

Figs. 17–23. *Nodopelta heminoda* sp. n., all from 21°N.—17–19. Holotype shell, exterior and interior (anterior at top) and lateral (right side views). Length 17.5 mm.—20, 21. Ventral and lateral (left side) views of paratype body in shell.—22. SEM view of radular ribbon, scale bar 100 μ m.—23. SEM view showing rachidian, 4 laterals and tips of marginals, scale bar 40 μ m.

oval, anterior slightly broader than posterior. Margin of aperture not in same plane, sides markedly raised relative to ends. All slopes except posterior convex, becoming flat toward margin in large specimens. Apex posterior, slightly right of midline, projecting, 7/8 shell length from anterior end. Protoconch scar dark brown, right side remaining visible; surface sculpture of protoconch unknown (juvenile shells not available). Early teleoconch growth lacking on posterior (columellar) slope until shell length of 2 mm; subsequent growth along posterior margin raises apex above margin. Periostracum strong, tightly

adhering, light brown, inturned at shell edge. Background sculpture of fine radial and concentric ribs beaded at intersections, arising in early teleoconch. Noded sculpture arising at shell length of 4 mm; nodes prominent, large, projecting, crescent-shaped; nodes aligned in curved rows, lacking on posterior slope; development of nodes subdued at final growth stages. Shell interior with strong angular ridge posteriorly, interior surface glossy. Muscle scar relatively broad, extending anteriorly 2/3 shell length, tips expanded inwardly, inserting posteriorly on inner edge of angular ridge; left arm of scar extending slightly

more anteriorly than right. Dimensions of holotype: length 17.5, width 11.9, height 6.6 mm.

External anatomy (Figs. 20, 21). Foot oval, rounded posteriorly, with opening of pedal gland at anterior end. Snout tapered, cephalic tentacles thick at base (contracted in present material), equal in size. Mantle margin with thin fold extending between shell and inturned periostracum, exposed surface of mantle margin with numerous transverse ridges, aligned perpendicular to edge. Epipodium a single row of faint tubercles. Mantle cavity extending more than half length of shell muscle; ctenidium bipectinate, lamellae elongate and broad, tips spatulate, free tip extending over head, afferent and efferent membranes pronounced, lamellae on left side of axis (uppermost) half as long as those on right side.

Radula (Figs. 22, 23) typical for family, cusps of rachidian and inner laterals relatively short, denticulation on outer side of fourth lateral fine, unlike that of marginals, nubs of laterals prominent, shafts of outer marginals fused.

Remarks. The original association of these limpets with the substratum was described as follows: "recovered from sulfide samples knocked loose from a 'black smoker'—edifices up to 6 m high with 350°C water exiting from the top. The samples were riddled with tubes and burrows, constructed by a polychaete called the Pompei worm by geologists. The limpets were found inside the surface furrows. The samples were collected from older parts of the black smoker—presumably well away from the superheated water." (William Smithey, *in litt.* 21 January 1980). All specimens have associated iron sulfide particles, the black particles visible in Figs. 20 and 21.

This is the largest member of the Peltospiridae, reaching a length of 19.0 mm, considerably larger than the maximum for *Rhynchopelta concentrica*, which reaches a maximum length of 12.6 mm. The exceptionally large size of this species may be correlated with the protection afforded by the burrows of the Pompei worm *Alvinella*.

Specimens from 13°N are of similar size as those from 21°N; no apparent differences were noted. Juvenile specimens have not been recognized; the smallest specimen examined (length 6.7 mm) came from 13°N.

The name is a Latin rendition of the vernacular name 'half-node', denoting the truncate, crescent-shaped nodes.

Nodopelta subnoda sp.n. (Figs. 24–31)

"Elongate tapersnout limpet", McLean 1985, p. 160.

Type locality. East Pacific Rise at 13°N (12°48.6'N, 103°56.7'W), 2630–2635 m.

Holotype. MNHN, *Cyana* dive 84-83 at type locality, 15 March 1984.

Paratypes. From 7 *Cyana* dives at type locality, dive 82-35, 2 specimens, MNHN; dive 82-36, 2 specimens, MNHN; dive 84-34, 2 specimens, MNHN; dive 84-38, 83 specimens, LACM 2317, USNM 859944; dive 84-41, 15 specimens, MNHN; dive 84-44, 1 specimen, MNHN; dive 84-46, 11 specimens, MNHN.

