127.
*Molgula cooperi*: Van Name, 1945: 416.
*Molgula regularis*: Sanamyan and Sanamyan, 1998: 214. Not Ritter, 1907: 8.

**Material examined:** RV *Gefest*, 52°47.6N, 158°52.4'E–52°48.7'N, 158°46.5'E, 300–500 m, two specimens, KBPIG 663/2; 58°17.1'N, 163°57.0'E–58°13.6N, 163°58.3'E, 280 – 720 m, one specimen, KBPIG 657/1; RV *Rubinovyi*, 52°56'N, 160°06'E – 52°56'E, 160°12'E, 138–218 m, one specimen, KBPIG 1049/3; 52°56'N, 160°10'E–52°57'N, 160°04'E, 185–119 m, KBPIG 1050/4, three specimens; from the same region but without exact locality, KBPIG 1051/5, two specimens. Collector B.Sheiko.

**Previous records:** NE Pacific, Departure Bay, British Columbia (Huntsman 1912b) and Newport, Oregon (Van Name 1945). NW Pacific, E Kamchatka (Sanamyan and Sanamyan 1998).

**Description.** Oval or almost globular specimens are from 15 to 45mm in greatest diameter. The two smallest specimens (KBPIG 663/2) are covered by fine sediment and sand grains and have sparse, short but discernible hair-like processes on the test. Other specimens are covered by a thick crust of rather large gravel and epibionts (Hydrozoa and Bryozoa) and hair-like processes were not detected. The largest specimen (KBPIG 1049/3) is attached to a large stone by a wide area; all other specimens also have a more or less definite area of attachment and apparently were attached to hard objects in life. Siphons are indiscernible on intact specimens and are inconspicuous on the body removed from the test. Body muscles are better developed in the anterior half of the body where crowded circular muscles surround the apertures, thick well-spaced muscle bands radiate from the apertures and a diffuse field of transverse muscles cover the intersiphonal area. In addition the whole body wall is covered by a loose network of thin muscle fibers. The tentacles are much branched, twenty or more larger and numerous smaller ones can be counted. The dorsal lamina has a plain margin. A robust branchial sac has six high equally developed folds, each with seven–13 longitudinal vessels. Vessels are not present between the folds or between the endostyle and most ventral fold. The stigmata are short and almost straight between the folds and form deep broad infundibula with twice subdivided apices in the folds. The narrow gently curved gut loop is open only at the pole. The pyloric region has well developed oblique glandular pouches. Gonads are very long and sinuously curved. The left gonad is in the secondary gut loop and runs in close contact with its descending limb; its posterior end extends above the pole of the gut loop. The right gonad extends along almost the whole extent of the ventral border bending around the dorsal side of the renal sac (which is much smaller than the gonad). Each gonad consists of a central tubular ovary surrounded on the sides and posterior end by numerous rather long male follicles which become well branched in larger specimens. There is one wide common sperm duct running along the mesial surface of the whole ovary and continuing beyond it to form a long male papilla on the body wall halfway between the distal (posterior) end of the ovary and the atrial orifice. The female opening, in contrast, is at the end of the ovary on a short inconspicuous papilla curved ventrally (Fig. 4B).

Tailed larvae are found in the peribranchial cavity in the largest specimen (KBPIG 1049/3).

**Remarks.** The original description of this species is based on numerous small specimens (7–15 mm) collected in British Columbia at about 10–30 m. These specimens (like the present ones) were directly attached by a large area to hard substrata, rather than by hairlike processes of the test. The long sinuously curved gonads are characteristic, but the most peculiar and significant distinguishing feature of this species is the structure of male and female ducts. Huntsman (1912b: 135) describes the ducts as "Ducts directed upward from the posterior end of each gonad: a long and narrow anterior one, the vas deferens, and a short and broad posterior one, the oviduct". Van Name (1945: 417) completely misinterpreted this description and stated that "Huntsman found a single common sperm duct for each gonad that opened near the end of the oviduct". Actually the description of Huntsman clearly corresponds to that found in the present specimens (in which com-

mon sperm duct continues far beyond the end of the oviduct, the distal end projecting from the body wall between the end of the ovary and the atrial aperture, see Fig. 4B). The other features, including the presence of only six branchial folds (without an additional rudimentary fold near the endostyle) and viviparous development are also in agreement with the original description although many of the present specimens are significantly larger and come from a greater depth.

