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TENEBRINCOLA FRIGIDA, A NEW GENUS AND SPECIES OF ABYSSAL VOLUTE FROM THE NORTHERN PACIFIC OCEAN (GASTROPODA: VOLUTIDAE)

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ABSTRACT. *Tenebrincola frigida*, a new genus and species of volute, is described on the basis of a specimen taken from the Aleutian Trench at a depth of 5020 meters. It differs from its only congener, *T. cukri* (Rokop, 1972), in having a broader shell with a distinct shoulder. *Tenebrincola* is included in the subfamily Fulgorariinae on the basis of the morphology of its radula, operculum, accessory salivary glands, and male reproductive system. The eastern Australian genus *Ericusa* is tentatively considered to be the sister group, based on conchological similarity.

Key words: Volutidae, Fulgorariinae, *Tenebrincola*, abyssal, anatomy, systematics.

INTRODUCTION

In the course of examining the collections of the Institute of Oceanology, Academy of Sciences of the U.S.S.R., in Moscow, a single specimen of an unusual, operculate volutid, collected by the R/V Vityaz in the Aleutian Trench, was discovered. This specimen represents a new species that most closely resembles *Sigaluta cukri* Rokop, 1972, which occurs in abyssal depths off Baja California. Because the genus *Sigaluta* Rehder, 1967, recently has been shown to be a synonym of *Marginellona* Martens, 1904, of the family Marginellidae (Harasewych & Kantor,

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1991), a new genus is proposed to include both abyssal species. *Tenebrincola* is referable to the subfamily Fulgorariinae, and represents the first record of this subfamily in the abyssal fauna.

SYSTEMATICS

Family Volutidae Rafinesque, 1815

Subfamily Fulgorariinae Pilsbry and Olsson, 1954

Tenebrincola new genus

Type species: *Tenebrincola frigida* new species [described below].

Description: Shell to at least 68.4 mm, ovately to elongate fusiform, extremely thin and fragile. Protoconch of about 2 inflated whorls, nucleus deflected about 45° from shell axis, transition to teleoconch indistinct. Teleoconch with up to 3 whorls. Outer lip smooth. Columella without folds. Color ivory to white, internally and externally. Periostracum smooth, extremely thin. Operculum small, corneous, ovate, with tapering, terminal nucleus. Eyes absent. Siphonal appendages tapering, symmetrical. Accessory salivary glands short, broad posteriorly. Radula uniserial, with tricuspid rachidian teeth having broadly U-shaped attachment region; lateral cusps much broader but slightly shorter than central cusp. Pallial sperm duct closed. Penis with broad, lateral flap.

Etymology: *L. tenebra*-darkness + *L. incola*-inhabitant.

Tenebrincola frigida new species

Figures 1, 4-10

Description: Shell (Fig. 1) to at least 68.4 mm, extremely thin, fragile, translucent, ovately fusiform, with low, blunt spire. Protoconch large, bulbous, eroded, of about 2 whorls. Nucleus deflected from shell axis by 43°. Transition to teleoconch indistinct. Teleoconch with about 3 convex, weakly shouldered whorls. Suture adpressed. Surface sculpture limited to very fine growth striae. Aperture ovate, rounded anteriorly, sharply tapered posteriorly. Outer lip smooth, thin, sinuous. Inner lip smooth, parietal region not thickened. Columella lacking columellar or siphonal folds. Periostracum (Fig. 4) very thin ($\approx 1.5 \mu\text{m}$), smooth, continuous, imparting lustrous, ivory color to outer surface of shell. Aperture white. Operculum (Fig. 7) small ($0.2 \times$ aperture length), corneous, narrowly ovate, with tapering terminal nucleus (abraded away in holotype).

Ultrastructure: Shell thin ($\approx 85 \mu\text{m}$), composed of three layers of

orthogonally oriented, crossed-lamellar crystals (Fig. 5): outer layer 50 μm thick, crystal planes perpendicular to growing edge; middle layer 33 μm thick, crystal planes parallel to growing edge; inner layer 2.5 μm thick, crystal planes perpendicular to growing edge.