Description. Shell (Figs. 24–26) of limpet form, produced through one half whorl of growth, medium sized for

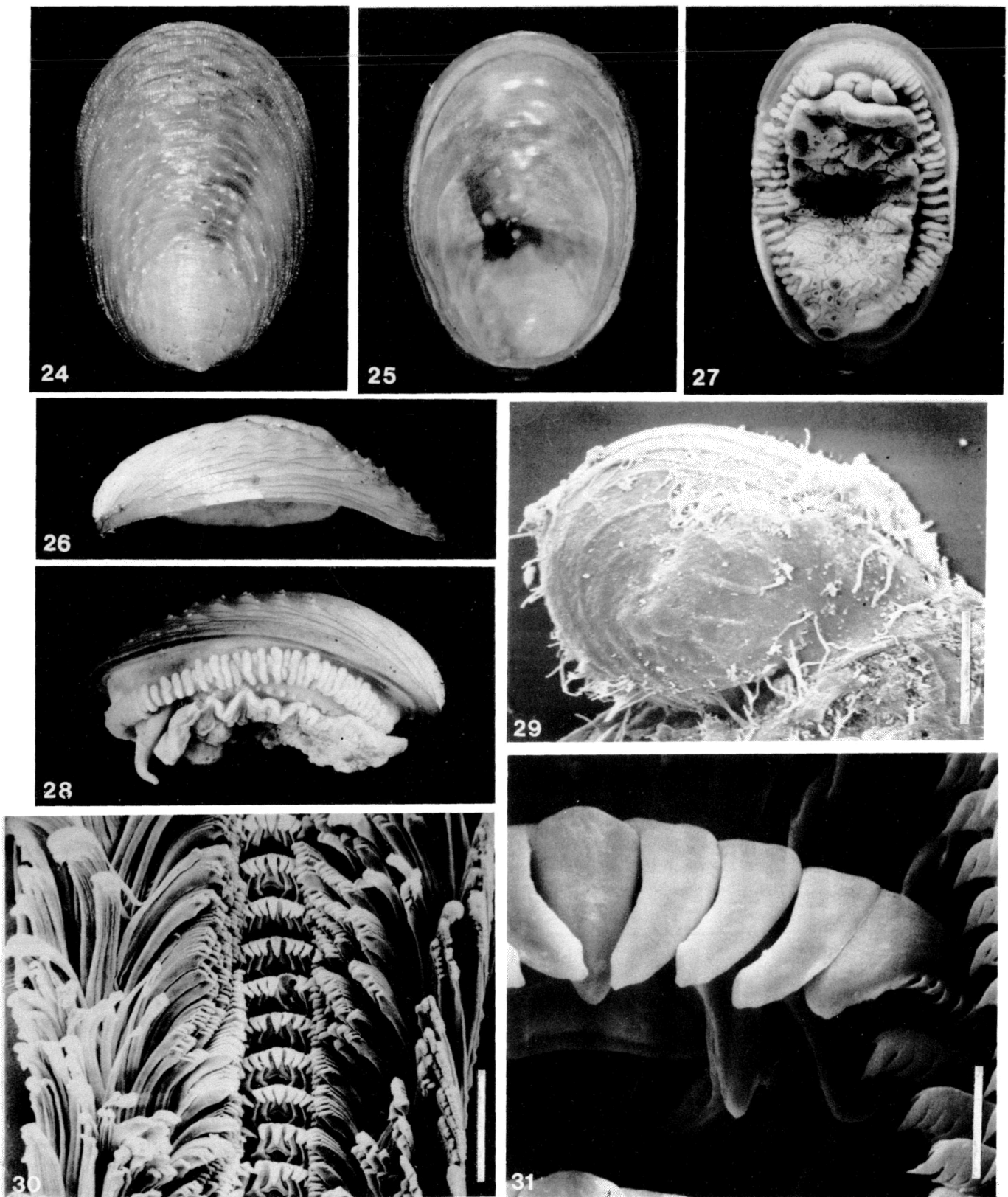
family (maximum length 9.6 mm); outline oblong oval, anterior markedly broader than posterior. Margin of aperture not in same plane, sides markedly raised relative to ends. All slopes except posterior convex. Apex posterior, slightly right of midline, slightly above level of margin and projecting slightly beyond posterior margin. Protoconch dark brown, weakly or not calcified, diameter 160 μm, right side remaining visible, surface sculpture of longitudinal ridges (Fig. 29). Early teleoconch growth lacking on posterior (columellar) slope at all growth stages. Periostracum strong, tightly adhering, light brown, inturned at shell edge, greatly thickened at posterior margin where it not only envelops shell edge but extends nearly to level of protoconch. Background sculpture of fine radial and concentric ribs, beaded at intersections, arising in early teleoconch. Noded sculpture arising at shell length of 4 mm; nodes represented by narrow, alternating, longitudinal swellings along line of growth; nodes aligned in curved rows. Shell interior with strong angular ridge posteriorly, interior surface glossy. Muscle scar relatively broad, close to edge of shell, extending anteriorly 2/3 shell length, tips expanded inwardly and tapered anteriorly, inserting posteriorly on inner edge of angular ridge; left arm of scar extending slightly more anteriorly than right. Dimensions of holotype: length 9.5, diameter 6.7, height 3.2 mm.

