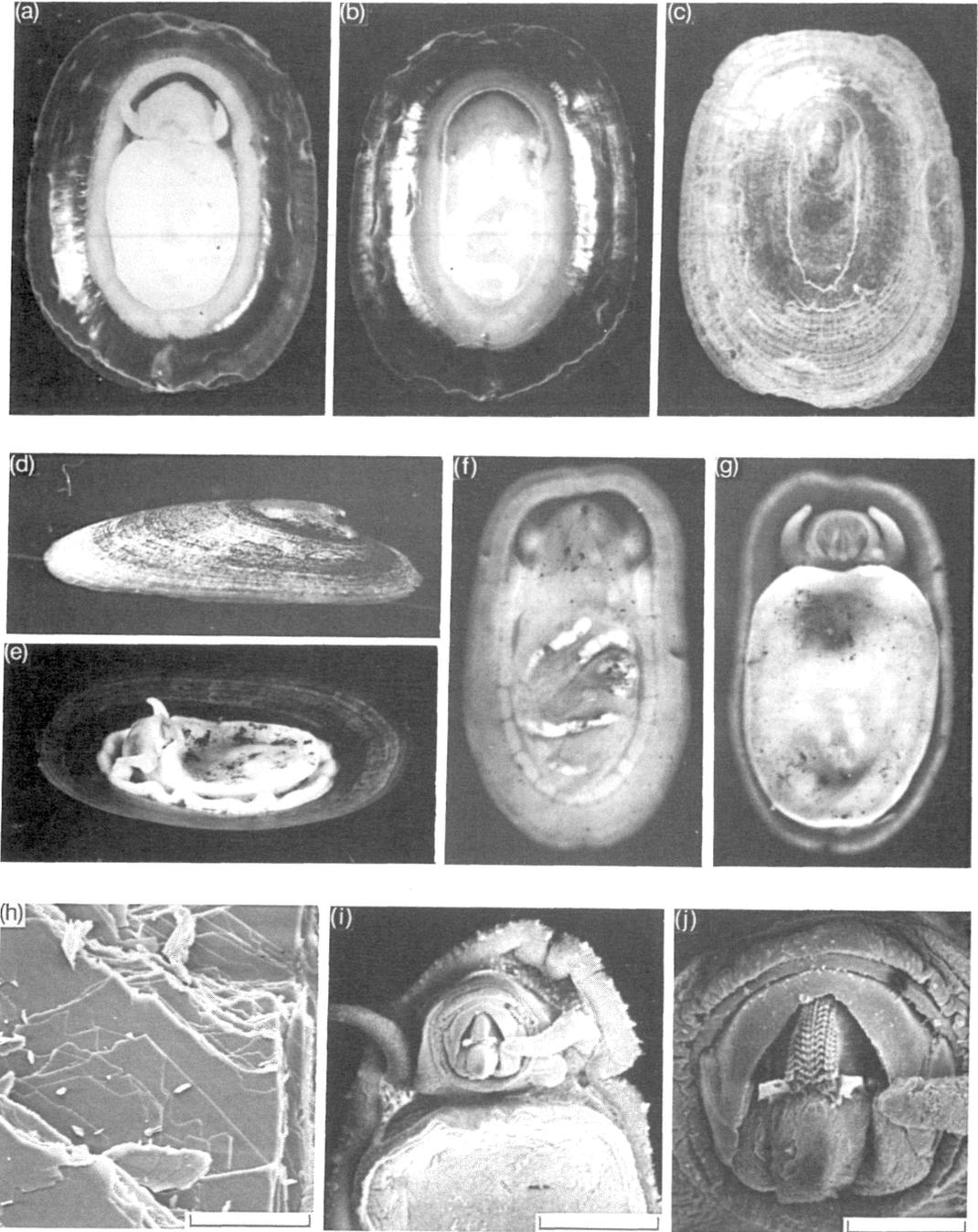


PLATE VII. *Eulepetopsis vitrea*, holotype, paratype, juvenile shell and protoconch. All from East Pacific Rise at 21° N. Anterior at top in vertical views. (a–d) Holotype, *Alvin* dive 1225. Length 16.9 mm. (a) Exterior, showing thick coating of mineral deposits. (b) Interior, showing muscle scar. (c) Left side. (d) Contracted body of holotype in shell, showing papillae at mantle margin. (e–g) Paratype with laterally compressed sides at later growth stage, showing flaking mineral deposits on shell. *Alvin* dive 1225. Length 14.5 mm. (e) Exterior. (f) Interior. (g) Left side. (h) Dorsal SEM view of protoconch and early teleoconch, showing lateral pouches first described by Morse (1910). From settling panel recovered at 21° N, courtesy C. Van Dover. Scale bar = 100 μ m. (i) Oblique SEM view of juvenile shell from right posterior, protoconch lost. *Alvin* dive 1225. Scale bar = 1 μ m.