Van Name (1945) suggested that *M. cooperi* may be conspecific with *M. regularis* (described from California) and claimed that the only feature that might separate these species is a viviparous development of *M. cooperi*. However, the position of the left gonad in *M. regularis* is different: Ritter (1907) says that it is in front of the intestinal loop and in his figure (plate 1, Fig. 7) the gonad is in contact only with the pole of gut loop, while in all present specimens it follows the descending limb of the gut loop and is in close contact with the intestine. The structure and position of the ducts of *M. regularis* are not known. There are other minor differences, e.g. the specimens appear not to be attached to hard objects and live freely in sand.

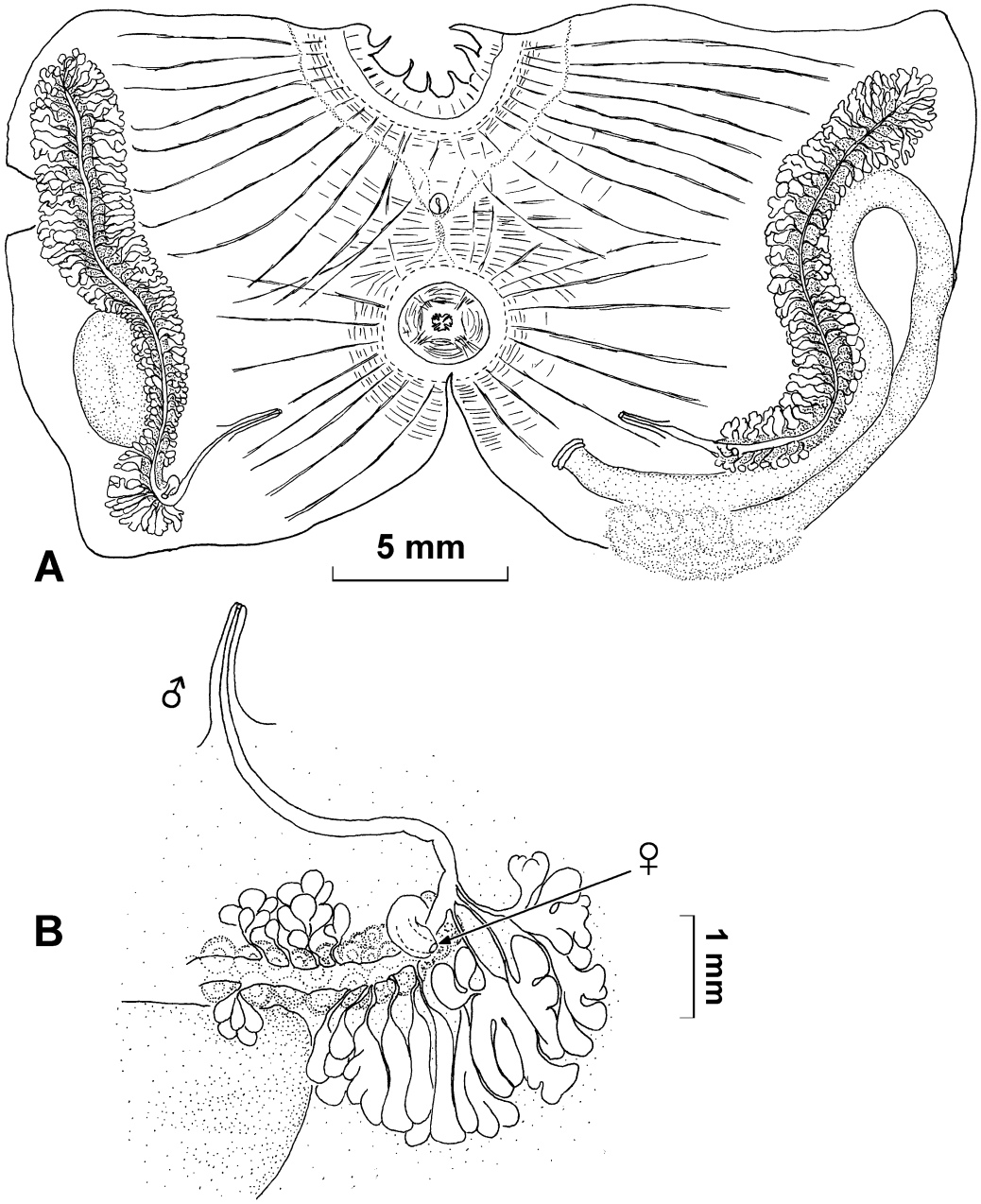


**FIGURE 4.** *Molgula cooperi* (KBPIG 658/1). A, specimen opened along ventral midline, branchial sac removed; B, anterior part of the right gonad.