Anatomy: [The soft tissues of the single, male specimen were very friable. The visceral mass and portions of the mantle cavity disintegrated during extraction from shell.] Animal uniformly rust-colored. Foot $\frac{3}{4}$ length of shell aperture, broad ($L/W \approx 2.3$), with small anterior lateral expansions delimiting propodial mucous gland, rounded posteriorly. Siphon (Fig. 8, S) short, stout, with paired, symmetrical, tapering siphonal appendages (Fig. 8, SA) on either side of siphon near base. Head broad, with long, narrow, tapering tentacles (Fig. 8, T) on either side of thin, medially furrowed hood (Fig. 8, MF) extending over rhynchostome. Outer edges of tentacles with short, narrow, wing-like lobes (Fig. 8, W). Eyes absent. Mantle cavity broad, shallow, with large, dark osphradium ($L/W \approx 2.8$); ctenidium as wide and twice as long as osphradium; hypobranchial gland large, transversely pleated; rectum broad with conspicuous rectal gland along anterior half of dorsal surface. Proboscis short, broad, pleurombolic, with thick, muscular walls. Proboscis retractor muscles thick, paired, extending from lateral mid-points of

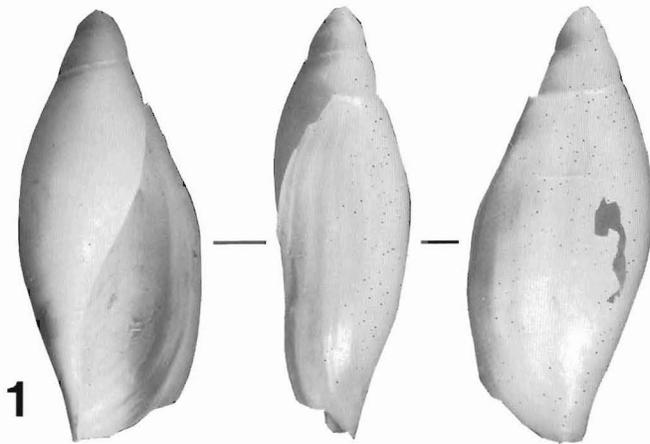


Figure 1. *Tenebrincola frigida*, new species. Holotype, ZMUM N Lc 16252, Aleutian Trench, SW of Agattu Island, Near Islands, 51°30'06"N, 172°04'30"E, in 5020 m. 0.8 X.

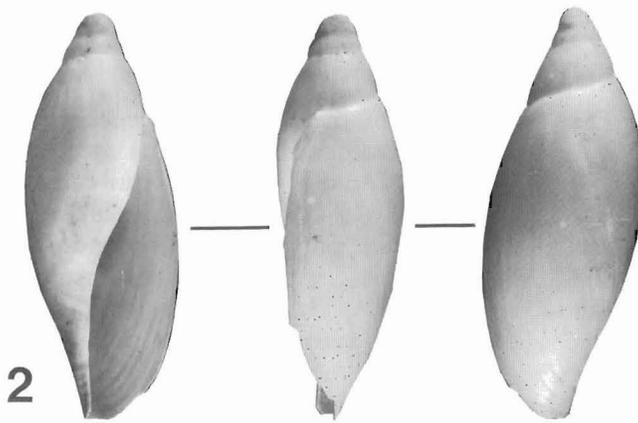


Figure 2. *Tenebricola cukri* (Rokop, 1972). Holotype, USNM 701261, WSW of Cortes Bank, approximately 225 miles W. of Ensenada, Baja California, Mexico, 32°05'N, 120°29'W to 32°03'N, 120°30'W, in 3775-3789 m. 0.8 X.