External anatomy (Figs. 27, 28). Foot oval, rounded posteriorly; anterior pedal gland not conspicuous. Snout tapered, cephalic tentacles thick at base (contracted in present material), equal in size. Mantle margin with thin fold extending between shell and inturned periostracum, exposed surface of mantle edge with numerous transverse ridges, aligned perpendicular to mantle edge. Epipodium a single row of projecting tubercles. Mantle cavity extending to half depth of muscle; ctenidium bipectinate, lamellae elongate and broad, tips spatulate, free tip extending over head, afferent and efferent membranes pronounced, lamellae on left side of axis (uppermost) half as long as those on right side.

Radula (Figs. 30, 31) typical for family, cusps of rachidian and laterals long, curved inwardly; nubs of laterals prominent; denticulation on outer edge of fourth lateral like that of marginals; outer marginals not prominently fused.

Remarks. *Nodopelta subnoda* is about half the size of *N. heminoda*, but differs chiefly in having almost no posterior slope, which places the apex at the level of the margin and slightly overhanging it. Also, the nodes of *N. subnoda* are narrower and lack the swelling that precedes the nodes of *N. heminoda*. The radula of *N. heminoda* is like that of most limpet members of the family, differing from that of *N. heminoda* in having longer cusps on the rachidian and laterals and having the dentition on the outer edge of the fourth lateral matching that of the marginals.

Specimens of *N. subnoda* have adhering iron sulfide particles and it is likely that the species is also associated with the Pompei worm *Alvinella* in its habitat at 13°N. Juvenile shells have not been examined, which is also the case for *N. heminoda*. The smallest shell in the present material is 7.5 mm in length.



Figs. 24–31. *Nodopelta subnoda* sp.n., from 13°N.—24–26. Holotype shell, exterior and interior (anterior at top) and lateral (right side) views. Length 9.5 mm.—27, 28. Ventral and lateral (right side) views of paratype body in shell.—29. Protoconch from right side, scale bar 40 μ m.—30. SEM view of radular ribbon, scale bar 100 μ m.—31. SEM view showing rachidian, 4 laterals and tips of marginals, scale bar 10 μ m.

Rhynchopelta gen.n.

Type species. Rhynchopelta concentrica sp.n.

Diagnosis. Shell of limpet form, apex projecting, close to posterior margin, interior with strong posterior ridge. Periostracum thick, enveloping shell edge. Sculpture of

radial striae and fine concentric ridges that bifurcate. Periostracum with longitudinal ridges.

External anatomy. Mantle edge with thin fold extending under periostracum, exposed surface of mantle edge puckered; epipodium a single row of low tubercles.

Radula typical for family, cusps of rachidian and laterals long, nubs of laterals prominent, denticulation on

outer edge of fourth lateral like that of marginals, outer laterals fused.

Remarks. A monotypic genus for the species *Rhynchopelta concentrica* is proposed on the combination of unique sculpture and the condition of the mantle margin and epipodium. The mantle margin does not have the pronounced transverse ridges of *Nodopelta*, and the epipodium is the least developed in the five limpet genera. The name means snout-shield—to make reference to ‘tapersnout’, the vernacular name previously used for this family (McLean 1985).

Warén & Bouchet (1989) noted that two species of the coiled genus *Lirapex* share longitudinal ridges on the protoconch similar to that of *Rhynchopelta concentrica* and on that basis considered the two genera to be more closely related than to other peltospirids.

Rhynchopelta concentrica sp.n. (Figs. 32–40)

“Concentric tapersnout limpet”; McLean 1985, p. 160.

“Unnamed limpet”; Turner *et al.* 1985, p. 172, figs. 5a–c.

“Concentric Group-A species”; Berg 1985, p. 192.

Type locality. East Pacific Rise at 21°N (20°50.0'N, 105°06.0'W), 2615–2622 m.

Holotype. LACM 2318, *Alvin* dive 1214 at type locality, 20 April 1982.