TABLE II

Station data, number of specimens and disposition for dives yielding *Eulepetopsis vitrea*

Dive	Depth/m	Position	Date	Number specimens, habitat
<i>Alvin</i> dives, East Pacific Rise near 21° N				
1211	2615	20 50-0' N, 109 06-0' W	17 APR. 1982	3, large shells, <i>Riftia</i> & clam wash
1213	2617	20 50-0' N, 109 06-0' W	19 APR. 1982	3, small, <i>Alvinella</i> wash
1214	2633	20 50-0' N, 108 06-0' W	20 APR. 1982	13, <i>Riftia</i> wash
1215	2616	20 50-0' N, 109 06-0' W	21 APR. 1982	2, juvenile, slurp sample
1218	2618	20 50-0' N, 109 06-0' W	24 APR. 1982	4, juvenile, clam & crab trap wash
1219	2612	20 50-0' N, 109 06-0' W	25 APR. 1982	31, all sizes, <i>Riftia</i> & clam wash
1220	2617	20 50-0' N, 109 06-0' W	26 APR. 1982	7, all sizes, washings
1221	2618	20 50-0' N, 109 06-0' W	04 MAY 1982	21, all sizes; 15 juveniles, <i>Riftia</i> & <i>Calyptogenia</i> wash
1222	2614	20 50-0' N, 109 06-0' W	06 MAY 1982	4, juvenile, rubble from <i>Calyptogenia</i> residue
1223	2616	20 50-0' N, 109 06-0' W	07 MAY 1982	12, all sizes; 10 juveniles, rubble samples
1225	2618	20 50-0' N, 109 06-0' W	09 MAY 1982	43, all sizes, rubble sample (holotype)
1226	2616	20 50-0' N, 109 06-0' W	10 MAY 1982	11, juvenile, <i>Riftia</i> , <i>Calyptogenia</i> & <i>Alvinella</i> wash
<i>Cyana</i> dives, East Pacific Rise near 12° N (counts received from P. Bouchet)				
82-33	2633	12 48-6' N, 103 56-7' W	08 MAR. 1982	7
82-35	2633	12 38-6' N, 103 56-7' W	12 MAR. 1982	4
84-32	2635	12 48-1' N, 103 56-9' W	09 MAR. 1984	1
84-34	2630	12 49-1' N, 103 56-9' W	11 MAR. 1984	1
84-37	2630	12 46-6' N, 103 56-7' W	14 MAR. 1984	1
84-39	2635	12 48-6' N, 103 56-7' W	16 MAR. 1984	5
84-42	2635	12 48-6' N, 103 56-7' W	14 MAR. 1984	18
84-43	2635	12 48-6' N, 103 56-7' W	25 MAR. 1984	2
84-44	2635	12 48-8' N, 103 56-8' W	26 MAR. 1984	1
84-45	2635	12 48-8' N, 103 56-8' W	27 MAR. 1984	1
84-46	2635	12 48-6' N, 103 56-7' W	28 MAR. 1984	1
<i>Alvin</i> dive, East Pacific Rise near 11° N				
1993	2600	11 26-3' N, 103 47-3' W	15 MAR. 1988	2, shells broken
<i>Alvin</i> dives, Galapagos Rift				
733	2500	00 47-3' N, 86 07-8' W	16 MAR. 1977	1, large shell only
879	2495	00 48-2' N, 86 04-1' W	20 JAN. 1979	93, all sizes, mussel washings
880	2493	00 47-6' N, 86 06-4' W	21 JAN. 1979	371, all sizes, mussel washings
884	2482	00 48-1' N, 86 07-0' W	25 JAN. 1979	103, all sizes, rubble from mussels
887	2488	00 48-5' N, 86 09-1' W	12 FEB. 1979	11, juvenile and medium size, no habitat data
888	2483	00 47-1' N, 86 08-5' W	13 FEB. 1979	44, all sizes, mussel wash
890	2447	00 48-9' N, 86 13-3' W	15 FEB. 1979	34, all sizes, no habitat data
892	2454	00 48-3' N, 86 13-8' W	17 FEB. 1979	1, medium size, no habitat data
893	2578	00 46-8' N, 86 01-9' W	18 FEB. 1979	1, juvenile, rock shards residue
894	2457	00 48-2' N, 86 14-9' W	19 FEB. 1979	2, juvenile, amphipod trap
895	2482	00 47-9' N, 86 09-3' W	20 FEB. 1979	35, all sizes, clam box washings
896	2460	00 48-2' N, 86 13-6' W	21 FEB. 1979	7, juvenile, no habitat data
983	2457	00 48-0' N, 86 13-0' W	30 NOV. 1979	92, all sizes, washings
984	2451	00 48-0' N, 86 13-0' W	01 DEC. 1979	77, all sizes, mussel washings
989	2482	00 48-0' N, 86 09-0' W	06 DEC. 1979	66, all sizes; 80 juveniles, mussel & clam wash
990	2451	00 48-0' N, 86 13-0' W	07 DEC. 1979	14, all sizes, <i>Riftia</i> wash
991	2490	00 48-0' N, 86 09-0' W	08 DEC. 1979	236, all sizes, mussel & clam wash
993	2518	00 47-0' N, 86 08-0' W	10 DEC. 1979	1, juvenile, crab trap wash