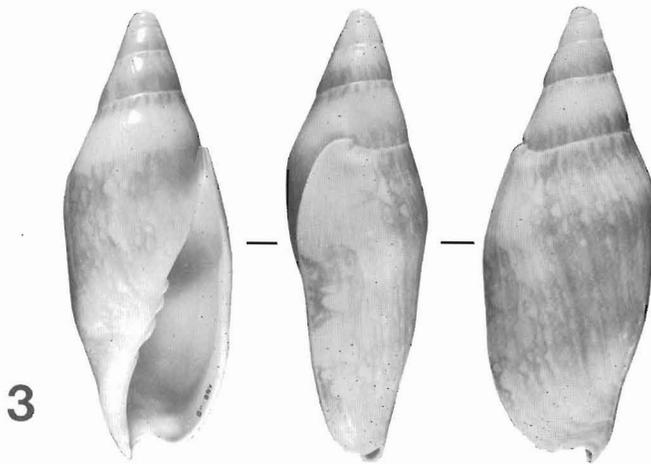
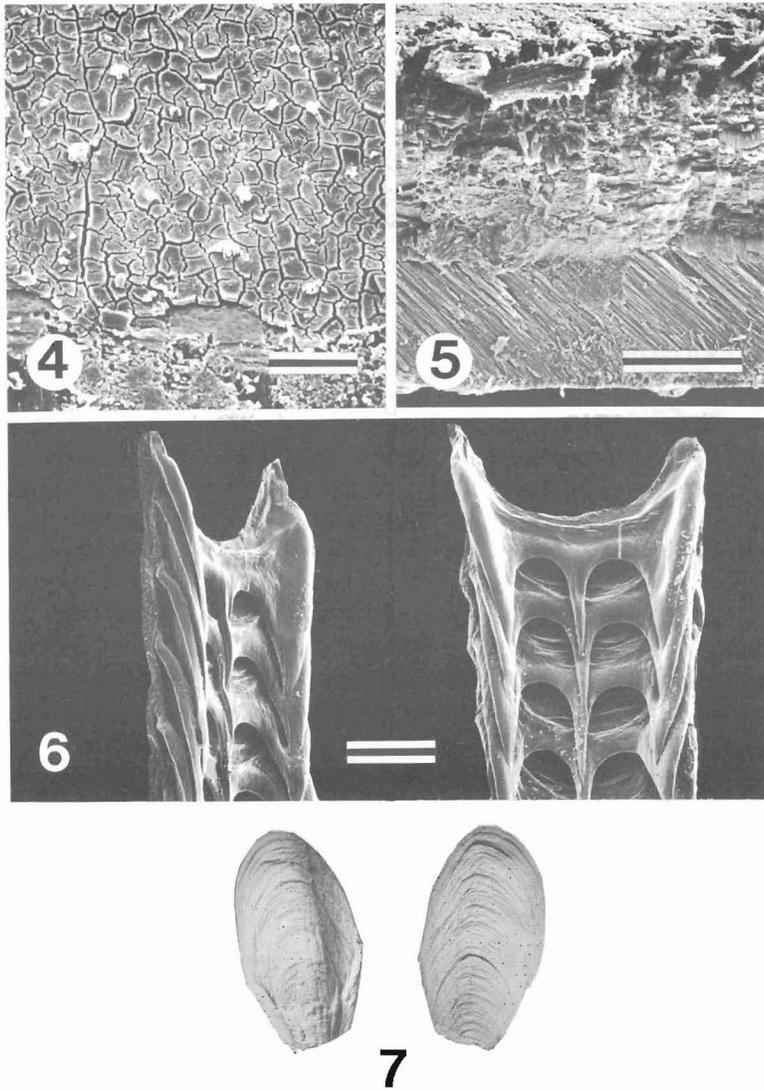
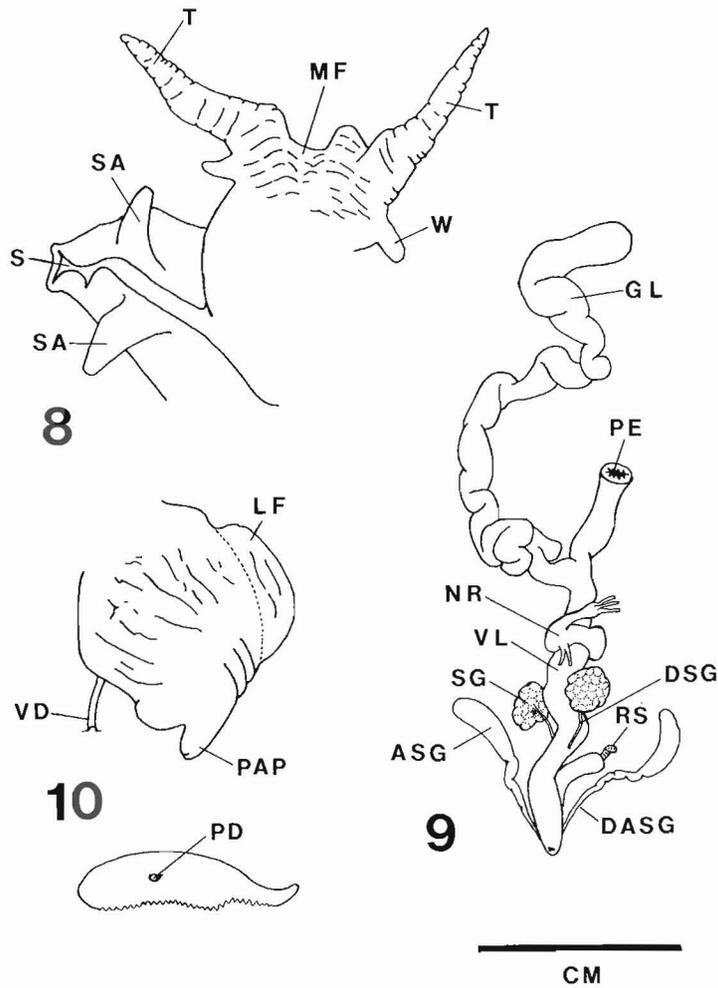