***Molgula beringense* sp.n.**
(Figure 5)

**Material examined:** RV *Keldish*, cruise 22, st. 2293, 92–90m, 55°05.8'N, 165°53.5'E – 55°05.7'N, 165°54.2'E, 25 July 1990, five specimens. The specimens will be stored in Zoological Museum of Moscow University (ZMMU). Holotype: ZMMU As-95.

**Description.** The specimens have a spherical or oval body, 8–14 mm in diameter, and are covered by thin and sparse hair-like test processes and sand grains, which are mostly attached to the body itself rather than to the hairs. A whole habitus suggests that they live unattached on a soft bottom or in sand. Apertures are close together on the upper surface of the body, siphons probably are long in life, short on contracted preserved specimens, and long on the body removed from the test. The body wall is thin and transparent. The musculature is mostly at and around the siphons and is composed of a continuous layer of circular siphonal muscles, thick, well-spaced muscle bands radiating from the siphons and ending abruptly more or less in a line not reaching middle of the body, and a wide bundle of thin parallel muscle fibers between the siphons (Fig. 5). Two bands of short parallel transverse muscles detected only on some smaller specimens (Fig 5B) are along each side of the ventral mid line, interrupted only by the gut loop. About 12 short but much branched branchial tentacles, of which five (two lateral and one ventral) are the largest, are on a short velum. The undulating prebranchial band (characteristic for many Molgulidae) is without dorsal indentation. The dorsal tubercle, with a small, transversely elongated slit, is close to the neural ganglion. The dorsal lamina has a smooth margin. The stigmata are long, making 0.5–1.5 coils. They form regular square rarely interrupted spirals arranged in seven longitudinal rows, the most ventral row with 12 spirals, the others with six, separated by five transverse vessels. Accessory spirals are not present. In two or three most ventral folds the spirals are almost flat, but they form more or less prominent infundibula in the folds on the dorsal half of the branchial sac. Apices of the infundibula are not subdivided. Thin intermediate transverse vessels cross each infundibulum but do not divide the stigmata. Seven well defined branchial folds have internal longitudinal vessels distributed according to a formula: (3)(6)(7)(8)(9)(10)(10)DL(9)(9)(10)(9)(9)(5)(5). Longitudinal vessels are not present between the folds. The primary gut loop is long, narrow and straight. The rectum, at a right angle to the descending limb of the gut loop, ends in a bilabiate anus with a smooth margin. Gonads are long, almost straight, bending slightly dorsally at their posterior (distal) ends. The left gonad is almost parallel to the primary gut loop, and the right one is parallel to the ventral line, just above and much longer than the small oval renal sac. Each gonad consists of a long central tubular ovary surrounded by rather large, mostly unbranched, regularly distributed testis follicles. Oviducts are of moderate length and open far from the atrial siphon. Vasa efferentia of individual male follicles join a vas deferens on the mesial surface of the ovary. The vas deferens has four to six openings on short papillae distributed evenly along its length.

**Remarks.** The structure of several species described from NE Pacific is not known in detail, but none of the existing descriptions exactly fits the present species.

The newly recorded specimens resemble the original description of *M. apoploa* (Huntsman, 1912) (correctly synonymized with *M. pugetiensis* Herdman, 1898 by Van Name, 1945) in the number of vasa deferentia projecting from the mesial surface of the ovary (up to six according to Huntsman, 1912a). The original description of *M. pugetiensis* is short and the detailed structure of gonads not known. They are described as "one ovate mass on each side" (Herdman, 1898: 265) but the figure (Herdman, 1898, Plate 14, Fig. 6) shows that the left gonad has a characteristic shape and its axis, at least at the distal (posterior) end of gonad, appears to be perpendicular to the gut loop rather than parallel to it. All specimens originally referred to *M. apoploa* and *M. pugetiensis* have only three or four internal longitudinal vessels on each fold of the branchial sac thus distinguishing them from the present species (which has up to ten).

