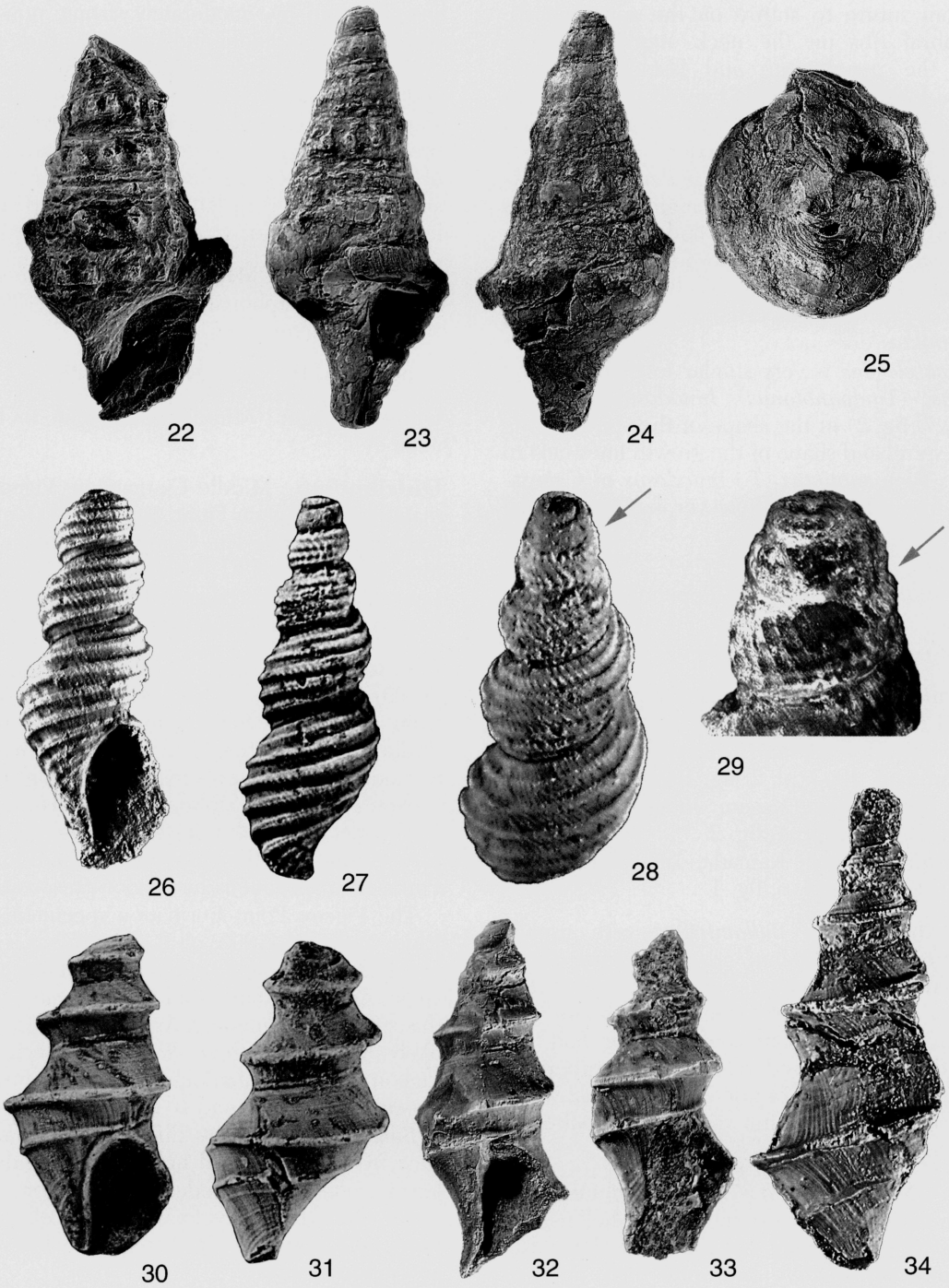

Figures 22–34. New cerithioid? and trichotropid gastropods. Specimens coated with ammonium chloride, unless otherwise noted. **22–25.** *Bullamirifica ainiktos* (Dailey and Popenoe, 1966) new genus. **22.** Hypotype LACMIP 13332, USGS loc. M-8601, height 35.8 mm, diameter 20 mm. **23–25.** Plasto-hypotype IGM 1325, height 80 mm, diameter 36.9 mm. **23.** Apertural view. **24.** Abapertural view. **25.** Basal view. **26–29.** *Minytropis melilota* new genus and species. **26.** Paratype LACMIP 13334, LACMIP loc. 10787, apertural view, height 7 mm, diameter 2 mm. **27–29.** Holotype LACMIP 13333, LACMIP loc. 10786, abapertural view, height 62 mm, diameter 2.2 mm. **27.** Abapertural view. **28.** Oblique apertural view of tip; arrow indicates where protoconch ends and teleoconch starts. **29.** Protoconch, height 0.5 mm, diameter 0.8 mm; arrow indicates where protoconch ends and teleoconch starts; SEM photomicrograph (uncoated). **30–34.** *Paxitropis dicriota* new genus and species. **30–31.** Paratype LACMIP 13336, LACMIP loc. 23643, height 12.7 mm, diameter 6.8 mm. **30.** Apertural view. **31.** Abapertural view. **32.** Holotype LACMIP 13335, LACMIP loc. 23639, apertural view, height 14.7 mm, diameter 6.6 mm. **33.** Paratype LACMIP 13337, LACMIP loc. 23642, apertural view, height 10.1 mm, diameter 4.4 mm. **34.** Paratype LACMIP 13338, LACMIP loc. 24217, abapertural view, height 11 mm, diameter 4.3 mm.

more rows of nodes, and absence of a notch on the outer lip near the suture and not having a thick, extensive callus that covers part of the noded sculpture near the suture on the last whorl. Using Kase (1984: 135–136, pl. 21, figs. 1–9; fig. 20) as a basis for comparison, we consider that *Bullamirifica ainiktos* differs considerably from the latter gastropod by having a much lower spire, more strongly sinuous growth lines, and a well developed, twisted siphonal canal.

Superfamily Capuloidea Fleming, 1822
Family Capulidae Fleming, 1822
?Subfamily Trichotropinae Gray, 1850

Discussion: We include a subfamily name because high-spired capulids, like those described below, are so distinctive from cap-shaped capulids. The subfamily allocation is tentative, pending much-needed taxonomic work on capulids.