Paratypes. From 4 *Alvin* dives at type locality: dive 1214, 288 specimens plus 33 juvenile specimens, LACM 2319, USNM 859945, MNHN; dive 1219, 7 specimens plus 3 juvenile specimens, USNM 859946; dive 1221, 8 specimens, USNM 859947; dive 1223, 2 specimens, USNM 859948. From 3 *Cyana* dives at East Pacific Rise at 13°N (12°48.6'N, 103°56.7'W), 2630–2635 m: dive 84-39, 11 specimens, MNHN; dive 84-41, 4 specimens, MNHN; dive 84-42, 159 specimens, LACM 2320, USNM 859949, MNHN.

Description. Shell (Figs. 32–36) of limpet form, produced through one half whorl of growth, relatively large for family (maximum length 12.6 mm); outline of aperture evenly elliptical; anterior slope convex, posterior slope concave, lateral slopes convex but concave near margin; highest point of shell 2/3 distance from anterior margin. Margin of aperture nearly in same plane, sides slightly raised relative to ends. Apex posterior, on mid-dorsal line, 9/10 shell length from anterior margin. Protoconch (Figs. 37, 38) brown, diameter 225 μ m, with strong ridges perpendicular to lip, right side of protoconch remaining visible. Early teleoconch growth lacking on posterior slope until shell length of 2 mm; subsequent growth along posterior margin raises apex above margin. Periostracum thin but tightly adhering, faintly yellow-green, inturned at shell edge. Early sculpture of teleoconch nearly smooth for first millimeter of length; mature sculpture of extremely fine concentric ridges that bifurcate along lateral slope so that there are more ridges on anterior slope than on lateral slopes. Radial sculpture fine and overriding concentric sculpture, under magnification appearing evenly clathrate. Shell interior white, showing fine lamellar pattern under magnification. Interior with sharp, angular posterior ridge. Muscle scar relatively broad anteriorly, narrowed posteriorly; muscle inserting on inner side of angular ridge. Dimensions of holotype: length 11.0, width 8.3, height 4.1 mm.

External anatomy (Figs. 35, 36). Foot oval, rounded

posteriorly, opening of anterior pedal gland not prominent. Snout with tapered tip. Mantle edge with thin fold extending between shell and inturned periostracum, exposed surface thick, puckered, having no apparent elaboration. Epipodium a row of very faint, retracted tubercles, extending forward to lateral extremities of foot, with a more prominent pair of tubercles close together posteriorly. Mantle cavity deeper than half length of shell muscle limb; ctenidium bipectinate, gill lamellae of left (dorsal) side half length of right (ventral) side; gill lamellae of free tip broad and thick on right side.

Radula (Figs. 39, 40) as described above for genus.

Remarks. *Rhynchopelta concentrica* is not easily confused with any other limpet, considering its unique shell sculpture, protoconch sculpture of longitudinal ridges, reduced epipodium and lack of modification to the mantle margin.

Specimens from 13°N collected by the *Cyana* were as robust as those from 21°N and no differences were detected. The “unknown organism” mentioned by McLean (1988a) on *Lepetodrilus* species and Warén & Bouchet (1989) on some species of coiled peltospirid species is also prevalent on *Rhynchopelta concentrica* from 13°N. Berg (1985) gave data on egg dimensions for this species.

This species is clearly associated with the vestimentiferan *Riftia pachyptila*, as relatively large numbers of specimens were recovered from ‘*Riftia* washings’, from *Alvin* dive 1214. Iron sulfide particles are absent, unlike the condition for most of the other peltospirid limpets, in which the sulfide particles indicate an affinity with the sulfide crust deposits.

Although the above mentioned count of 288 mature specimens from *Alvin* dive 1214 suggests that this species is relatively common, it is much less abundant than two lepetodrilid limpets associated with *Riftia*. Counts of *Lepetodrilus pustulatus* and *L. elevatus* at dive 1214 were 1853 and 14,574, respectively (McLean 1988a).

Echinopelta gen.n.

Type species. *Echinopelta fistulosa* sp.n.

Diagnosis. Shell of limpet form, apex close to posterior margin but left of center; interior with strong posterior ridge. Periostracum thick but only slightly enveloping shell edge. Sculpture finely pustular with spaced tubular spines.

External anatomy. Mantle edge unmodified, epipodial ridge extending anteriorly to position of muscle extension, projecting, bearing numerous elongate tentacles.

Radula typical for family, cusps of rachidian and laterals long, nubs of laterals moderately prominent; denticulation of outer edge of fourth lateral like that of marginals, shafts of marginals fused.

Remarks. Although the sculptural elements of *Echinopelta fistulosa* could qualify for inclusion in *Nodopelta*, and it shares the angular ridge of the interior and the tips of the muscle scar broader on the inside, this