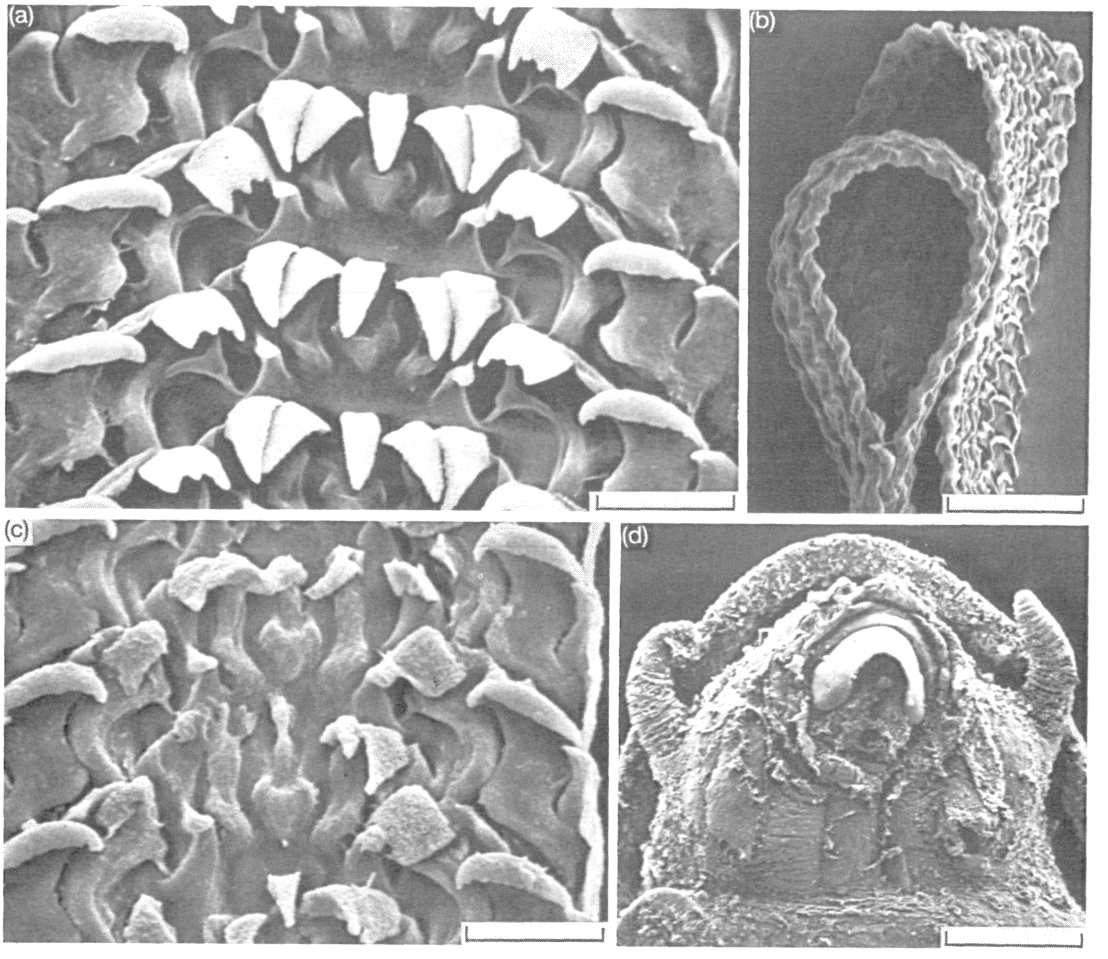

PLATE IV. *Neolepetopsis densata*, SEM views of radula and jaw. All from East Pacific Rise at 12° N, *Alvin* dive 2003. (a) Radular ribbon; rachidian, inner laterals, pluricuspid and marginals with intact cusps. Scale bar = 10 μm. (b) Folded piece of ribbon with degraded cusps. Scale bar = 40 μm. (c) Radular ribbon showing degradation resulting from preparation for SEM. Scale bar = 10 μm. (c) Critical-point dried specimen with exposed jaw. Scale bar = 200 μm.

with weakly developed posterior-lateral lappets. Mantle edge contracted to position of shell muscle, edge with fine papillae. Muscle horseshoe-shaped, narrow throughout, in oval bundles.

Remarks. Concentric sculpture in this species is denser than that of *N. verruca* (10 concentric ribs per mm between the 1 and 2 mm growth stage on the anterior slope compared to five in *N. verruca*). The nodes at the intersections of radial and concentric ribs are drawn out concentrically, rather than radially, as in *N. verruca*. Oral lappets are weakly developed in this species (Plate IVd), compared to other species in the genus.

