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MOLLUSKS OF LATEST CRETACEOUS AND PALEOCENE AGE, LAKE NACIMIENTO, CALIFORNIA

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ABSTRACT

Mollusks from the vicinity of Lake Nacimiento, San Luis Obispo County, California, range in age from early late Maastrichtian through early Paleocene. The mollusks are predominantly of shallow-water aspect, although some may have been deposited in water deeper than that they inhabited. The faunas of early late Maastrichtian and later Maastrichtian age from Cantinas Creek and the north shore of Lake Nacimiento largely comprise genera endemic to the North Pacific. The Dip Creek fauna of latest Maastrichtian (and possibly earliest Paleocene) age contains a larger component of genera not found in earlier West Coast faunas. Some of these forms appear to be most closely related to Western Interior and Gulf Coast genera. Additionally, at least a third of the Dip Creek fauna, which is considered to be of Maastrichtian age because of an included ammonite, comprises taxa of Paleocene age. Southeast of Dip Creek along the ridge west of Godfrey Road, a late early Paleocene fauna has been recognized in strata that overlie the Dip Creek beds.

INTRODUCTION

Fossil mollusks of the Nacimiento Lake area (Figure 1) have proven to be very useful for determining age of the strata and for correlating with other sections of latest Cretaceous age. At most Lake Nacimiento area localities, turritellas are the most abundant form, and at some, as along Dip Creek, turritellas dominate the fauna. The more common turritella species at Dip Creek was described by Merriam (1941) as *Turritella pachecoensis adelaidana*, and the strata there were assigned a Paleocene age (Taliaferro, 1944). Verastegui (1953) recognized that the *Venericardia* from the Dip Creek strata was not *V. (Venericor) venturaensis* WARING, 1917, and named it *V. (Pacificor) taliaferroi*. The turritellas of the area were restudied by Saul (1983a). The Dip Creek turritellas were assigned to *Turritella peninsularis adelaidana* MERRIAM, 1941, and *Turritella webbi* SAUL, 1983. Turritellas from underlying strata on the north side of Lake Nacimiento are *T. chaneyi orienda* SAUL, 1983, and *T. webbi paynei* SAUL, 1983; and those farther down section at Cantinas Creek are *T. chaneyi* intergrades to *T. c. orienda* and *T. webbi paynei* SAUL, 1983. From the ridgetop west of Godfrey Road, Addicott (*in* Durham, 1974, *in* Howell et al., 1977) identified *T. infragranulata* GABB, 1864, and assigned a Paleocene age to these beds that overlie the Dip Creek-Nacimiento strata. Saul (1983a) has suggested that these turritellas might instead be *T. peninsularis* ANDERSON & HANNA, 1935, which would indicate a mid Paleocene rather than late Paleocene age, but the specimens should be restudied. Turritellas correlative with those from Cantinas Creek are found at the top of the Garzas beds of the Moreno Formation along the west side of the Diablo Range, Stanislaus and Merced Counties. The turritellas from the north shore of Lake Nacimiento correlate with the basal San Francisquito Formation on Warm Springs Mountain, Los Angeles County (Saul, 1983a). Those from the Dip Creek outcrops are also found above the base of the San Francisquito Formation on Warm Springs Mountain and on Machesna Mountain, San Luis Obispo County (Saul, 1983a). The Godfrey Road turritellas are undoubtedly of Paleocene age, "Martinez" Stage.

West Coast bivalves and gastropods from the latest Cretaceous stage, the Maastrichtian, are poorly documented in the literature and more than half of the species remain undescribed. Nearly all described West Coast Paleocene mollusks are from the "Martinez" Stage, which is approximately equivalent to Foraminiferal Zones P3 - P5 (Saul, 1983b). Lake Nacimiento area molluscan taxa are mainly of Maastrichtian and possibly earliest Paleocene age, and little useful data regarding these taxa is available in print. Distributions and abundances of Lake Nacimiento mollusks elsewhere are from comparisons with those from other West Coast localities, primarily collections housed at the Natural History Museum of Los Angeles County.