*Molgula hecateia* (Huntsman, 1912) synonymized by Van Name (1945) with *M. pugetiensis*, might be a related species, however it is much larger, and although the detailed structure of the gonads is not recorded,

the shape appears to be different, more oval, with the left gonad filling the whole secondary gut loop (Huntsman, 1912, Plate 17, Fig. 2) and the dorsal lamina forming "a number of large teeth or lobes" (Hutsman, 1912: 131). Although the significance of these features is not known it is unlikely that the present specimens are conspecific with *M. hecateia*.

*Molgula pacifica* (Huntsman, 1912) has, as the present species, seven branchial folds, each with up to 11 internal longitudinal vessels, but the gonads are wide, short and ovate (see Huntsman, 1912b, Plate17, Fig. 8). According to Huntsman (1912a) the structure of gonads is as in *M. apoploa*, but only two vasa deferentia are present. Further, unlike the present species, living unattached on soft bottom, *M. pacifica* is found attached to a rock on exposed shore and is not covered with attached sand.

*Molgula cooperi* and *M. tzetlini* recorded in the same region in the present work have very different gonads and the former has only six branchial folds.

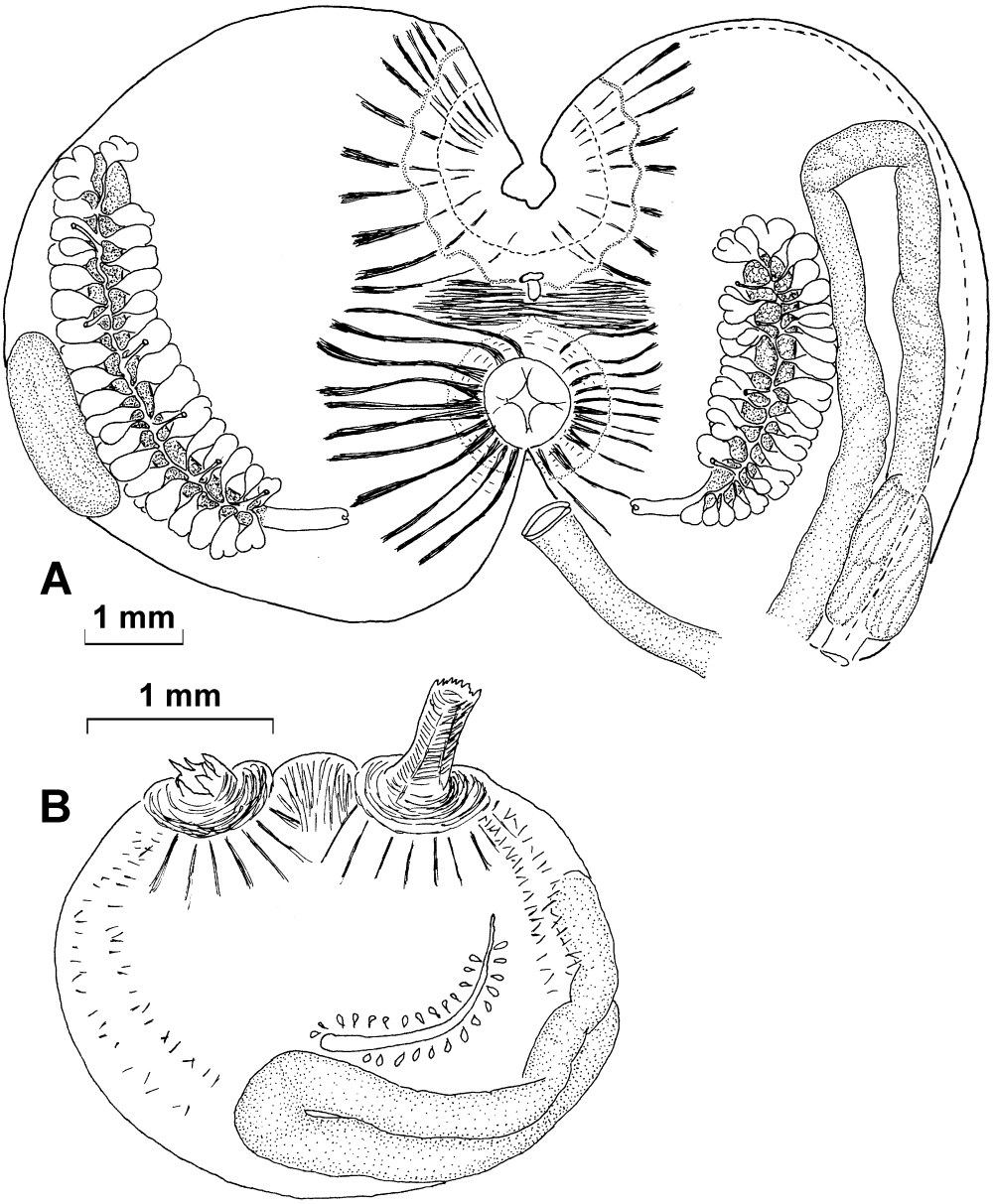


**FIGURE 5.** *Molgula beringense* **sp.n.** A, holotype (ZMMU As-95) opened along ventral midline, branchial sac removed; B, juvenile specimen, body removed from the test.

Redikorzev (1941) described three species from NW Pacific, of which *M. primitiva* Redikorzev, 1941 has a dentate dorsal lamina, *M. eobia* Redikorzev, 1941 is conspecific with *M. retortiformis* Verrill, 1871 (K. San-

amyan, type revision), and *M. lapidifera* Redikorzev, 1941, from the Sea of Okhotsk, might be similar to the present species, but has extremely numerous male openings – 13 on the left gonad and 18 on the right. Nishikawa (1991: 157) compares *M. lapidifera* with *M. siphonalis* Sars, 1859 and *M. xenophora*: Tokioka, 1967. However *M. siphonalis* is an unrelated species, with different gonads: a distinctly lobed ovary, no common sperm duct on the mesial surface of the ovary, and a distinct enlargement on the ascending limb of the intestine just before the pole of the gut loop (see Redikorzev, 1916, Fig. 16, Monniot, 1969b, Fig. 23). The constant presence of the latter feature is confirmed by examining the specimens of *M. siphonalis* from the White Sea. This feature and the structure of its gonads distinguish *M. siphonalis* from *M. beringense* **sp.n.**

***Molgula tzetlini* Sanamyan, 1993**
(Figure 6)

*Molgula tzetlini* Sanamyan, 1993: 129.