None of the specimens showed any thickening of the shell close to the interior margin, as in

N. verruca or *N. occulta*, which suggests that shells of the latter two species are fully mature. The present specimens of *N. densata* are probably not yet mature and the species may reach larger sizes.

The absence at the type locality of other mega-faunal species is noteworthy and suggests that this species has exacting requirements for a sulphide substratum free of other vent fauna. As noted above, this is probably characteristic for at least the three southernmost occurring members of the genus.

Etymology: The specific name is derived from Latin, *densus*, thick, with reference to the closely-spaced concentric sculpture.

Neolepetopsis verruca new species
(Plate Va–g)

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

Type locality. [Inactive sulphide chimney?], East Pacific Rise at 21° N (20° 51·0′ N, 109° 04·9′ W), 2593 m.

Type material. Two specimens from *Alvin* dive 915 at type locality, 22 April 1979.

Holotype, LACM 2407. The body of the holotype (Plate Ve, f) remains preserved, although the radula has been extracted. Paratype, LACM 2408 (Plate Vg), body lost during handling.

Description. Shell (Plate Va–d, g) relatively thick, oblong, slightly narrower anteriorly; profile low, highest point of shell at apex; shell margin not in same plane, sides raised relative to ends. Apex on midline, 2/5 shell length from anterior. Protoconch unknown (apical area eroded on present material); shell thickened on interior side. Periostracum thin, greenish brown. Sculpture reticulate, concentric ribs strong, separated by broader interspaces; radial ribs broad, low, with narrower interspaces, producing rounded nodes on overriding concentric ribs. Muscle scar not apparent on inner surface; thin edge of shell appears white; this represents the opaque outer surface of shell. The dark band along the margin (Plate Va, b, d) is a completely transparent zone; central to this zone there is a broad opaque zone showing coalescing lamellae under high magnification; fine, irregular radial ridges are also visible along the outer edge of the opaque zone; interior to this zone there is a completely transparent zone through which the opaque outer surface is visible. Apical area thickened on inner side, opaque white. Muscle scar within transparent zone, barely detectable, horseshoe-shaped, narrow, same width throughout, arranged in oval bundles.

Dimensions of holotype: length 6·0, width 4·6, height 1·5 mm. Dimensions of paratype: length 5·5 (anterior end damaged), width 4·6, height 1·3 mm.

Radula. Ribbon small, width 20 μm, tooth rows spaced at 12 μm apart (the ribbon of the holotype was mounted upside down for SEM; attempts to remount it failed).

External anatomy (Plate Vd, e, f). Cephalic tentacles tapered, jaw not projecting in single preserved specimen; oral disk with well-developed lappets. Mantle edge contracted to position of shell muscle; edge with microscopic papillae. Muscle horseshoe-shaped, narrow throughout, in oval bundles.

Remarks. As noted above under the discussion for *N. densata*, there are fewer concentric ribs in this species than in *N. densata* and the nodes are drawn out radially rather than concentrically. Shells of the two specimens have a thickened area inside the transparent margin (the opaque white