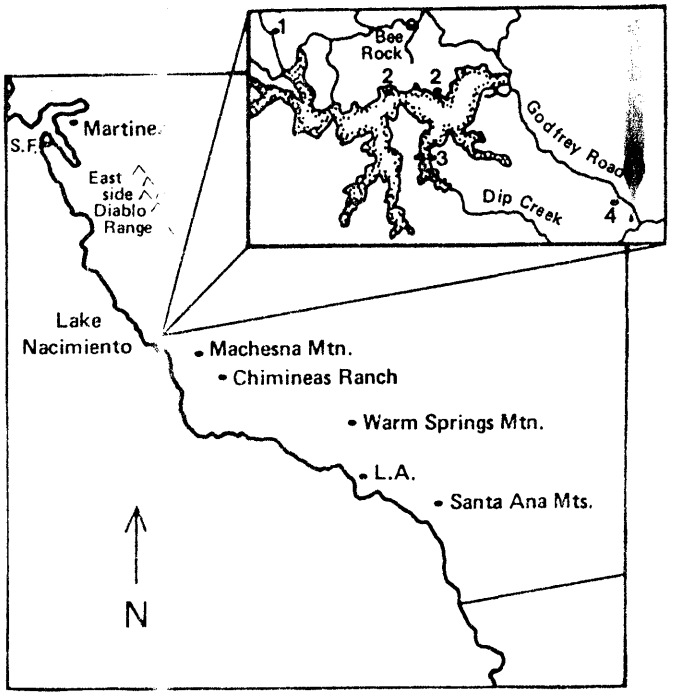


Fig. 1. Geographic reference map. Locations of California sections having molluscan faunas similar to those of the Lake Nacimiento area. Lake Nacimiento area localities discussed are: 1) Cantinas Creek, 2) north shore of Lake Nacimiento, 3) Dip Creek, and 4) ridge west of Godfrey Road.

CANTINAS CREEK

Over several summers in the 1930's, N. L. Taliaferro, his associates, and students collected small lots of fossils from numerous localities in the Adelaida, Bradley, Bryson, and Cape San Martin Quadrangles, southern Santa Lucia Range, California. Taliaferro (1944, p. 502) published a list of 24 genera from these localities; at least two-thirds of those listed probably refer to forms found at Cantinas Creek, Bryson Quadrangle. The specimens were identified by Alex Clark, B. L. Clark, H. G. Schenck, and J. W. Merriam, and the resultant list contains redundant names and includes fossils of different ages. Recently more voluminous collections by V. M. Seiders, K. G.

Provine, R. B. Saul, and L. R. Saul have made reassesments of the identifications and better correlations possible.

Coralliochama cf. *C. orcutti* WHITE, 1896, is from a locality in the Cape San Martin Quadrangle and suggests shallower water than other forms listed by Taliaferro or found at Cantinas Creek. Most occurrences of *C. orcutti* are of early Maastrichtian age and somewhat older than that of the Cantinas Creek beds. .

A reworked fossiliferous boulder collected by V. M. Seiders from a conglomerate that crops out west of the Pebblestone Shut-in, has reluctantly yielded specimens suggestive of a Late Campanian age. *Opis* n. sp. aff. *O triangulata* (COOPER, 1894) is common in this clast, as is *Calva bowersiana* (COOPER, 1894); both are found in Campanian strata of the Santa Ana Mountains in Orange County, and the strata from which the boulder was derived are older than the Cantinas Creek beds. A similar clast may have provided the *Opis* cited in Taliaferro's list.

The mollusks of the Cantinas Creek locality (see also Seiders, this volume) are of early late Maastrichtian age. Fossils found at Cantinas Creek localities include:

Acila sp.

Indogrammatodon cf. *I. vancouverensis* (MEEK, 1858). Figures 2 - 4 . The genus is typical of fine-grained sediment throughout the West Coast Cretaceous.

Glycymeris (Glycymerita) banosensis ANDERSON, 1958. Figures 5 - 6. This species is abundant in the Garzas beds of the Moreno Formation along the east side of the Diablo Range, Stanislaus and Merced Counties. It ranges from early through mid late, but apparently not into the latest Maastrichtian. Its sharp topped ribs distinguish it from *G. (G.) veatchii* (GABB, 1864), the ribs of which are flat topped.

Brachidontes n. sp. A similar form occurs in the Moreno Formation on the west side of the Diablo Range

Pycnodonte sp. An off-shore oyster.