Type material. Holotype, LACM 2417, *Alvin* dive 1225 at type locality, 9 May 1982.

Paratypes. 179 specimens from 12 *Alvin* dives at type locality (Table II): dive 1211, 3 specimens LACM 2411; dive 1213, 3 specimens LACM 2412; dive 1214, 7 specimens LACM 2413, 6 specimens USNM 860489; dive 1215, 2 specimens USNM 860490; dive 1218, 4 specimens USNM 860491; dive 1219, 16 specimens LACM 2414, 15 specimens USNM 860492; dive 1220, 7 specimens USNM 860493; dive 1221, 11 specimens LACM 2415, 10 specimens USNM 860494; dive 1222, 4 specimens USNM 860495; dive 1223, 12 specimens LACM 2416, 10 specimens USNM 860496; dive 1225, 22 specimens LACM 2418, 20 specimens USNM 860497; dive 1226, 11 specimens LACM 2419.

Referred material. 42 specimens from 11 *Cyana* dives, East Pacific Rise at 12° N (Table II); 2 specimens from *Alvin* dive 1993, East Pacific Rise at 11° N (Table II); 1269 specimens from 18 *Alvin* dives at Galapagos Rift (Table II).

Description. Shell (Plate VIIa–i, VIIIa–e) oblong, anterior end slightly narrower than posterior; profile low, highest point of shell slightly posterior to apex; shell margin in same plane. Apex on midline one-quarter shell length from anterior end. Protoconch (Plate VIIh) symmetrical, length 400 µm, lost at early stage, broken off and sealed from within. Periostracum very thin; shell often coated with rusty appearing sulphide deposits; shells in fluid nearly transparent; dried shells with opaque white exterior surface. Sculpture of fine radial striae and concentric growth irregularities. Shell interior with metallic sheen when viewed at angle; completely transparent when viewed directly, revealing detail of exterior surface. Muscle scar barely apparent, not impressed in shell interior, positioned much closer to mid-dorsal line than to shell edge (Plate VIIb, VIIIc).

Dimensions of holotype: length 16.9, width 13.7, height 3.3 mm.

External anatomy (Plate VIId, VIIIe–g, i, j). Cephalic tentacles long and tapered. Snout with oral lappets, some preserved specimens with dorsally arched jaw and licker projecting (Plate VIIIj). Mantle edge thickened, after preservation contracted to position of shell muscle; edge appears smooth, but bears fine papillae under high magnification (Plate VIIIi). Muscle in elongate bundles (Plate VIIIf).