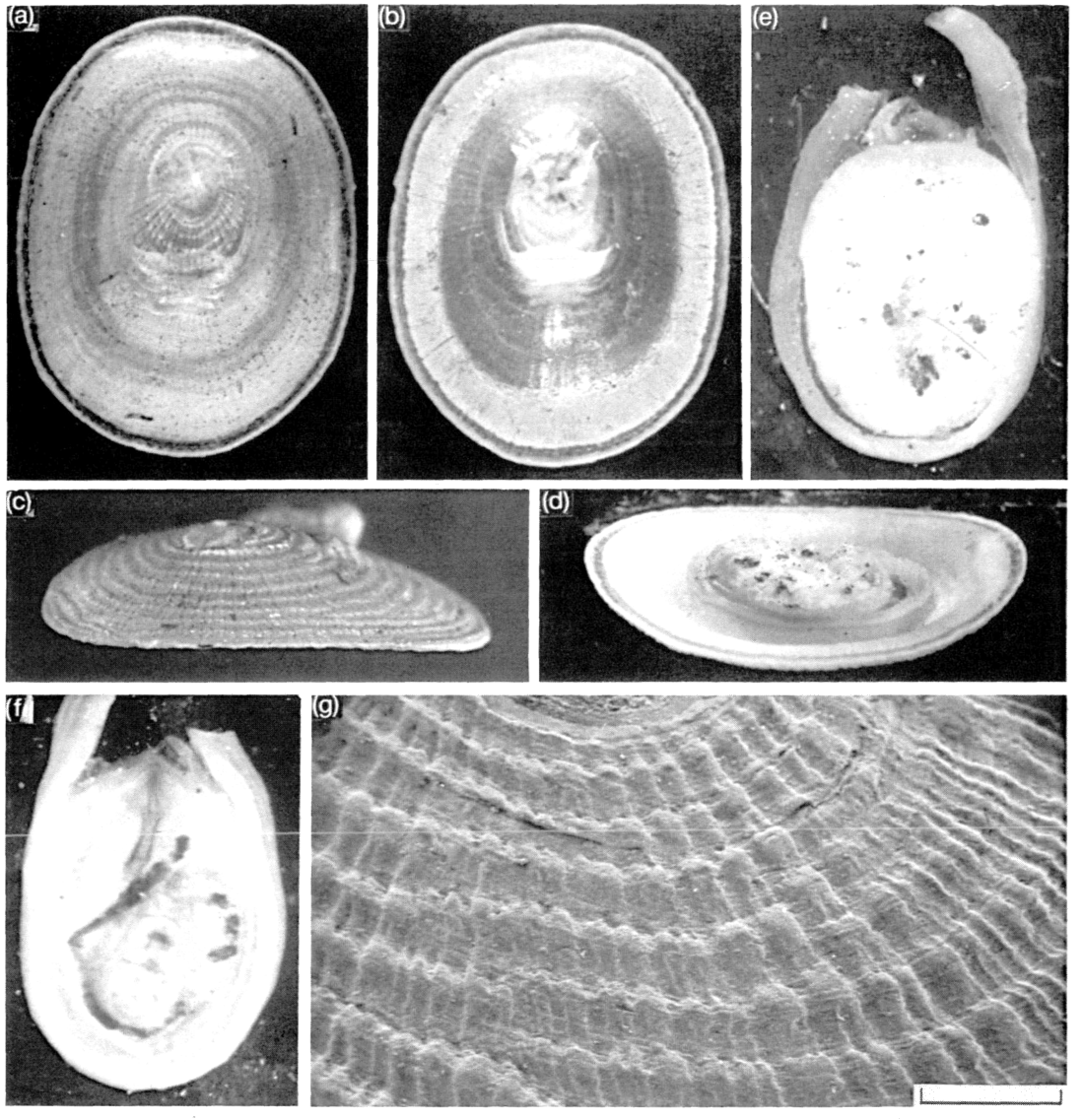

PLATE V. *Neolepetopsis verruca*, shell and external anatomy. All from East Pacific Rise at 21° N, *Alvin* dive 915. Anterior at top in vertical views. (a–d) Holotype shell. Length 6·0 mm. (a) Exterior, showing eroded apex. (b) Interior, showing thin layer of lamellar shell layer inside transparent margin and central area. (c) Left side. (d) Oblique ventral view from left side, contracted body still attached to shell. (e, f) Holotype body, mantle skirt cut on right side. Length 3·5 mm. (e) Ventral view, showing sulphide particles attached to foot. (f) Dorsal view, showing sulphide particles within intestine. (g) SEM view of paratype shell, showing detail of sculpture. Scale bar = 400 μm.

area in Plate Vb), which suggests that these specimens had ceased to increase in length and had restricted growth to thickening the shell on the interior.

This species was collected from 21° N during the reconnaisance expedition of April 1979; no specimens were taken on the return expedition of April–May 1982. The position for dive 915 is one minute of latitude (one nautical mile) north of the rich hydrothermal-vent community that yielded specimens of *Eulepetopsis vitrea*, as well as other species from 21° N. No other species of limpets of any family were taken on *Alvin* dive 915, and the particular association of this species is unknown. Although no details of the microhabitat were provided with the original two specimens, iron sulphide particles were adhering to the foot. These particles were also present on the exposed surfaces of the peltospirid limpets *Nodopelta heminoda* and *Echinopleta fistulosa*, which were also first collected in 1979 (McLean, 1989*a*). The latter two species are definitely associated with the burrows and tubes of the pompei worm *Alvinella pompejana* Desbruyères & Laubier, 1980, which supports a community of living organisms at the base of the black smoker chimneys. It is therefore likely that *N. verruca* is also a member of this community, or that it came from an inactive sulphide chimney, as did *N. densata*.

The specific name is a Latin noun in apposition, meaning wart, with reference to the noded sculpture.

Neolepetopsis occulta new species
(Plate VIa–g)

Limpet; Levin & Lonsdale, 1983: 1017.

