

Culeolus tenuis (Urochordata, Ascidiacea) Newly Found off Fukushima, Japan in the Japan Trench

Teruaki Nishikawa^{1,*} and Takashi Kuramochi²

¹Department of Zoology, National Museum of Nature and Science,
4-4-1 Amakubo, Tsukuba, Ibaraki 305-0005, Japan

²Hayama Shiosai Museum, 2123-1 Isshiki, Hayama, Miura,
Kanagawa 240-0111, Japan

*E-mail: nishikawateruaki@gmail.com

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Abstract The ascidian genus *Culeolus* (family Pyuridae) is known exclusively from deep-sea floors, being anchored by a long, thin hard stalk. A specimen of *Culeolus* sp. sensu Kuramochi *et al.* (1999), collected in 1998, was identified as *C. tenuis* Vinogradova, 1970, and described in detail, including some taxonomic and ecological remarks. The specimen had been one of 6 individuals observed *in situ* from the remote-operated submersible “KAIKO”, supported by the JAMSTEC R/V “KAIREI” (KR98-07 #79 Leg. 1), at depths of 5,726 to 5,792 m off Fukushima Prefecture, Japan, on the land-slope side of the Japan Trench. The species has been previously recorded from the NW Pacific, including the Japan Trench off Sendai, Miyagi Prefecture. The examined specimen was characterized by 6 branchial folds with 3 elongated lobed gonads on each side, and one of the left gonads within the first intestinal loop. The habitat floor off Fukushima was composed of yellowish sand mixed with black manganese-coated pebbles of olivine basalt, the bottom water likely being oxygen-rich.

Key words: *Culeolus tenuis*, *Culeolus*, stalked ascidian, deep sea, Japan Trench, manganese precipitation, oxygen-rich environment.

Introduction

The ascidian genus *Culeolus* (family Pyuridae), recorded exclusively from deep-sea floors, being anchored by a long, thin hard stalk, includes ca. 30 nominal species, of which three are known from the vicinity of Japan: *C. herdmani* Sluiter, 1904 from Sagami Bay, 400 m deep (Tokioka, 1953, pp. 289–289), *C. murrayi* Herdman, 1881 from the Japan Trench off Sendai, Tohoku District, 6,156 to 6,207 m (Vinogradova, 1970, pp. 498–502), and *C. tenuis* Vinogradova, 1970 from the Japan Trench off Sendai, 6,156 to 6,207 m (Vinogradova, 1970, pp. 491–493). In addition, Kott (2002, Tab. 1) listed *C. annulatus* Sluiter, 1904 and *C. quadrula* Sluiter,

1904 from “Japan”, but such occurrences are apparently without any literature basis.

Kuramochi *et al.* (1999) made *in situ* observations in 1998 of 6 similar ascidians at depths of 5,726 to 5,792 m off Fukushima Prefecture, Japan, on the land-slope side of the Japan Trench, from the remote-operated submersible “KAIKO” (JAMSTEC), with a brief description of a single collected specimen referred to as *Culeolus* sp. It is here identified as *C. tenuis* Vinogradova, 1970, previously recorded from abyssal or hadal floors in the NW Pacific, from 5,027 to 6,282 m depth (Vinogradova, 1970; Sanamyan and Sanamyan, 1998, 2006; Fig. 1). A detailed description of the specimen is given, with some remarks on taxonomic and ecological considerations. This is the second record of *C. tenuis* from the Japan Trench.

Taxonomic Account

Culeolus tenuis Vinogradova, 1970

(Figs. 1–2; Table 1)

Culeolus tenuis Vinogradova, 1970, pp. 491–493, text-figs. 1–2; Sanamyan and Sanamyan, 1998, p. 214; Sanamyan and Sanamyan, 2006, pp. 329–331.

Culeolus sp.: Kuramochi *et al.*, 1999, pp. 1–3, photos 1–3.

Material examined (Deposited in National Museum of Nature and Science, Tsukuba). NSMT-Pc 5353, land-slope side of Japan Trench off Fukushima Prefecture, Japan (36°23'86.72"N; 143°45'59.96"E), 5,784m, T. Kuramochi [from remote-operated submersible "KAIKO" supported by JAMSTEC R/V "KAIREI" (KR98-07 #79 Leg. 1)], 15 July 1998.