Genus *Minytropis* new genus

Type Species: *Minytropis melilota* new species; Late Cretaceous, Santonian, northern California.

Description: Shell very small, estimated maximum height just over 10 mm. Shell thin, narrowly fusiform-elongate. Protoconch flat-topped and smooth, approximately two whorls. Teleoconch whorls rounded. Sculpture consisting of several strong spiral ribs with wide interspaces, both ribs and interspaces crossed by well delineated prosocline growth lines. Aperture oval, produced anteriorly to short, with narrow siphonal canal. Outer lip thin with no varix or inner denticulations. Inner lip callused, narrow.

Geologic Age: Early and Late Santonian.

Etymology: Combination of the Greek *minys*, meaning little, small, or short; and the Latin *tropis*, meaning keel.

Discussion: The placement of *Minytropis* among the trichotropids is suggested by the strongly prosocline and well marked growth lines, strong spiral sculpture, and the short, open siphonal canal. *Minytropis* resembles *Opposirius* Iredale, 1931, which is known only from the Recent of Australia (Wenz, 1940). *Minytropis* differs from *Opposirius* by having a narrower aperture, a longer siphonal canal, and a rounded rather than a bladelike inner lip.

Finlay and Marwick (1937) reported that *Opposirius* is more similar to *Certhioderma* Conrad, 1860, than to any other trichotropid genus. In comparison to *Certhioderma*, *Minytropis* is similar in having a flat-topped, smooth protoconch and in having a short siphonal canal, but *Minytropis* differs by having a much narrower shell, longer and much narrower aperture, stronger spiral sculpture, sculpture not recticulate on adult whorls, and no hint of an umbilicus. Wenz (1940) reported *Cerithioderma* to have a geologic range of Late Cretaceous to Oligocene, but Marwick (1965) reported that this genus is also extant. Dockery (1993) reported *Cerithioderma* from Campanian strata in Mississippi. High-spired trichotropids very similar to *Cerithioderma* are best represented in New Zealand Tertiary strata (Maxwell, 1992). According to Maxwell (1992), *Trichosirius* Finlay, 1926, might be a junior synonym of *Cerithioderma*.