Figure 3. *Ericusa sericata* Thornley, 1951. USNM 845887, off Cape Moreton, Queensland, Australia, in 180 m. 0.55 X.



Figures 4-7. *Tenebrincola frigida*, new species. 4. Periostracum on shell fragment from dorsal surface of body whorl (see Fig. 1). Scale bar = 30 μm . 5. Shell ultrastructure (same fragment as in Fig. 4). Fracture surface parallel to growing edge, inner surface at bottom of photograph, periostracum at top. Scale bar = 30 μm . 6. Lateral (55°) and dorsal views of radula. Scale bar = 100 μm . 7. Inner and outer surfaces of operculum. 2.6 X.



Figures 8-10. *Tenebrincola frigida*, new species. Anatomical features. **8.** Dorsal view of head, with siphon reflected to left. **9.** Anterior portion of alimentary system. **10.** Penis, dorsal view and transverse section at mid-length. Scale bar = 1 cm for all drawings.

ASG, accessory salivary gland; DASG, duct of accessory salivary gland; DSG, duct of salivary gland; GL, gland of Leiblein; LF, lateral flap; MF, medial furrow; NR, nerve ring; PE, posterior esophagus; PAP, papilla; PD, penial duct; RS, radular sac; S, siphon; SA, siphonal appendage; SG, salivary gland; T, tentacle; VD, vas deferens; VL, valve of Leiblein; W, wing-like projection.

inner proboscis wall to walls of cephalic hemocoel. Buccal mass muscular. Anterior esophagus broad, thick-walled. Radula (Fig. 5) short (4.2 mm), uniserial, with 44 teeth; teeth tricuspid, with narrow, anteriorly recurved basal plates; lateral cusps broadly triangular, thickened along lateral edges, slightly shorter than narrow, flexible central cusp. Accessory salivary glands (Fig. 9, ASG) short, tubular, distally expanded, lying dorsal and anterior to salivary glands and entering buccal cavity by separate ducts (Fig. 9, DASG). Salivary glands (Fig. 9, SG) small, acinous, with ducts running laterally along esophagus before becoming embedded in the walls at rear of retracted proboscis. Valve of Leiblein (Fig. 9, VL) large, inflated. Gland of Leiblein (Fig. 9, GL) long, highly convoluted, tubular, as wide as posterior esophagus (Fig. 9, PE). [Stomach and intestine not preserved in dissected specimen.] Rectum large, inflated, distally tapered, with green rectal gland lining anterior half of dorsal surface. Anus with long, ventral papilla. Penis (Fig. 10) as broad as long, dorsoventrally flattened, with short, terminal papilla (Fig. 10, PAP) and thin lateral flap (Fig. 10, LF). Vas deferens (Fig. 10, VD) leading to base of penis and proximal 2/3 of penial duct closed (Fig. 10, PD). Distal 1/3 of penis with penial duct running along ventral surface forming groove extending to tip of papilla. Nerve ring (Fig. 9, NR) highly concentrated, of Type 2 (Ponder, 1970: 159).

Type Locality: Aleutian Trench, SW of Agattu Island, Near Islands, 51°30'06"N, 172°04'30"E, in 5020 m. R/V Vityaz sta. 3359, Sigsbee trawl, 8 June 1955.

Material examined: Holotype, Zoological Museum, University of Moscow (ZMUM) N Lc 16252, 68.4 mm.

Distribution: This species is known only from the type locality.

Ecology: Although this species lives below both the calcite and aragonite compensation depths (Morse & Berner, 1979), there is no evidence of pitting or dissolution on the shell surface. Regions of the protoconch are eroded, possibly by abrasion. Rectal contents included polychaete spicules, sand, and foraminiferans.

Etymology: *L. frigidus*-cold.