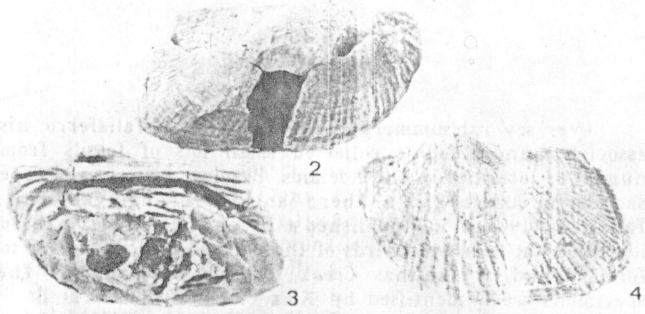
Anomia sp.

Clisocolus aff. *C. dubius* (GABB, 1864). The genus ranges from Turonian through Maastrichtian on the West Coast and is present in the Western Interior Maastrichtian (Speden, 1970). A Japanese species of similar age is placed in the subgenus *Crenocolus* (Hayami, 1975). All are round and very inflated.

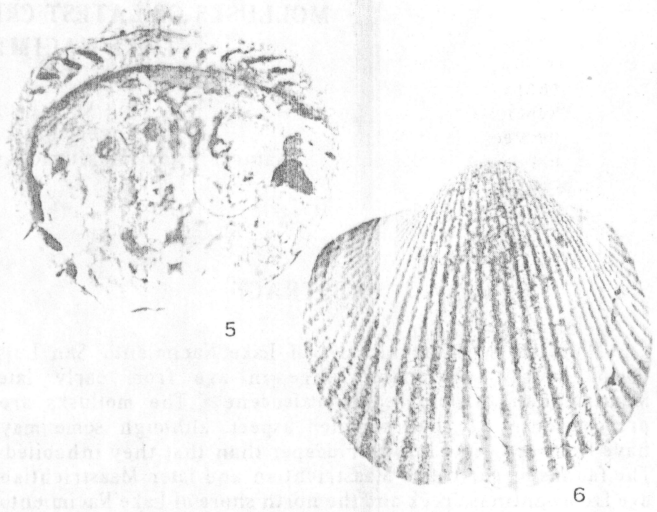
Crassatella mercedensis ANDERSON, 1958. Figures 24 - 27.

Calva varians (GABB, 1864). Figures 7 - 9. The species is of Maastrichtian age and has been found near the top of the Great Valley Series near Martinez, Contra Costa County and in the Garzas beds of the Moreno Formation, east side of the Diablo Range.

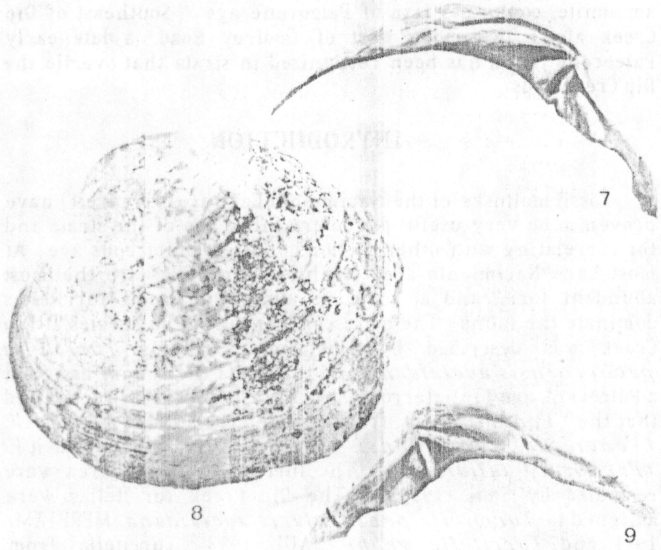
Aphrodina? cf. *A.? fragilis* (GABB, 1864). Figures 10 - 11. This species is also present in the Moreno Formation along the east side of the Diablo Range and at Martinez, Contra Costa County. The genus may be undescribed. The species is congeneric with *A.? arata* (GABB) of Turonian age.