**Material examined:** Four specimens collected during July and August 1995 on Medny Island (Commander Islands), 8–20 m, KBPIG 700/3, 723/5, 725/6, 741/7; Kamchatka, Avacha Bay, 5 m, one specimen, KBPIG 1066/8.

**Previous records:** NW Pacific, Commander Islands (Sanamyan, 1993).

**Description.** All specimens are small, 5.5–11 mm in diameter and heavily incrusted with sand. Sand grains are attached directly to the test and hair-like processes are not present. The shape of the body removed from the test is characteristic (Fig. 6B). Both siphons are long and muscular and have well marked pointed lobules fringing the rim of the apertures. Body muscles are present only on the anterior half of the body and consist of 1) crowded thick circular siphonal muscles present only on the siphons and not extending outside the bases of the siphons; 2) spaced thick muscle bands radiating from siphons to about the middle of the body; 3) compact field of short muscle fibers crossing the intersiphonal area and completely covering the region of neural ganglion and dorsal tubercle; 4) rows of short transverse muscles running along mid-ventral and mid-dorsal lines in the anterior half of the body. The branchial sac has a regular structure of seven longitudinal rows of 12 (in the most ventral row) or six (in all other rows) square spirals separated by five transverse vessels. There are seven branchial folds, all except the most ventral one being well developed with 4–6 internal longitudinal vessels. The most ventral fold is represented by only one longitudinal vessel in all the specimens. The typical formula is: (1)(5)(5)(6)(6)(6)(6)DL(5)(6)(5)(6)(4)(4)(1). Longitudinal vessels are not present between the folds or, rarely, a single vessel is between the dorsal lamina and adjacent fold on the right side of the branchial sac. Radial and rather irregular parastigmatic vessels are present and bear minute papillae (recognizable only after staining). The dorsal lamina has a plain margin. The gut forms a long, narrow loop, usually but not always open at the pole, and curved to varying degrees, from a slight arc to a J-shaped curve (Fig. 6D). The shape of the gonads varies with maturity. Commonly they are of moderate length, almost straight (Fig. 6C) or only slightly curved (Fig. 6A). The central tubular ovary ends in a wide, short, almost sessile oviduct, which may be slightly longer only in smaller specimens with immature gonads. A wide ring of minute papillae on the body wall surrounds the opening of the oviduct. Large testis follicles surrounding the ovary may be simple, pear or sausage-shaped or become branched terminally, especially in larger specimens. One or two male papillae are on the mesial surface of the ovary. Eggs were found being incubated in the peribranchial cavity in all examined specimens, but tailed larvae were not present.