Comparative remarks: This species is distinguished from *Tenebrincola cukri* (Rokop, 1972), its only congener, by its proportionally broader shell, by the presence of a weak shoulder on the body whorl, and by the slightly concave region between the shoulder and suture. Because *T. cukri* is known only from a single specimen lacking soft parts, comparisons of radula or anatomical features cannot be made.

DISCUSSION

Although Stuardo and Villarroel (1974: 146) regarded the radular morphology of the volutid subfamilies Zidoninae and Fulgorariinae to be convergent, the three-dimensional topology of radular teeth, elucidated by scanning electron microscopy, clearly distinguishes these two subfamilies. Radular teeth of Zidoninae are generally flat or convex on their dorsal surface, with central cusps that are longer and as broad or broader than the lateral cusps (Harasewych, 1991). Those members of Fulgorariinae examined to date (Harasewych, 1991) are characterized by rachidian teeth that have strongly curved basal plates and lateral cusps that are thickest along the lateral edges and broader and generally longer than the central cusps, forming a trough along the mid-line of the radular ribbon. The radula of *Tenebrincola frigida* is of the fulgorariine type, but is unusual in having very thin and somewhat flexible central cusps that are slightly longer than the lateral cusps.

Comparatively few of the ten Recent subfamilies of Volutidae have been studied anatomically in any detail. The best known are the Zidoninae and Odontocymbiolinae (Clench & Turner, 1964; Ponder, 1970; Harasewych, 1987; Leal & Bouchet, 1989). The Volutinae, Scaphellinae, Calliotectinae, Lyriinae and Athletinae are less well known (Fischer, 1867; Woodward, 1900; Pace, 1902; Clench & Turner, 1964), while knowledge of the remaining subfamilies is largely limited to radular or gross external morphology (summarized in Weaver & duPont, 1970).

The presence of an operculum, short accessory salivary glands that are not wound around the salivary glands, and a closed vas deferens and penial duct prevent inclusion of *Tenebrincola* in the Zidoninae, but support its assignment to Fulgorariinae.

The shallow, medial furrow in the head of *Tenebrincola frigida* is regarded as a plesiomorphic volutid character that is shared with members of the subfamilies Calliotectinae, Athletinae and Scaphellinae. The long tentacles, absence of functional eyes, thin shell, and lack of columellar or siphonal folds are all convergently derived adaptations for abyssal life.

The protoconch and teleoconch morphology of both species of *Tenebrincola* most closely resembles that of *Ericusa sericata* Thornley, 1951 (Fig. 3), from 80 to 200 m off eastern Australia. Thus, the genus *Ericusa* H. & A. Adams, 1858, is tentatively considered to be the sister group.

Of the abyssal volutes known to date (List 1) all but *Arctomelon benthalis* are members of genera that are endemic to abyssal depths. *Tenebrincola* is the first record of the subfamily Fulgorariinae in the abyssal fauna. *Tenebrincola frigida* is the deepest dwelling volutid yet discovered, and the only volutid known to occur in a trench.

List 1. Members of the family Volutidae reported from abyssal (≥ 2000 m) depths. Subfamily assignment in square brackets []. Geographic and bathymetric distributions based on references in {}.

Arctomelon benthalis (Dall, 1896) [Zidoninae] 3058 m. Peru Basin. {Clarke, 1962: 27}.

Guivillea alabastrina (Watson, 1882) [Zidoninae] 2688-4063 m. Southern Ocean, from Drake Passage east to Croizet Basin, and north to Mozambique Channel. {Knudsen, 1973; Dell, 1990: 220-221}.

Tractolira sparta Dall, 1896 [Odontocymbiolinae] 2990-4082 m. Peru, Guatemala and Central Pacific Basins. {Rokop, 1972}.

Tractolira germonae Harasewych, 1987 [Odontocymbiolinae] 1976-3944 m. South Antilles and Atlantic-Indian-Antarctic Basins. {Dell, 1990: 217}.

Tractolira tenebrosa Leal & Bouchet, 1989 [Odontocymbiolinae] 2370-3270 m. Brazil Basin. {Leal & Bouchet, 1989: 6-7}.

Tractolira sp. [Odontocymbiolinae] 1772-3596 m. Ross Sea, Pacific Antarctic Basin. {Dell, 1990: 217}.

Tenebrincola cukri (Rokop, 1972) [Fulgorariinae] 3775-3789 m. Central Pacific Basin. {Rokop, 1972: 16-17}.

Tenebrincola frigida Harasewych & Kantor, 1991 [Fulgorariinae] 5020 m. Aleutian Trench. {herein}.

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