Radula (Plate IXa–f). Cusps of lateral teeth descending away from cusp of rachidian tooth. Shaft of rachidian tooth broad at base, with lateral projections, constricted at neck, overhanging

PLATE VIII. *Eulepetopsis vitrea*, shell, external anatomy and shell structure. Specimens from Galapagos Rift and East Pacific Rise at 21° N. Anterior at top in vertical views. (a–b) Intact specimen. Galapagos Rift, *Alvin* dive 879. Length 5.4 mm. (a) Ventral view. (b) Dorsal view, showing complete transparency of shell, course of intestine visible. (c) Dry shell. Dorsal view, showing fine radial and concentric sculpture. Details of interior show through: pattern of muscle scar (inner edge marked by white line), outline of muscle bundles readily apparent adjacent to this; pallial line continued anteriorly. Galapagos Rift, *Alvin* dive 879. Shell missing prior to measuring. (d, e) Intact specimen. 21° N, *Alvin* dive 1220. Length 11.5 mm. (d) Right side of shell, surface with light coating of black mineral deposits. (e) Oblique view of body in shell; foot with adhering sulphide particles. (f, g) Detached body. 21° N, *Alvin* dive 1220. Length 5.3 mm. (f) Dorsal view, head visible through transparent mantle skirt, narrow horseshoe-shaped shell muscle in discrete bundles, and sulphide particles in two loops of intestine. (g) Ventral view, mouth expanded to show jaw. (h) SEM view of fractured surface within shell, showing zigzag crystal edges indicative of lathic calcite. Galapagos Rift, *Alvin* dive 880. Scale bar = 40 µm. (i, j) SEM views of small, critical-point dried specimen (shell length 5.8 mm). Galapagos Rift, *Alvin* dive 879. (i) Ventral view of anterior showing mantle edge with fine papillae, cephalic tentacles, head with oral lappets, protracted jaw and radula. Scale bar = 1 mm. (j) Enlarged view of mouth; radula framed by jaw, attached to licker anteriorly (white horizontal strip between radula and licker is an artefact of drying process). Scale bar = 400 µm.