**Remarks.** The species is based on two small specimens collected in the intertidal zone of the Commander Islands. Both specimens agree well with the original description, the only difference is that the holotype has two vessels in the most ventral fold on the right side of the branchial sac, while only one vessel is present in all newly examined specimens. Also, oviducts are described as "relatively long" (Sanamyan, 1993: 130), but

actually they are not longer than those of the specimen KBPIG 723/5 (Fig. 6D). The following features are characteristic and appear to be stable in this species: 1) the body covered by sand but without hair-like processes; 2) seven branchial folds, the most ventral represented by one (exceptionally two) vessels; 3) one or two male papilla on the mesial surface of the ovary; 4) eggs being incubated in the peribranchial cavity and, probably associated with this feature, a ring of papillae around the opening of the oviduct.

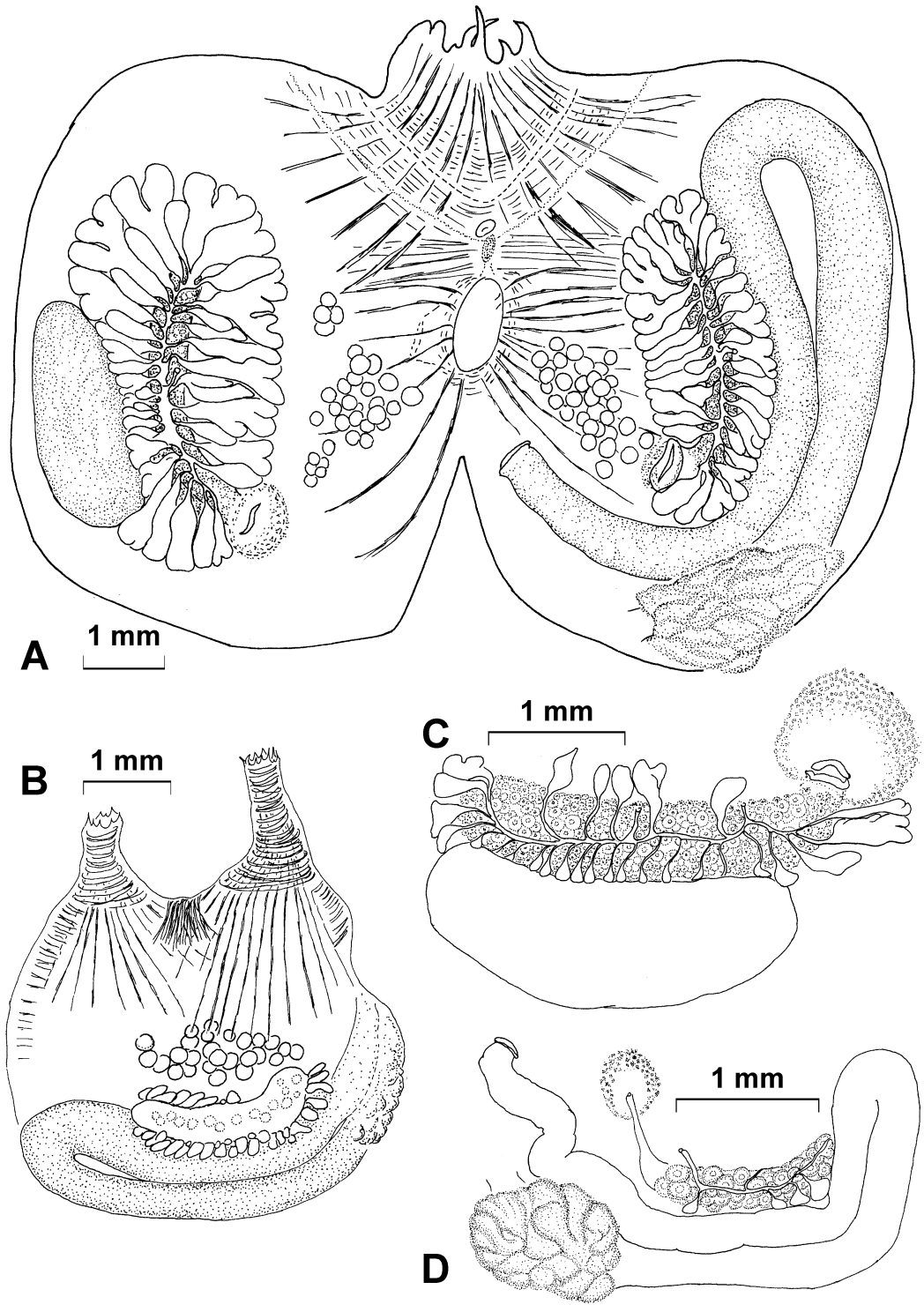


**FIGURE 6.** *Molgula tzetlini*. A, specimen opened along ventral midline, branchial sac removed (KBPIG 1066/8); B, body removed from the test (KBPIG 725/6); C, right gonad and renal sac (KBPIG 700/3); D, gut loop and left gonad of juvenile specimen (KBPIG 723/5).

In brooding its eggs in the peribranchial cavity *M. tzetlini* resembles *M. cooperi*, but they differ in many features including the number of the branchial folds, the structure of the gonads and especially the gonoducts. *Molgula tzetlini* is found in depths of 0–20m.

## References


Bonnevie, K. (1896) Ascidiae Simplices og Ascidiae Compositae fra Nordhavs Expeditionen. *Norske Nordhavs Expedion*, 7(23), 1–16.

Herdman, W.A. (1898) Descriptions of simple ascidians collected in Puget Sound, Pacific coast. *Proceedings and Transactions of Liverpool Biological Society*, 12, 248–267.

Hoshino, Z. & Nishikawa, T. (1985) Taxonomic studies of *Ciona intestinalis* (L.) and its allies. *Publications of the Seto Marine Biological Laboratory*, 30, 61–79.