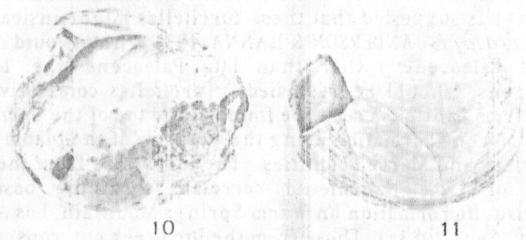
Figs. 2 - 4. *Indogrammatodon* aff. *I. vancouverensis* (MEEK, 1858); x 1; LACMIP loc. 9196, Cantinas Creek, Bryson Quad.; 2-3. LACMIP 7546; 4. LACMIP 7547.



Figs 5 - 6. *Glycymeris (Glycymerita) banosensis* ANDERSON, 1958; x 1, LACMIP 7548; LACMIP loc. 9196, Cantinas Creek, Bryson Quad.



Figs. 7 - 9. *Calva varians* (GABB, 1864); x 1; UCB loc. A-3369, 1/2 mi. west of Bee Rock Road, Tierra Redonda Quad.; 7 - 8. UCBMP 38029; 9. UCBMP 38030.



Figs. 10 - 11. *Aphrodina?* cf. *A.? fragilis* (GABB, 1864); x 1; LACMIP 7549; LACMIP loc. 9196, Cantinas Creek, Bryson Quad.

Turritella chaneyi intergrade to *T. c. orienda*. Figures 12 - 13. *T. chaneyi* MERRIAM, 1941 ranges from late early through mid Maastrichtian age; *T. c. orienda* SAUL, 1983, ranges through the late, but not the latest, Maastrichtian. Specimens from Cantinas Creek are morphologically between *T. chaneyi* and *T. c. orienda* and of late mid - early late Maastrichtian age.

Turritella webbi paynei SAUL, 1983. Figures 14, 31-32. The species ranges from late early to early late Maastrichtian.

Pyktes hamulus (GABB, 1864). Figures 15-16. The species is of mid to late Maastrichtian age and probably inhabited shallow water (Popenoe, 1983).

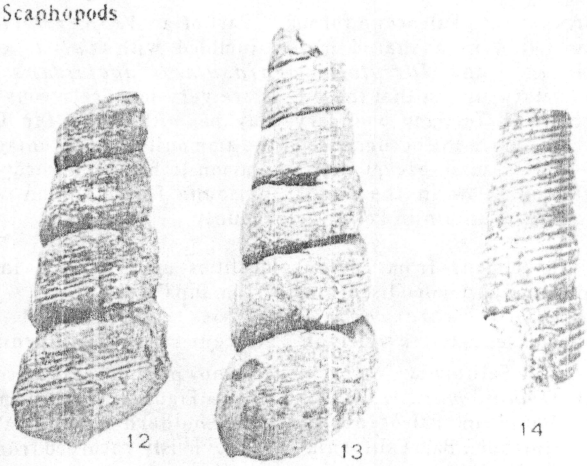
Tessarolax aff. *T. distorta* GABB, 1864. Figures 17 -18. This genus has four long bent canicular extensions (one apical, two labral, and one anterior) and a shorter ablabral one, all of which propped the animal up above the soft bottom. A spike on the last whorl, in living position, pointed upward. As in the specimens figured, these extensions are commonly broken leaving only stubs. The base of the vertical spike is up in the spiral view (Figure 18) and the aperture down. In the abapertural view (Figure 17), the stub of this spike is normal to the plane of the page. *Tessarolax* is found throughout the West Coast Cretaceous, usually in fine-grained sediments, and suggests deeper water or softer bottom.

Polinices (Polinices) n. sp. Figures 19 - 20.

Cophocara stantoni STEWART, 1927. Figure 21. The anterior canal of this juvenile specimen is broken. The species is of mid to late Maastrichtian age.

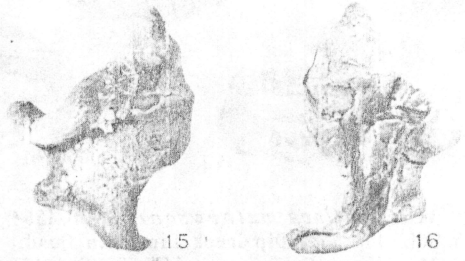
Nekewis? n. sp. Figure 22 - 23. Congeneric, but perhaps not conspecific, specimens are found in the early Maastrichtian Rosario Formation of Baja California and the Moreno Formation along the east side of the Diablo Range. The genus has been considered to have only an early Tertiary range.