Description. Body proper pale pink, gonads visible through tunic, with a long brownish stalk (*in situ* observation), but body proper later becoming brown (Kuramochi *et al.*, 1999, p. 2, photos 1–3); brownish coloration persisting for several years following formalin-fixation and 70%-ethanol preservation, subsequently becoming pale yellow (same preservative) by early 2023. Body length 68mm, width 22mm, and dorsoventral depth 35mm; a long blackish-brown stalk, ca. 365mm (length), 2.5 to 3mm (diameter), distal end fixed in bottom substrate, proximal end running posteriad along anterior half of mid-ventral line of body (Fig. 1A, St);

stalk comprising a dark brown, hard, wire-like but relatively fragile shaft, covered with thin, almost transparent tunic layer; body tunic thin, tough, semi-transparent whitish, entire surface densely covered with pale to moderately dark brownish papillae, up to 0.2mm high (coloration becoming pale yellow by early 2023); both siphons indistinct, branchial aperture terminal, widely opened with many protruding branched tentacles, atrial aperture situated at posterior one-fifth of body, very wide with anal end of intestine exposed on left; a distinct low U-shaped crest widely opened dorsally, running from antero-lateral aspect to posteroventral aspect of atrial aperture on each side to unite at mid-ventral line (Fig. 1A). Mantle very thin, white (almost transparent), body musculature a sparse network of very thin fibers, except around apertures (furnished densely with circular fibers). Branchial tentacles 28 in total, including both second- and third-order branches (*sensu* Tokioka, 1953); ciliated groove C-shaped, opening to right (Fig. 1D), many distinct dorsal languets following posteriorly, with six branchial folds on each side (formula: L. D. 3(14)2(17)2(15)4(15)4(12)4(6)10V.; R. D. 2(13)3(17)2(16)4(14)4(12)4(7)8V). Intestinal loop simple, U-shaped, elongated longitudinally; stomach extensively covered with complicatedly branched hepatic lobes (Fig. 1C). Three

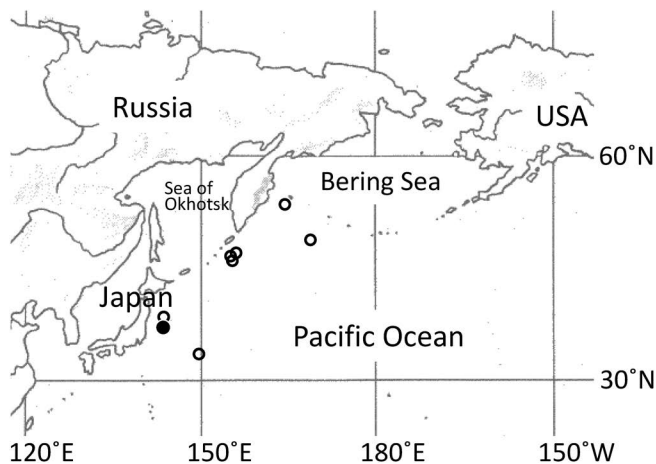


Fig. 1. Map showing the localities of *Culeolus tenuis* Vinogradova, 1970, so far known (open circles) or newly recorded in the present study (solid circle).

