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Redescription of the holotype of the deep-sea ascidian *Culeolus uschakovi* (Urochordata: Ascidiacea) from the Sea of Okhotsk

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Abstract *Culeolus uschakovi* Redikorzev, 1941, formerly considered as conspecific with *C. murrayi* and *C. suhmi*, is redescribed as a valid species. Examination of the holotype (by monotypy), dredged from 3350 m depth in the Sea of Okhotsk, revealed the following significant morphological features: The proximal end of the stalk ran posteriad along the anterior part of the mid-ventral line of the body proper; a complete ring of conical projections, up to 1.5 mm high and 0.5 mm in basal diameter, widely encircled the atrial aperture obliquely from the middorsal to posteroventral margins of the body proper, being most crowded ventrally; similar conical projections were apparent on each side as a wide dense belt from around the branchial aperture ventrally to the proximal end of the stalk; two large elongated gonads, roughly 2- to 3-lobed, were present on each side, those on the left being relatively well separated from each other, the intervening space apparently having been occupied by the intestine, now completely detached from the mantle and deformed, but originally described as having a simple narrow U-shape. One of the left gonads was likely located within the intestinal loop.
Key words: *Cuelolus uschakovi*, *Culeolus murrayi*, *Culeolus suhmi*, holotype, validity, deep sea, tunic conical papillae, gonads.

Introduction

Redescriptions of name-bearing type specimens are often essential in subsequent taxonomic studies of the taxa concerned. This holds true particularly for the deep-sea ascidian genus *Culeolus* (family Pyuridae) considered here, as shown by Van Name (1912) for a syntype of *C. tanneri* Verrill, 1885, the latter now being recognized as a junior synonym of *C. suhmi* Herdman, 1881; by Monniot and Monniot (1982) for a syntype of *C. murrayi* Herdman, 1881 and holotype (by monotypy) of *C. moselyi* Herdman, 1882; and by Sanamyan and Sanamyan (2006) for a paratype of *C. robusta* Vinogradova, 1970, a paratype of *C. longipedunculatus* Vinogradova, 1970, and the two syntypes of *C. tenuis* Vinogradova, 1970.

The present study concerned the holotype (by monotypy) of *C. uschakovi* Redikorzev, 1941, the original description and subsequent redescription by Vinogradova (1970) both lacking important details of tunic surface morphology and gonadal arrangement. According to Redikorzev (1941, pp. 183–185, 211, pl. 3, fig, 5, text-figs. 10–13 in Russian), the tunic was furnished with a closed ring of large and variously-shaped appendages near the atrial aperture, although its exact position (whether encircling the aperture or not) was unknown. Similarly, a series of similar appendages was described as an arch beginning at the stalk attachment site and continuing towards the dorsal surface on each

side of the branchial aperture, but without further details (whether as a single row or a dense zone). Such appendage distribution patterns appeared to be reminiscent of *C. easteri* Tokioka, 1967, so far recorded only off the Marquesas Islands (4433 m depth), and bearing on the tunic surface "two transverse rows of comparatively large conical prominences, one at level of branchial aperture, other at middle of range between apertures and confined to dorsal half of body" (Tokioka, 1967, p. 220, text-fig. 100b). The original description of *C. uschakovi* also indicated the existence of 2 gonads on each side, the internal [probably ventral, because the body was opened dorsally, see below] gonad being half the length of the external [dorsal] one. However, their arrangement on the left side in relation to the simple narrow U-shaped intestine was not described. In addition, the attachment of the stalk to the body proper in *C. uschakovi* has remained unclear as to whether its proximal end ran posteriad along the anteriormost part of the mid-ventral line of the body (as usual in the genus), or anteriad towards the ventral rim of the branchial aperture, as seen in *C. herdmani* Sluiter, 1904 (see Sluiter, 1904, p. 105 and fig. 4 of pl. 12). To clarify these features in *C. uschakovi*, and for a better understanding of the morphological diversity of the genus, the holotype is redescribed below in detail.

Material and Method

A single specimen of *Culeolus uschakovi*, presently deposited in the Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia, and labelled "Zool. Mus. Acad. Sci. No. 53-1934/1771, bore the following information: *Culeolus uschakovi* Redik./Typ./St. 208, 2. VII. 1932, Sea of Okhotsk; 46°41′5N, 147°28′0E, Dredge, 3350 m deep, silt and pebbles, R(esearch)/t(rawl) "Gagara", P. Ushakov." (original in Russian). This was entirely consistent with the sampling information originally provided by Redikorzev (1941); Sea of Okhotsk: St. 208, depth 3350 m, silt, pebble, 1 specimen. (P. Ushakov) (p. 183, in Russian) and "Ochotsk-Meer: 46°41′5N, 147°28′E, 3500 m Tiefe, Schlamm, Geröll (1 EX.)" (p. 211, in German summary). The identity of the specimen as the holotype (by monotypy) of *Culeolus uschakovi* was unquestioned. The body proper of the specimen had been cut open longitudinally from the branchial to atrial apertures along the dorsolateral line on the left side, just dorsally of the left gonads; the tunic and mantle had been cut together during the original examination, with the mantle wall still firmly attached to the tunic. The external appearance of the specimen, although somewhat deformed due to the original dissection, remained consistent with the original description (based on a single specimen), as follows: Body proper bluntly pear-shaped, 46 mm long by 30 mm in diameter, with a long (157 mm) 2 mm thick stalk, and approximately 8 short branched root-like processes; tunic surface shagreen-like, densely papillated; tunic often white but mostly irregularly dark brown. The following description of the specimen was made by TN, totally dependent upon a number of photographs taken by NI.