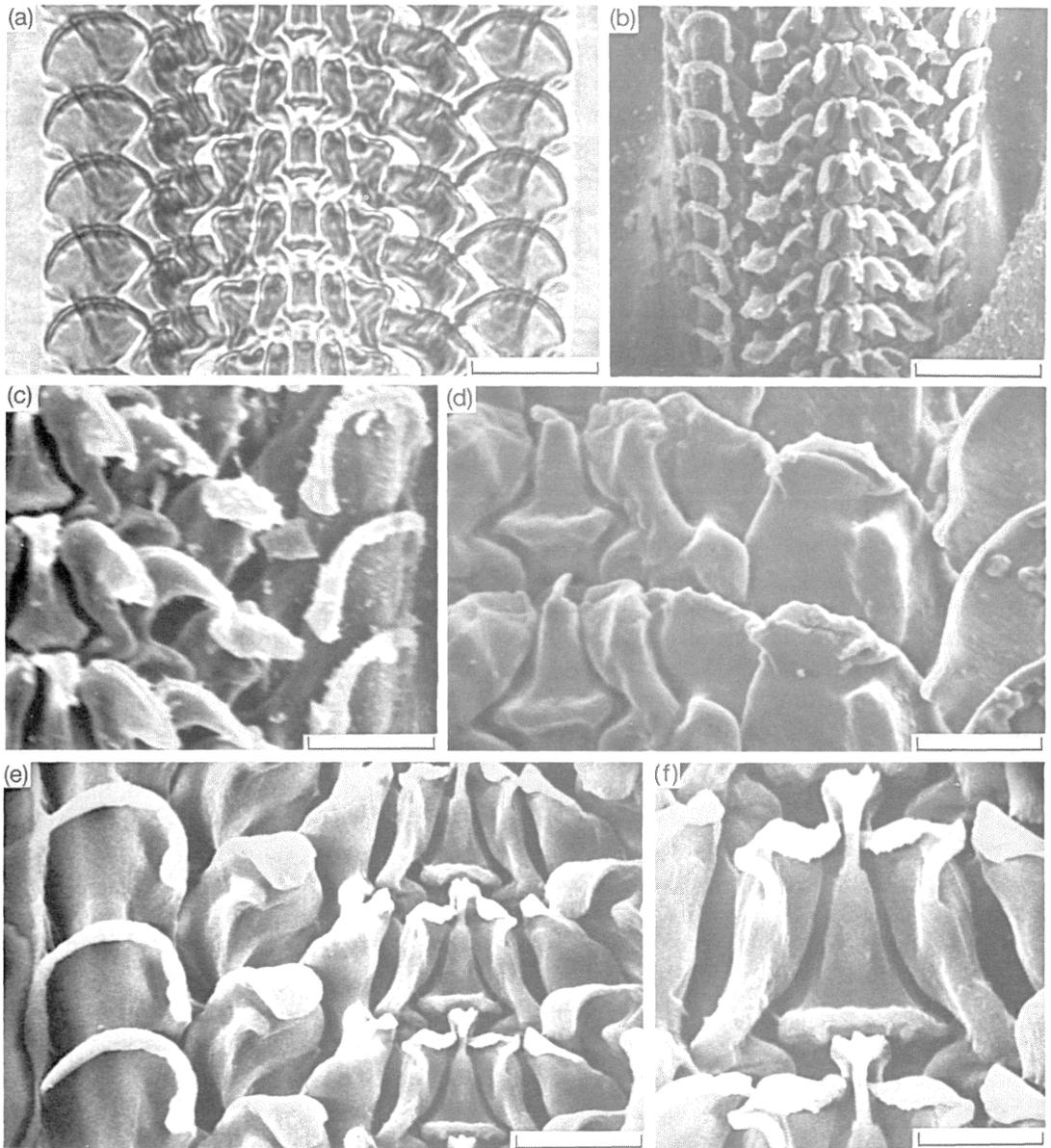


PLATE IX. *Eulepetopsis vitrea*, radula. Specimens from Galapagos Rift and East Pacific Rise at 21° N. (a) Stained whole mount of intact ribbon, showing the vestigial second marginal teeth at ribbon edge. Shafts of rachidian, laterals and pluricuspid have taken stain; delicate cusps of these teeth lack stain. East Pacific Rise at 21° N, *Alvin* dive 1225. Scale bar = 43 μ m. (b, c) Enlarged SEM views of radula of same specimen as in Plate VIII, j, top to bottom reversed from those illustrations to show tooth rows in usual perspective. (b) Full width of radula; jaw edge visible in lower corner. Scale bar = 100 μ m. (c) Enlarged view, showing rachidian, first and second lateral teeth, pluricuspid, and first marginal. Lateral teeth are seen from inner side due to longitudinal bending (see text). Scale bar = 20 μ m. (d) SEM view of half row of radular ribbon from mature specimen, in which cusps of all teeth have been degraded in preparation; narrow base of pluricuspid concealed. Galapagos Rift, *Alvin* dive 880. Scale bar = 10 μ m. (e, f) SEM views of radular ribbon of mature specimen (shell length 14.5 mm). Note constricted shaft near tip. East Pacific Rise at 21° N, *Alvin* dive 1225. (e) Half row of ribbon, showing rachidian, first and second inner laterals, pluricuspid with groove, and large first marginal tooth. Scale bar = 20 μ m. (f) Enlarged view of rachidian and inner laterals. Scale bar = 10 μ m.

cusps narrow, tapered. Shaft of first inner lateral tooth with indentation on inner side to accommodate basal projection of rachidian, overhanging cusp broad. Second inner lateral tooth much broader, its base accommodating projection of first inner lateral; mid-shaft nub prominent. Pluricuspid tooth with long, narrow base, outer edge with ridge and broad channel, overhanging cusp broad. First marginal tooth broad, overhanging edge narrow, its outer edge rising obliquely. Second marginal tooth vestigial.

Remarks. Here again an understanding of the radula of *Eulepetopsis vitrea* derives both from whole mount preparations and SEM preparations. Degradation of the cusps during preparation for SEM was so extensive that numerous attempts were necessary to achieve the results shown in Plate IXe, f. These views show a constricted neck on the rachidian and first laterals, corresponding to the unstained areas on the light microscope view (Plate IXa), in turn corresponding to the limits of the tooth degradation shown in Plate IXd. The SEM views have the advantage of showing the nub on the second lateral and the groove on the pluricuspid, while light microscope preparations reveal the remarkable fan-shaped structure of the first marginal and also show the vestigial second marginal, which had been completely undetectable in the SEM views.

The relatively large size of the fan-shaped first marginal teeth in this genus indicates a particularly important role in food gathering played by these teeth, compared to these teeth in the other two genera.

Teeth of a small specimen (shell length 5.8 mm) in which the radula was protracted on preservation are shown in Plate IXb, c. Here the ribbon is partially flexed longitudinally and the inner sides of the first and second inner lateral teeth are exposed. Cusps are longer on these teeth than those shown for a larger specimen (shell length 14.5 mm, Plate IXe, f).

No other limpet has such a transparent shell, allowing anatomical details to show through the shell (Plate VIIIb).

There are no apparent differences among populations occurring at the Galapagos Rift, 11° N, 13° N and 21° N.