Scaphopods

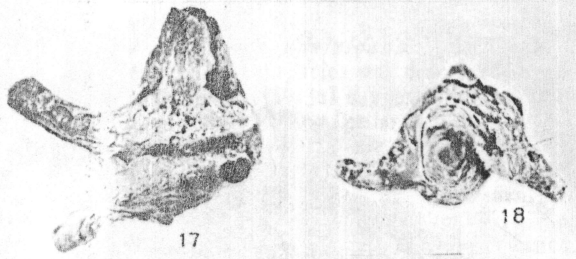


Figs. 12 - 13. *Turritella chaneyi* MERRIAM, 1941, intergrades to *T. c. orienda* SAUL, 1983; x 1; 12. UCBMP 37349, UCB loc. A-3368, Cantinas Creek, Bryson Quad.; 13. UCBMP 37348, UCB loc. A-3366, east branch Cantinas Creek, Bryson Quad.

Fig. 14. *Turritella webbi paynei* SAUL, 1983; x 1; UCBMP 37345, UCB loc. A-3368, Cantinas Creek, Bryson Quad.



Figs. 15 - 16. *Pyktes hamulus* (GABB, 1864); x 1; UCBMP 38031, UCB loc. A-3368, Cantinas Creek, Bryson Quad.



Figs. 17- 18. *Tessarolax* aff. *T. distorta* GABB, 1864; x 1; UCB loc. A-3368, Cantinas Creek, Bryson Quad.; 17. UCBMP 38032; 18. UCBMP 38033.

Figs. 19 - 20. *Polinices (Polinices)* n. sp.; x 1; LACMIP 7550; LACMIP loc. 9196, Cantinas Creek, Bryson Quad.

Fig. 21. *Cophocara stantoni* STEWART, 1927; x 2; LACMIP 7551, LACMIP loc. 9196, Cantinas Creek, Bryson Quad.

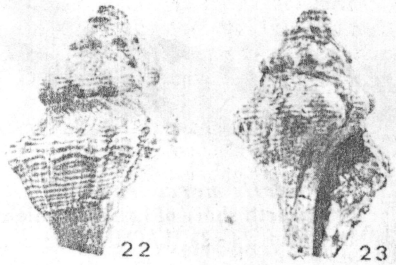


Fig. 22 - 23. *Nekewis?* n. sp.; x 1; LACMIP 7552; LACMIP loc. 9196, Cantinas Creek, Bryson Quad.

NORTH SHORE LAKE NACIMIENTO

The fauna from these localities (see Provine, this volume) is less diverse and of more uniform habitat than that of the Cantinas Creek localities. Notably lacking is the deeper water, softer bottom element (*i.e.*, *Indogrammatodon*, *Tessarolax*). It is also of slightly younger late Maastrichtian age. Molluscan faunas of this age are not known from the Moreno Formation along the east side of the Diablo Range. The beds with *Turritella chaneyi orienda* SAUL, 1983, at the base of the San Francisquito Formation on Warm Springs Mountain, Los Angeles County and on Chimineas Ranch, San Luis Obispo County, yield not *T. webbi paynei* but *T. webbi* SAUL, 1983. The fauna of these north shore Lake Nacimiento localities is slightly older than that of the near correlatives on Warm Springs Mountain and Chimineas Ranch.