Holotype Redescription of *Culeolus uschakovi* (Fig. 1)

Body proper pear-shaped, with proximal end of stalk running posteriad along anterior one-seventh of body mid-ventral line (Fig. 1A, Dst). Surface of body proper often white to pale yellow, mostly irregularly dark brown to black (Fig. 1B, Bp), entirely bearing low papillae up to 100 to 200 µm base diameter, each mostly filled with opaque roundish matter (white in black or white patches, yellow in pale yellowish patches). A complete ring of prominent conical projections (up to 1.5 mm tall and 0.5 mm in basal diameter) widely encircling atrial aperture obliquely from middorsal to posteroventral margins of body proper (Fig. 1A), most crowded ventrally (Fig. 1B); projections mostly transparent white (Fig. 1B), rarely opaque due to central white matter; containing some or many white to pale yellow opaque spherules, 0.1 to 0.2 mm in diameter; sur-

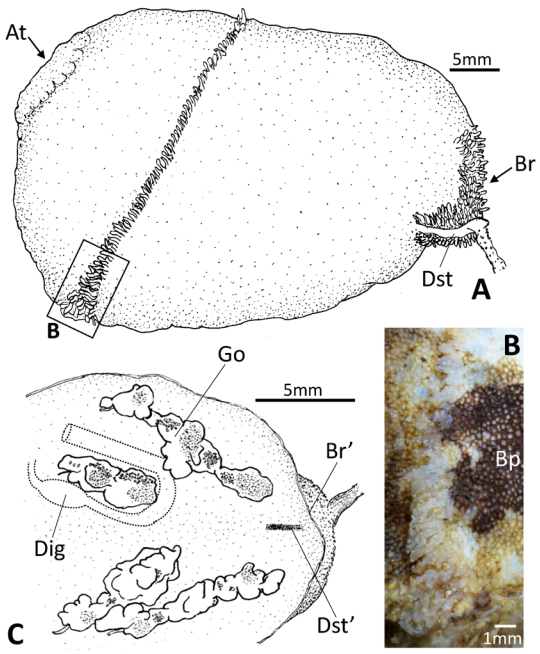

Fig. 1. Holotype of *Culeolus uschakovi* Redikorzev, 1941 from the Sea of Okhotsk (3350 m depth), registered in the Zoological Institute of Russian Academy of Sciences, St. Petersburg as Zool. Mus. Acad. Sci. No. 53-1934/1771. A: Right side of body, B: Tunic surface partly enlarged from square B in A, C: Two gonads on each side, viewed dorsally, mantle musculature omitted. Abbreviations: At, Atrial aperture; Bp, Black patch; Br, Branchial aperture; Br', approximate position of branchial aperture opening in original description; Dig, apparent position of digestive system; Dst, distal end of stalk along anterior-ventral margin of body proper; Dst', distal end of stalk seen through tunic; Go, Gonad.

face without lateral tubercles (in original description; p. 183 and text-fig. 10). Similar conical projections apparent on each side as a dense wide belt from around branchial aperture to proximal end of stalk fused with body proper (Fig. 1A), forming an anteroventral "beard". No other obvious tunic ridges or projections along ventro- and dorsomedian lines or elsewhere, although some minute cylindrical or bubble-like malformed prominences randomly detectable. Tunic very thin, tough, its inner surface white; mantle very thin, almost transparent, firmly attached to tunic, with body musculature as a sparse network of thin yellow fibers. Part of branchial sac still present, with at least 5 folds on each side, but exact number uncertain due to loss of ventralmost portion; 6–12 longitudinal vessels on each fold, with 1–4 between folds (consistent with original description of 6–11 longitudinal vessels on each fold and intermediate longitudinal vessels 2–4). Digestive system completely detached from mantle, too deformed to determine original configuration; originally described as hepatic appendages on an elongated-oval stomach (p. 184 and text-fig. 12) and with a smooth anal edge (p. 184) confirmed here. Two parallel gonads on each side (as described originally), containing many ovarian eggs (up to ca. 200 µm diameter) and testicular follicles, roughly 2- to 3-lobed (Fig. 1C). Right gonads in tight contact with each other, left gonads separated rather widely from each other, allowing space for occupation by intestine (Fig. 1C, Dig) [described as having a simple narrow U-shape in original description]. Heart not found due to damage.