Minytropis melilota new species
(Figures 26–29)

Description: Small, up to 10.2 mm estimated height and 3.5 mm diameter, same specimen. Shell narrowly fusiform-elongate. Spire high, 60% (estimated) of shell height. Pleural angle approximately 22°. Protoconch flat-topped, with two whorls, and smooth (0.5 mm height, 0.8 mm diameter). Teleoconch of approximately seven to eight subangulate whorls, last whorl nearly one-third total height. Suture deeply impressed, nearly coincident with very weak rib. Sculpture nearly cancellate on earliest teleoconch whorl, but four spiral riblets slightly stronger than numerous collabral threads. Sculpture on subsequent whorls progressing into five strong, flat-topped ribs on middle spire, six ribs on lower spire, and approximately eight to nine ribs on last whorl; most posterior spiral rib weak to very weak on all these whorls. Interspaces of nearly equal width on spire whorls but becoming twice as wide as ribs on last whorl. On last whorl, ribs on whorl face equally strong but on base, ribs become much less prominent and more closely spaced. Growth lines strongly prosocline, marked by fine collabral threads strongest on early whorls where they produce slight beading of spiral ribs. Growth lines less prominent and closer-spaced on later whorls; growth lines can be somewhat prominent on base of last whorl. Aperture oval, produced anteriorly to short, narrow siphonal canal. Outer lip thin, arcuate, crenulated by ribs. Columellar lip narrow, weakly callused, and barely forming a pseudo-umbilical chink between base of whorl and indistinct fasciole.

Dimensions of Holotype: Nearly complete specimen (siphonal canal mostly missing), 6.2 mm height, 2.2 mm diameter.

Holotype: LACMIP 13333.

Type Locality: LACMIP loc. 10786.

Paratype: LACMIP 13334.

Geologic Age: Early and Late Santonian.

Distribution: Lower Santonian: Redding Formation, Member V, Clover Creek, Shasta County, northern California. Upper Santonian: Chico Formation, Musty Buck Member, Chico Creek, Butte County, northern California.

Etymology: Latin *melitota*, meaning sweet clover (in reference to the occurrence of the new species near Clover Creek).

Discussion: Description of this new species is based on 29 specimens, most of which represented by small fragments. The better preserved specimens are all from the Redding Formation, however, none of these specimens is as large as the larger ones from the Chico Formation localities. Only two specimens, both from LACMIP loc. 10786, have retained the protoconch. The protoconch of one of these specimens is illustrated in Figures 27–29. The other specimen's protoconch is mostly embedded in hard matrix. The flat-topped protoconch of *M. meliota* supports the position of this gastropod among the Trichotropidae.

The new species can be distinguished from the similar looking *Opposirius idoneus* Iredale (1931: 210, pl. 22, fig. 7; Wenz, 1940: fig. 2631), an extant species in southwestern Australia, by having a narrower shell, one more rib on the spire, two to four more ribs on the base of the last whorl, a much longer siphonal canal, an a rounded columella. *Opposirius idoneus* is the type species of *Opposirius* Iredale, 1931.

Genus *Paxitropis* new genus

Type Species: *Paxitropis dicriota*; Late Cretaceous, late Santonian to early Campanian, northern California.

Description: Shell medium small, narrowly pagodiform. Spire whorls with prominent keel medially. Suture bordered posteriorly by relatively weak spiral rib becoming keel-like on last whorl and, in concert with aforementioned keel, producing bicarinate last whorl. Shell base with several weak spiral riblets. Growth lines prosocline. Columellar lip callused, abaxial margin well-delineated. Siphonal canal short but distinct. Anomphalous.

Geologic Age: Late Santonian to early Campanian.

Etymology: Combination of the Latin *pax*, meaning peace (in reference to the peaceful Pacific coast); and the Latin *tropis*, meaning keel.

Discussion: *Paxitropis* is similar to *Trichotropis* Broderip and Sowerby, 1829, a genus known (Sohl, 1960) from the Late Cretaceous to Recent. The modern distribution of *Trichotropis* is restricted to circum-boreal waters, in both the northern and southern oceans and, as Sohl (1960) noted, this modern distribution is in sharp contrast to its Cretaceous distribution in temperate shallow-water deposits. *Paxitropis* differs from *Trichotropis* by having a smaller size, much narrower shell (including a narrower aperture), a siphonal canal, much lower variability in sculpture, and being anomphalous.

Paxitropis resembles the trichotropid *Icuncula* Iredale, 1924, which is known from the Recent of the Indo-Pacific (Wenz, 1940). *Paxitropis* differs from *Icuncula* by having no hint of an umbilicus, less prominent keels that are unwavy, one less keel on the last whorl, and no axial riblets on the ramp. The aperture of *Paxitropis* is not entirely known.