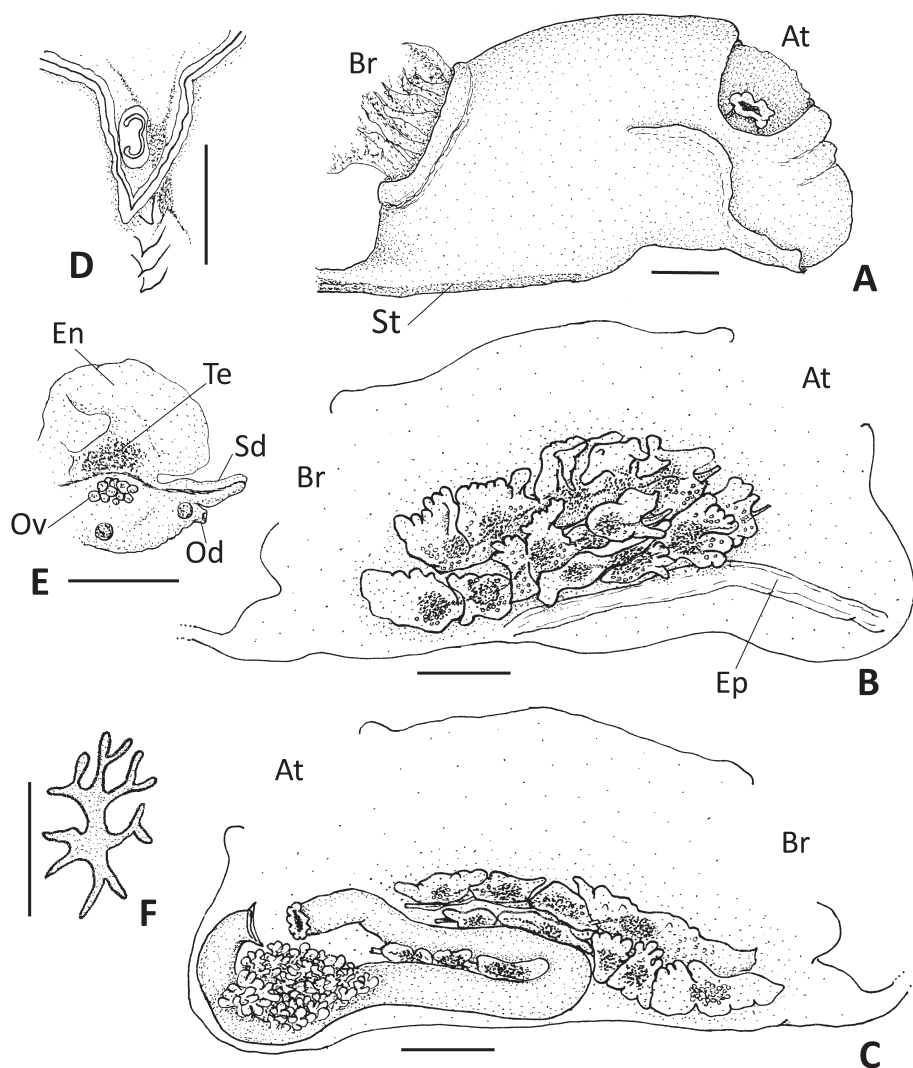


Fig. 2. *Culeolus tenuis* Vinogradova, 1970 from off Fukushima Prefecture in the Japan Trench. A: Left side of body proper with branchial tentacles projecting from branchial aperture (Br) and anal end visible through atrial aperture (At), B: Inner view of right mantle of body, C: Inner view of left mantle of body; D: Dorsal tubercle and vicinity, E: Proximal (= posterior) terminal of right dorsal-most gonad, directed to atrial aperture end, to show openings of oviduct (Od) and sperm duct (Sd); F: A horny polygonal spicule from pericardium. Mantle musculature and spicules in B and C, and in B-E, respectively, omitted. Abbreviations: At: atrial aperture, Br: branchial aperture, En: endocarp, Ep: pericardium, Od: oviduct, Ov: ovarian eggs, Sd: sperm duct, St: proximal end of stalk along anterior mid-ventral half of body proper, Te: testicular follicles. Scales for A, B, and C 10 mm, for D and E, 5 mm, and for F, 1 mm.

partly matured, longitudinally elongated gonads on each side, each comprising several lobes discernible as simple or complicated endocarps, two gonads in tight contact with each other along dorsal aspect of descending limb of gut loop, a third gonad occupying first intestinal loop on left

(Fig. 1C), all three in close contact with one another along epicardium on right (Fig. 1B), each gonad furnished distally (near atrial siphon) with a free elongated end of sperm duct, accompanied by almost sessile end of oviduct (Fig. 1E); ovarian eggs up to 0.6 mm in diameter; non-

Table 1. Known localities of *Culeolus tenuis* Vinogradova, 1970, listed from north to south, also see Fig. 1

Latitude (N)	Longitude (E)	Depth (m)	Number of individuals	Source
54°58'	165°44'	6,074–5,300	1	Sanamyan & Sanamyan, 1998
48°15'	169°39'	6,272–6,282	23	Vinogradova, 1970
46°08'	155°16'	5,070–5,090	1	do.
45°18'	156°00'	5,035–5,210	10	do.
45°18'	156°00'	5,030–5,031	2*	Sanamyan & Sanamyan, 2006
44°43'	153°49'	5,027	3	Vinogradova, 1970
38°11'	143°56'	6,156–6,207	2	do.
36°24'	143°46'	5,784	1	present study
33°18'	149°46'	6,096	1	Vinogradova, 1970

*) Part of Vinogradova's 10 specimens listed immediately above.

gonadal endocarps absent from mantle and intestinal surface facing peribranchial cavity. Flat, yellowish or white (almost transparent) polygonal horn-shaped spicules up to 1.5 mm long discernible densely in walls of branchial sac, pericardium (not heart), intestine (including hepatic lobes), and gonads (Fig. 1F).