Remarks. The left gonad arrangement, significant for *Culeolus* taxonomy, was not given in the original description, which stated only that one and a half gonads occurred on each side, the internal (ventral) gonad being shorter than the external (dorsal) one. Clearly, the gonadal number on each side should be regarded as two, the said difference in gonadal length on each side being consistent with the present redescription, illustrated in Fig. 1C. The original configuration of the two left gonads was reconstructed as described above, the intervening space between the two being considered to have accommodated the simple narrow U-shaped intestine (that is to say, one of the two left gonads was situated inside the intestinal loop). The holotype was originally described as having 16 branchial tentacles, 6 (left) and 5 (right) folds of various heights, stigmata without cilia, and a few horny spicules (simple or having a few short branches) in the longitudinal folds. These last-mentioned features could not be confirmed here due to deterioration of the material.

Taxonomic Considerations on the Validity of *C. uschakovi*

C. uschakovi was considered to be a junior synonym of *C. murrayi* Herdman, 1881 by Vinogradova (1970, pp. 498–503), following re-examination of the holotype of the former. However, the supporting description lacked important details, saying only that the holotype of the former was fully consistent with Herdman's [original] description and 55 specimens of *C. murrayi* (from deep water in the NW Pacific) in body shape, proportions, and surface texture, the sculpture and structure of the crest [= *Culeolus*-ridge], and structure of the internal organs, without any reference to gonads. Later, Sanamyan and Sanamyan (2006, p. 333) redescribed part of Vinogradova's (1970) material, an intact well-preserved specimen from 5035–5210 m depth in the Chishima (Kurile)-Kamchatka Trench, as having "two gonads on each side" and "on the left, one gonad —— inside and the other outside the gut loop", and concluded that "We failed to find any reliable feature distinguishing this specimen from *C. suhmi* and all the specimens of *C. murrayi* of Vinogradova (1970) and here considered conspecific with *C. suhmi*". Accordingly, Sanamyan and Sanamyan (2006) considered *C. uschakovi* conspecific with *C. suhmi* Herdman, 1881, the latter taking precedence, after comparing Redikorzev's (1941) original description of the former with a newly collected 24 mm long specimen of *C. suhmi* from 4820 m depth near the Aleutian Trench, emphasizing similarities in "a complete ring of papillae around the posterior end of the body and the two gonads on each side".

Sanamyan and Sanamyan's (2006) specimen of *C. suhmi*, as described (p. 331) and depicted (text-fig. 13A), is clearly similar to the holotype of *C. uschakovi* in having a complete ring of elongated conical projections widely encircling the atrial aperture on the tunic and being most developed ventrally, its surface furnished wholly with low papillae, many of which included opaque matter. The specimen also had two gonads on each side, with one of the left gonads inside the intestinal loop. However, the authors also noted that "a few separate and relatively long papillae are on the mid-ventral line", especially between the posteroventral area of the ring towards the atrial aperture, and a similar, although rather insignificant, longitudinal row also detectable posterodorally between the ring and aperture (see their text-fig. 13A) in their *C. suhmi* specimen, quite unlike the *C. uschakovi* holotype condition. Furthermore, the anteroventral "beard" of elongated projections along the proximal end of the stalk comprised only a very few (3, according to the figure) large elements in their specimen, such projections being smaller and much more numerous in the aforementioned holotype. These differences may represent intraspecific variations among the NW Pacific populations. However, the type locality of *C. suhmi* is in the NW Atlantic (3060 m depth), east of New York, North America (see Herdman, 1881, p. 87; 1882, p. 117), a good distance from the NW Pacific locality of *C. uschakovi*. Also, the holotype of *C. suhmi* was not fully described, and its gonadal number and arrangement remain unknown. Consequently, conspecificity of these two species should not yet be entertained.

The tunic surface of *C. murrayi*, originally from the far east off Japan in 4140 m depth, appeared to be quite similar to that of the holotype of C. *uschakovi* (see Fig. 1A), according to Monniot and Monniot's (1982, p. 117; text-fig. 26) redescription of one of the two syntypes (body proper length 45 mm) of *C. murrayi* and NT's reexamination of the other (one of BMNH 1887.7.2.4.29–30 specimens in the Department of Zoology, The Natural History Museum; the length 49 mm). However, the former 45 mm long syntype had 3 gonads, 1- to 3-lobed, on each side, with one inside the intestinal loop on the left, while the latter 49 mm long syntype had 5 gonads on the left, 1- to 3-lobed, with one inside the loop, but no gonads on the right, thereby differing from the holotype of C. *uschakovi* (2 gonads on each side). The difference in gonadal number is probably enough to distinguish

between the two species.

All in all, C. *uschakovi* should continue to be treated as a valid species, although future studies, including more detailed morphological information plus molecular data, would be welcome. Thus, the results of the present taxonomic considerations may be summarized as:

Culeolus uschakovi Redikorzev, 1941
(Fig. 1)

Culeolus uschakovi Redikorzev, 1941, pp. 183–185, 211, Pl. 3, fig. 5, text-figs. 10–13.
Culeolus murrayi Herdman, 1881: Vinogradova, 1970, pp. 498–502, Tab. 3, text-figs. 5–7.
Culeolus suhmi Herdman, 1881: Sanamyan and Sanamyan, 2006, pp. 331–333, text-fig. 13.

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