The new genus has a whorl profile very similar to the turrid *Austrocarina* Laseron, 1954, known only from the Recent of New South Wales and Victoria, southeastern Australia and Tasmania. *Paxitropis*, however, is not a turrid because it does not have the turrid growth lines, which tend to be opisthocline anterior to the notch and across the whorl periphery curving toward prosocline very near the siphonal area.

Paxitropis dicriota new species
(Figures 30–34)

Description: Shell small, up to height estimated 14.5 mm and 6.6 mm diameter. Shell pagodiform. Spire high, approximately 60% of shell height. Pleural angle approximately 30°. Protoconch unknown. Teleoconch approximately six strongly angulated whorls, with wide ramp on middle spire whorls and on last whorl. Sculpture dominated by prominent spiral rib, medially located on shoulder and keel-forming on later whorls. Early teleoconch whorls with two spiral ribs anterior to carina. On mature whorls, these additional ribs become mere threads and equivalent in strength to growth lines, thus producing microscopic cancellate surface, especially on ramp. Suture impressed, nearly coincident with weakly noded subsutural spiral rib located immediately posterior to suture. Subsutural spiral rib relatively weak on spire whorls but becoming keel-like on last whorl. Last whorl with two sharp keels, one just above middle whorl height and second one weaker and occasionally minutely noded, emergent at anterior suture. Shell base with several weak spiral ribs. Growth lines prosocline, most prominent on shell base, near outer lip. Aperture lanceolate and produced anteriorly to short, but distinct siphonal canal. Outer lip thin, angulate, crenulated by ribs. Columellar lip callused, abaxial margin well-delineated. Columellar lip narrow, barely forming pseudo-umbilical chink between base of whorl and indistinct fasciole.

Holotype: LACMIP 13335, 14.7 mm height, 6.6 mm diameter.

Paratypes: LACMIP 13336, 13337, and 13338.

Type Locality: LACMIP loc. 23643.

Geologic Age: Late Santonian to Early Campanian.

Distribution: Upper Santonian: Redding Formation, Member VI, area east of Redding, Shasta County, northern California. Lower Campanian: Chico Formation, Ten Mile Member, Chico Creek, Butte County, northern California; Ladd Formation, upper Holz Shale Member, Santa Ana Mountains, Orange County, southern California.

Etymology: Combination of the Greek *di*, meaning two, and the Greek *criota*, meaning ringed.

Discussion: Twenty incomplete specimens were available, and the six most complete of these are the basis for the above description. The only specimen from the

Redding Formation is geologically the oldest specimen (LACMIP loc. 24217). The only specimen from the upper Holz Shale is from LACMIP loc. 21536.

The new species is very similar to the Pliocene to Recent *Trichotropis bicarinata* (Sowerby, 1825; Pitt and Pitt, 1989: pl. 1, figs. 3–4; Egorov and Alexeyev, 1998: 25, figs. 22–23), which is a Pacific upper boreal Arctic species, occurring in the waters off northern Japan, Kamchatka, southern Chukchi Sea, and Queen Charlotte Islands in British Columbia (Egorov and Alexeyev, 1998). The new species differs from *T. bicarinata* by having a much narrower last whorl and a much narrower aperture. These same differences distinguish the new species from *Trichotropis vokesae* Pitt and Pitt, 1989, which is extremely similar to *T. bicarinata*. *Trichotropis vokesae* is of Pliocene age and from northwestern Ecuador, and the new species differs from *T. vokesae* in the same ways that it differs from *T. bicarinata*.

The new species can be distinguished from the similar looking *Icuncula torcularis* (Tenison-Woods 1879; Wenz, 1940: fig. 2630), an extant species living off the coasts of southeastern Australia and Tasmania, by having less projecting and non-wavy keels, one less keel on the last whorl, and an absence of axial riblets on the ramp. *Icuncula torcularis* is the type species of *Icuncula* Iredale, 1924.

The new species is remarkably similar to the extant *Austrocarina recta* (Hedley, 1903; 1922: 223, fig. 3; Powell, 1966: 34, pl. 3, fig. 2; 1969: 364, pl. 276; Wilson, 1994: 187) but differs from *A. recta* by having a shell approximately 14 mm in height instead of 6 mm, a more projecting and usually wider keel on the shoulder of the adult whorls, several weak spiral ribs on base of last whorl, several spiral ribs on earliest teleoconch whorls, straight rather than a curved profile of the base, columellar lip callused with abaxial margin well-delineated, and no tendency to develop collabral ribs on earliest teleoconch whorls.