Remarks. The present specimen is closely similar to the original description of *C. tenuis* given by Vinogradova (1970) for 40 syntype specimens (holotype not designated) from 6 stations in the NW Pacific at depths of 5,027 to 6,282 m; in particular, in the proximal end of the stalk running along the anteroventral aspect of the body, the tunic crest U-shaped and opening dorsally, the dense visceral distribution of horny spicules, 6 distinct branchial folds, a simple ciliated groove, simple U-shaped intestine, and 3 elongated, (almost always) lobed and endocarp-bearing gonads on each side, opening near the atrial aperture. The position of the ventral-most gonad on the left (i.e., within the first intestinal loop or not), seems to be a significant diagnostic character within the genus, but the original description of *C. tenuis* lacked that detail. An attempt (by TN) to examine the syntypes of *C. tenuis*, deposited at the P. P. Shirshov Institute of Oceanology of Russian Academy of Sciences, Moscow (Vinogradova, 1970, p. 490), was unsuccessful. However, Sanamyan and Sanamyan (2006) described "two intact specimens" of *C. tenuis*, collected at [R/V 'Vityaz'] "St. 5621, 5030–5031 m" and "identified as *Culeolus tenuis* by Vinogradova" (p. 330) [part of Vinogradova's

(1970) 10 syntypes from the 'Vityaz' station 5621 (K. Sanamyan, personal communication; see Tab. 1)], as having three elongated lobed gonads on each side, with one of the left gonads included in the first intestinal loop. In gonadal number and arrangement, therefore, the present specimen from the Japan Trench is identical to those described by Sanamyan and Sanamyan (2006), supporting the identification of the specimen collected off Fukushima. The description by Sanamyan and Sanamyan (1998) of a single non-type specimen of *C. tenuis* from the Aleutian Trench noted only two gonads (instead of three) on the right side, whereas the number and arrangement of left gonads matched the description in Sanamyan and Sanamyan (2006) of specimens from the Kurile-Kamchatka Trench, as well as the present Japan Trench specimen. The taxonomic status of the Aleutian specimen should be reconsidered following examination of further material.

Sanamyan and Sanamyan (2006) noted specimens as having the tunic surface "almost smooth, without papillae" (p. 330), Vinogradova (1970) having earlier described the tunic surface in some specimens as being furnished with irregularly-shaped flat papillae at the posterior end of the body (p. 493). However, the entire body surface of the present specimen was densely covered with minute papillae. Any taxonomic significance of this difference is presently questionable, and requires further investigation.

Although Monniot and Monniot (1991, p. 421) regarded *C. sluiteri* Ritter, 1913 from the NW Pacific as "peut-être synonyme de" (perhaps a

synonym of) *C. tenuis*, they overlooked the presence of only “five prominent (branchial) folds on each side” (Ritter, 1913, p. 464) in the former species, compared with six in *C. tenuis*, as noted by Sanamyan and Sanamyan (1998, 2006). Thus, *C. tenuis* can be regarded as valid, being distinct from *C. sluiteri*. Although Sanamyan and Sanamyan (1998, 2006) questioned the validity of *C. nadejdae* Sanamyan, 1992 as a species distinct from *C. tenuis*, the former is so far known only from the Sea of Okhotsk, in 1,050–1,040 m depth (Sanamyan, 1992, pp. 188–190), and is clearly distinguishable from *C. tenuis* by the number and arrangement of left gonads [total of 2–5, all in the first intestinal loop in the former; 3 (one in the loop) in the latter], as correctly noted by Sanamyan and Sanamyan (2006).

Ecological Considerations

The *in situ* observations by Kuramochi *et al.* (1999) of 6 individuals of *C. tenuis*, made at depths of 5,726 to 5,792 m off Fukushima in the Japan Trench from the remote-operated submersible “KAIKO” over a period of 2 hours, indicated that individuals occurred sparsely on the sand and gravel sea floor, and at no time on neighboring rocky substrata. The long stalk projected almost vertically from the sea floor, the body proper moving slightly in the water column with the dorsal surface upward (i.e., longitudinal axis horizontal). A video is available at https://www.godac.jamstec.go.jp/jedi/static_player/j/KAIKO0079BCSV10_00503890 (accessed on Mar. 2, 2023). The sea floor comprised yellowish sand mixed with manganese-coated black pebbles of olivine basalt. As stated above, the live body color of the collected individual was initially pale pink, becoming brown on board soon after collection, and later pale yellow in preservative. The chemical processes behind the color changes remain to be determined, but it is likely that the body was also coated with manganese (possibly with iron as a ferromanganese crust), which becomes brown depending upon oxygen concentration. In any case, because manganese or ferro-

manganese in deep water is precipitated by oxidation (Usui *et al.*, 2020), the habitat of *C. tenuis* can be regarded as oxygen-rich, although the *in situ* measurements taken of dissolved oxygen content are now unavailable (JAMSTEC Data Management Office, personal communication).

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