Type locality. On sulphide deposits on caldera floor, Green Seamount, near 21° N (20° 49·0′ N, 109° 17·0′ W), 1990 m. For further information about the expeditions to eastern Pacific seamounts see Levin & Lonsdale (1983) and Levin & Nittrouer (1987).

Type material. 38 specimens from type locality, *Alvin* dive 1185, 5 February 1982. Holotype, LACM 2409; 18 paratypes LACM 2410, 9 paratypes, USNM 860488.

Description. Shell (Plate VIa–d, f) relatively thick, oblong, broader anteriorly; profile low, highest point of shell at apex; shell margin not in same place, sides raised relative to ends. Apex on midline, 1/3 shell length from anterior. Protoconch unknown (apical area eroded on present material); shell thickened on interior side. Periostracum thin, greenish brown. Sculpture reticulate, concentric ribs strong, separated by broader interspaces; radial ribs less prominent than concentric ribs, narrow, low, with nearly equal interspaces, producing rounded nodes on intersecting concentric ribs. Shell interior transparent, showing the pattern of exterior sculpture. Innermost, apical area thickened on inner side and opaque white. Muscle scar not apparent on shell interior.

Dimensions of holotype: length 3·4, width 2·6, height 0·9 mm.

Radula. No trace of a radula was found after five attempts at clearing the soft parts in NaOH at room temperature. Sectioned specimens showed that a very small radula is present, however (V. Fretter, pers. comm.).

External anatomy (Plate VIc–e). Cephalic tentacles tapered, mouth with dorsally arched jaw; oral lappets well developed, triangular, with ventral nubs; mantle margin not showing any papillae.