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APPENDIX 1

LOCALITIES CITED

Localities are LACMIP, unless otherwise noted. All quadrangle maps listed below are U. S. Geological Survey maps.

10786. Near crest of south slope of divide between Basin Hollow and Clover creeks, at approximately southeast corner of the northwest 1/4 of section 33, T. 32 N, R. 2 W. Lower Santonian. Redding Formation, Member V (lower part). Coll.: W. P. Popenoe and D. W. Scharf, August 8, 1931.

10787. Near crest of north slope of divide between Basin Hollow and Clover creeks, near northeast corner of northwest 1/4 of section 33 and not more than 122 m south of section line, T. 32 N, R. 2 W, Millville Quadrangle (15 minute, 1953), Shasta County, northern California. Lower Santonian. Redding Formation, Mem-

ber V (lower part). Coll.: W. P. Popenoe and D. W. Scharf, August 8, 1931.

12582. Turritellas and oysters along beach just south of La Bocana Roja Formation outcrop, approximately 2 km north of south tip on west side of Punta Baja, Mexico. Middle upper Campanian. Punta Baja Formation. Coll.: L. R. Saul, October 12, 1990.

21536. Corona Quadrangle, Santa Ana Mountains, Orange County, southern California. Lower Campanian. Ladd Formation, upper Holz Shale Member. Coll.: T. Bear, 1940.

23639. East bank of Chico Creek in concretions in massive, greenish-gray sandstone, 373 m south and 293 m west of northeast corner of section 23, T. 23 N, R. 2 E, Paradise Quadrangle (15 minute, 1953), Butte County, northern California. Lower Campanian. Chico Formation, Ten Mile Member. Coll.: L. R. and R. B. Saul, August 20, 1952.

23642. On W bank of Chico Creek, west of big westward projection of east lava cap and approximately N 27°W of BM 1770, 122 m south and 632 m west of northeast corner of section 26, T. 23 N, R. 2 E, Paradise Quadrangle (15 minute, 1953), Butte County, northern California. Lower Campanian. Chico Formation, Ten Mile Member. Coll.: L. R. and R. B. Saul, August 20, 1952.

23643. Concretionary sandstone on west side of Big Chico Creek, 670 m south and 762 m west of northeast corner of section 26, T. 23 N, R. 2 E, Paradise Quadrangle (7.5 minute, 1953), Butte County, northern California. Lower Campanian. Chico Formation, Ten Mile Member. Coll.: L. R. Saul and R. B. Saul, August, 1952.

24124. Hard, medium-grained, gray, arkosic sandstone, 158 m north of Jalama Creek, 3.3 km west and 0.6 km north of southeast corner of the topographic sheet, Lompoc Hills Quadrangle (7.5 minute, 1947). Upper Campanian. Jalama Formation. Coll.: D. Dailey and J. R. Dorrance, October, 1929.

24125. Hard, fine to medium-grained arkosic sandstone, 2.8 km west and 0.53 km north of southeast corner of the topographic sheet, Lompoc Hills Quadrangle (7.5 minute, 1947). Upper Campanian. Jalama Formation. Coll.: D. Dailey and J. R. Dorrance, October 29, 1929.

24217. Hard sandstone slabs in bed of Clover Creek, 213 m north and 366 m west of southeast corner of section 22, T. 32 N, R. 2 W, Millville Quadrangle (15 minute, 1953), Shasta County, northern California. Upper Santonian. Redding Formation, Member VI. Coll.: W. P. Popenoe and D. Dailey, August 27, 1959.

24337. Along east side of Highway 70, 792 m north and 305 m west of southeast corner of section 36, T. 21 N, R. 3 E, Cherokee Quadrangle (7.5 mintue, 1949), Butte County, northern California. Lower Campanian. Chico Formation, Pentz Road member (informal). Coll.: E. Göhre.

UCMP B-3388. In south-trending arroyo which reaches coast about 2.8 km north of the tip of Punta Baja. Marine invertebrates from massive, chert conglomerate at confluence of this arroyo and northwest-trending tributary about 122 m upstream from confluence. This locality is about 488 m northwest of the Punta Baja road. Middle upper Campanian. Punta Baja Formation. Coll.: F. H. Kilmer, date unknown.

USGS M-8601. In lens in sandstone on beach 0.5 km southeast of Bolsa Point, Pigeon Point Quadrangle, San Mateo County, northern California. Middle Campanian. Pigeon Point Formation. Coll.: W. P. Elder, 1989?