As is evident in illustrations of Hessler & Smithey (1983), this species occurs widely on the basalt substratum and on mussels (*Bathymodiolus thermophilus* Kenk & Wilson, 1985). Shells that are iron-coated appear black in the photographs. Although a few specimens were recovered from washings of the vestimentiferan *Riftia pachyptila* Jones, 1981, it is evident from the collection data in Table II that the largest samples came from mussel washings. Specimen counts of the limpets from *Alvin* dive 1214 at 21° N, which were obtained by washing a *Riftia* sample, produced 14,574 specimens of *Lepetodrilus elevatus*, 1853 specimens of *L. pustulosus* (McLean, 1988a), but only 13 specimens of *E. vitrea*.

The only known specimen of *E. vitrea* having an intact protoconch was recovered from a settling panel placed at 21° N (Plate VIIh, courtesy C. Van Dover). The apical area of other small specimens is sealed from within (Plate VIIi).

Most samples have shell lengths ranging from 8–12 mm; specimens from dive 1225, from which the holotype was selected, include some exceptionally large specimens (maximum length 16.9 mm, holotype), including some that have developed compressed sides at later stages of growth (Plate VIIe–g).

Etymology: The specific name is a Latin adjective meaning glassy or transparent.

***Paralepetopsis* new genus**

Type species: Paralepetopsis floridensis new species

Diagnosis. Shell opaque, surface with faint radial sculpture, shell height about one-half the dimension of width; rachidian tooth with quadrate cusp; pluricuspid with tapered shaft and long overhanging edge.

Remarks. *Paralepetopsis* differs from *Eulepetopsis* in higher shell proportions. Its radula is unique in the family in having the rachidian and inner laterals with straight rather than tapered cusps. The rachidian, inner laterals and pluricuspid have relatively straighter shafts, not having the basal projections of *Eulepetopsis*. Of the three genera, the mid-shaft projection of the second inner lateral is least developed in *Paralepetopsis*. As in *Neolepetopsis*, but unlike *Eulepetopsis*, the second marginal is well developed in *Paralepetopsis*.

This genus is as yet known only from a single species from cool, hypersaline, sulphide seeps in the western Atlantic, at the base of the continental slope off the west coast of Florida.

***Paralepetopsis floridensis* new species**

(Plates Xa–h, XIa–f)

Limpet; Paull *et al.*, 1984: 956; Hecker, 1985: 466.

Florida Group-C symmetrical limpet; McLean, 1985: 160.

Type locality. On shells of mytilid bivalves, hypersaline sulphide seeps at base of continental slope, Florida Escarpment off south-western Florida (26° 03·0' N; 84° 54·0' W), 3270 m.

Type material. Holotype, LACM 2420, *Alvin* dive 1343 at type locality, 9 March 1984.

Paratypes. 47 specimens from 3 *Alvin* dives at type locality: dive 1343, 3 specimens LACM 2421; dive 1753, 11 specimens LACM 2422, 8 specimens USNM 860498; dive 1755, 8 specimens LACM 2423, 6 specimens USNM 860499.

Description. Shell (Plate Xa–c), elliptical in outline, anterior end slightly narrower; profile moderately high, highest point of shell at apex: shell margin in one plane. Apex on midline, two-fifths shell length from anterior end. Protoconch (Plate Xf–h) symmetrical, length 400 μ m, retained only on shells to length of 1·5 mm, detached and sealed from within on larger shells. Periostracum thin, light tan. All slopes straight to slightly convex. Sculpture of fine radial striae and concentric growth irregularities. Shell interior with transparent margin, 0·5 mm in width; area between margin and muscle scar with fine lamellae running parallel to edge, visible under high magnification and making surface opaque. Muscle scar well marked, horseshoe-shaped, narrow throughout, weakly impressed in shell interior and indicating muscle bundles. Muscle position slightly closer to mid-dorsal line than to shell edge.

Dimensions of holotype: length 9·4, width 6·8, height 3·3 mm.

External anatomy (Plate Xd, e). Cephalic tentacles long and tapered, snout with oral lappets, mouth with dorsally-arched jaw. Mantle edge with fine papillae. Muscle narrow, arranged in oval bundles (Plate Xd).

Radula (Plate XIa–f). Cusp position of lateral and marginal teeth descending away from that of rachidian tooth in nearly straight line in inverted-V. Shaft of rachidian three times longer than wide, overhanging cusp broad, quadrangular, with pointed tips at corners. Shaft of first inner