Huntsman, A.G. (1912a) Ascidians from the coasts of Canada. Transactions of the Canadian Institute, 9, 111–148.

Huntsman, A.G. (1912b) Holosomatous ascidians from the coast of western Canada. *Contributions to Canadian Biology and Fisheries*, 1906–1910, 103–185.

Monniot, C. (1969a) Ascidies récoltées par la 'Thalassa' sur la pente du plateau continental du golfe de Gascorne (18–25 octobre 1968). *Bulletin du Muséum national d'Histoire naturelle, Paris*, 41(5), 1131–1145.

Monniot, C. (1969b) Les Molgulidae des mers europeennes. *Mémoires du Muséum national d'Histoire naturelle, Zoologie*, 40(4), 172–272.

Monniot, C. (1998) Abyssal ascidians collected from proximity of hydrothermal vents in the Pacific Ocean. *Bulletin of Marine Science*, 63(3), 541–558

Monniot, C. & Monniot, F. (1989) Ascidians collected around the Galapagos Islands using the Johnson-Sea-Link research submersible, *Proceedings of the Biological Society of Washington*, 102(1), 14–32.

Nishikawa, T. (1991) The ascidians of the Japan Sea 2. *Publications of the Seto Marine Biological Laboratory*, 35(1/3), 25–170.

Redikorzev, V. (1941) Ascidien der Meere des fernen Osten der Ud.S.S.R. *Investigation of far Eastern Seas of U.S.S.R.*, (1), 164–212. (In Russian with German descriptions).

Ritter, W.E. (1907) The ascidians collected by the United States Fisheries Bureau steamer Albatross on the coast of California during the summer of 1904. *University of California Publications in Zoology*, 4, 1–52.

Sanamyan, K. (1993) Ascidians from the North-Western Pacific region. 2. Molgulidae. *Ophelia*, 38(2), 127–135.

Sanamyan, K. (1998) Ascidians from the North-Western Pacific region. 5. Phlebobranchia. *Ophelia*, 49(2), 97–116.

Sanamyan, K. & Sanamyan, N. (1998) Some deep-water ascidians from the NW Pacific (Tunicata: Ascidiacea). *Zoosystematica Rossica*, 7(2), 209–214.

Van Name, W.G. (1945) The North and South American ascidians. *Bulletin of the American Museum of Natural History*, 84, 1–476.