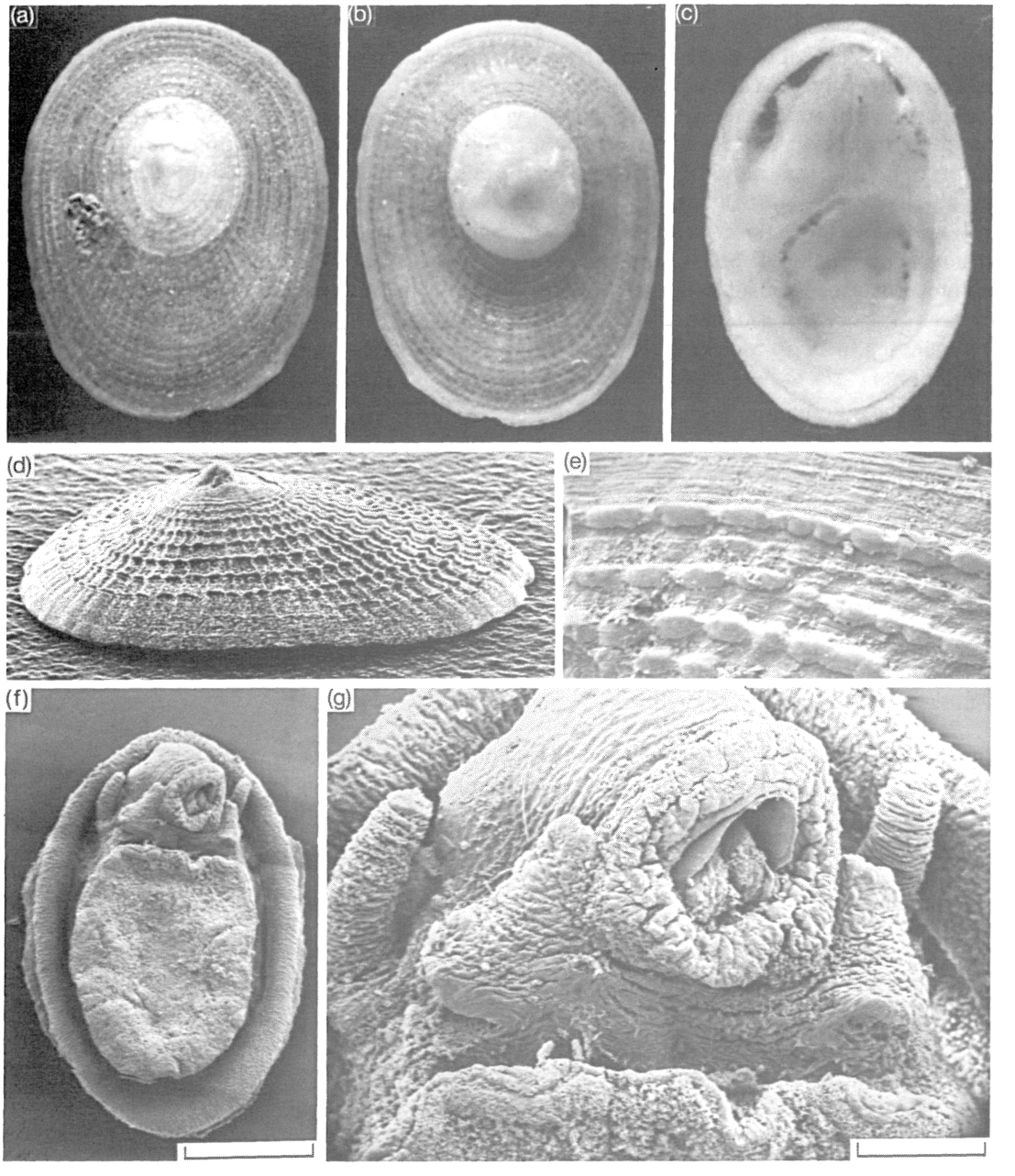

PLATE VI. *Neolepetopsis occulta*, shell and external anatomy. All from Seamount B, near 21° N, *Alvin* dive 1185. Anterior at top in vertical views. (a–c) Holotype. Shell length 3·4 mm. (a) Exterior, showing eroded apical area. (b) Interior, showing exterior sculpture by transparency, apical area thickened by secondary deposition. (c) Dorsal view of body, showing transparent mantle skirt over head and dark sulphide particles within intestine. Length 2·1 mm. (d) SEM view of immature shell from left side subsequent to loss of protoconch and early teleoconch sculpture. Length 2·6 mm. (e) SEM view of shell fragment, showing detail of sculpture. Scale bar = 200 μm. (f, g) SEM views of critical-point dried specimen. (f) Ventral view of entire animal. Scale bar = 400 μm. (g) Ventral view of head, showing jaw and oral lappets lateral to mouth, foot with opening of anterior pedal gland. Scale bar = 100 μm.

Remarks. Although there is a possibility that this could prove to be conspecific with *N. verruca*, there is a major habitat difference and a size difference. Specimens of *N. occulta* are smaller than those of *N. verruca* (maximum length 3·4 mm, compared to 6·0 mm). These specimens of *N. occulta* are considered mature, as the shell interior is thickened near the margin, comparable to that noted in *N. verruca* and large specimens of *E. vitrea*. Concentric sculpture is more crowded than that of *N. verruca*, being more comparable to that of *N. densata*, but not as crisply formed.

According to Levin (pers. comm.): 'only one active hydrothermal site (with water up to 13 C flowing downhill) was found during the survey. Most marked was the absence of large animal life characteristic of the 21 N and Galapagos vents . . . The limpets were preferentially distributed on a metallic grey material (possibly marquisite) on the sulfide rocks.' The habitat information is consistent with that provided for *N. densata* in the lack of other animal life.

Etymology: The specific name is a Latin adjective meaning concealed, suggested by the remote locality and exacting habitat requirements for this species.

Eulepetopsis **new genus**

Type species: ***Eulepetopsis vitrea*** **new species**

Diagnosis. Shell transparent, surface nearly smooth; profile relatively low; height about one-quarter the width. Rachidian with expanded base; pluricuspid with ridge to accommodate cusp of first marginal; second marginal vestigial.

Remarks. Eulepetopsis differs from *Neolepetopsis* in lacking beaded sculpture; the proportional height of *Eulepetopsis* is about half that of *Paralepetopsis*. The radula of *Eulepetopsis* differs from that of *Neolepetopsis* in having a much larger first marginal, and a vestigial second marginal. The second inner lateral is relatively large and the pluricuspid is unique in having a deep channel on its outer lateral surface.

Shell structure of *Eulepetopsis* is unique in the family, as indicated by the fact that shells do not break cleanly, instead breaking in steps, much like sheets of mica. The outer layer of the shell is composed of lathic calcite, which is the most transparent structure possible for a calcium carbonate shell (see **Discussion**).

A single species of *Eulepetopsis* is known, the broadly distributed *E. vitrea* from 21° N, 13° N, and 11° N on the East Pacific Rise and the Galapagos Rift.

Eulepetopsis vitrea **new species**

(Plates VIIa–i, VIIIa–j, IXa–f)

Group-C hydrothermal-vent limpet; Hickman, 1983; 87, figs 34, 35 [radula].

Translucent limpet; Hessler & Smithey, 1983: 742, figs 2, 6 [limpets visible in habitat photos].

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

Type locality. Hydrothermal-vent community near 21° N on East Pacific Rise (20° 50·0′ N, 109° 06·0′ W), 2612–2633 m.