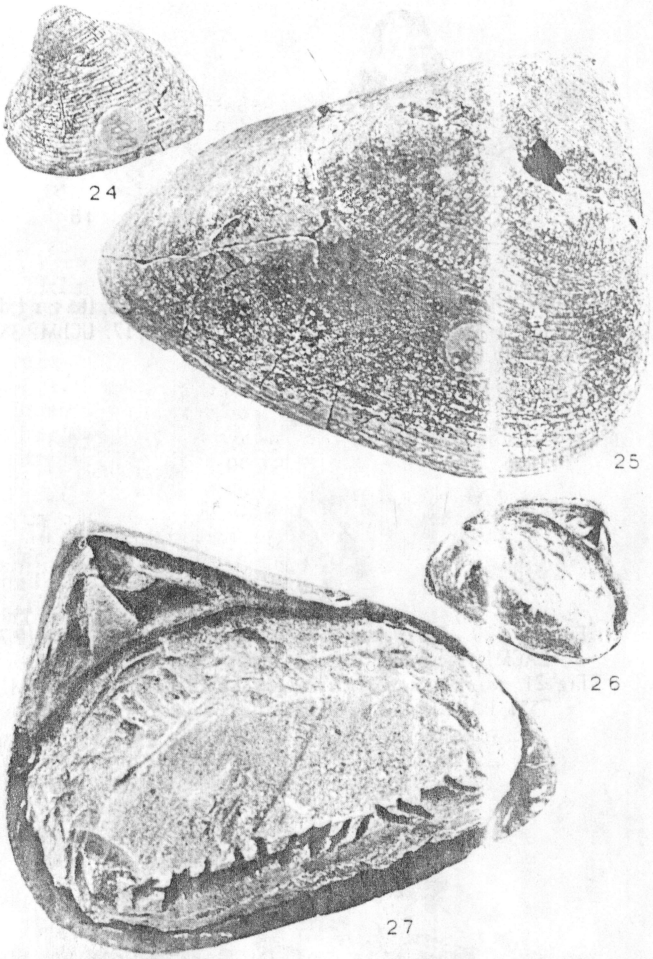
Brachidontes n. sp.

Ostreidae. Small indeterminate specimens.

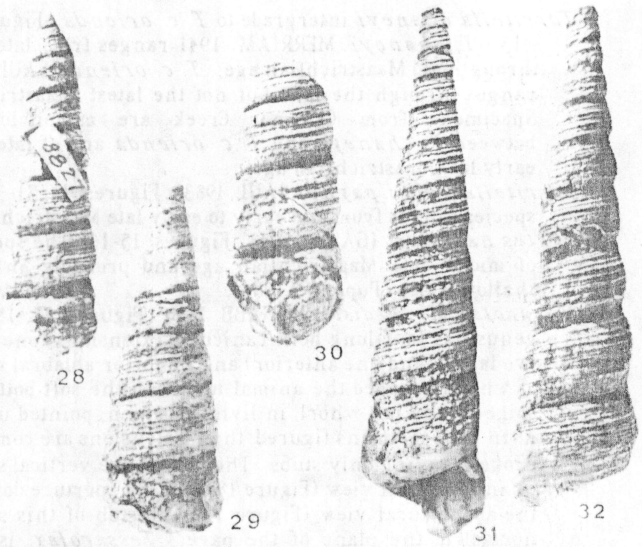
Anomia sp.

Crassatella mercedensis ANDERSON, 1958. Figures 24 - 27. The type locality is in the Garzas beds of the Moreno Formation along the east side of the Diablo Range. This species belongs to the group of *C. gamma* POPENOE, 1937, of Turonian age.

Cymbophora sp.



Figs. 24 - 27. *Crassatella mercedensis* ANDERSON, 1958; x 1; UCLA loc. 6486, north shore of Lake Nacimiento, Tierra Redonda Mtn. Quad.: 24 - 25. LACMIP 7553; 26 - 27 LACMIP 7554.



Figs. 28 - 30. *Turritella chaneyi orienda* SAUL, 1983; x 1; 28. UCLA 58827, UCLA loc. 6486, north shore of Lake Nacimiento, Tierra Redonda Mtn. Quad. 29 - 30. USGS loc. M6588, north shore of Lake Nacimiento, Tierra Redonda Mtn. Quad. 29 USNM 307678, 30 USNM 307679.

Figs. 31 - 32. *Turritella webbi paynei* SAUL, 1983; x 1; UCLA loc. 6486, north shore of Lake Nacimiento, Tierra Redonda Mtn. Quad. 31 UCLA 58778, 32 UCLA 58779. Figs. 33 - 34. *Cucullaea mathewsonii* GABB, 1864; x 1; LACMIP 7555; UCLA loc. 6525, Dip Creek, Lime Mtn. Quad.

Turritella chaneyi orienda SAUL, 1983. Figures 28 - 30. This late (but not latest) Maastrichtian subspecies is also found at the base of the San Francisquito Formation on Warm Springs Mountain, Los Angeles County, and Chimineas Ranch, San Luis Obispo County.

Turritella webbi paynei SAUL, 1983. Figures 14, 31-32.

Polinices (Polinices) n. sp.

Scaphopods

Pachydiscus (Neodesmoceras) sp.

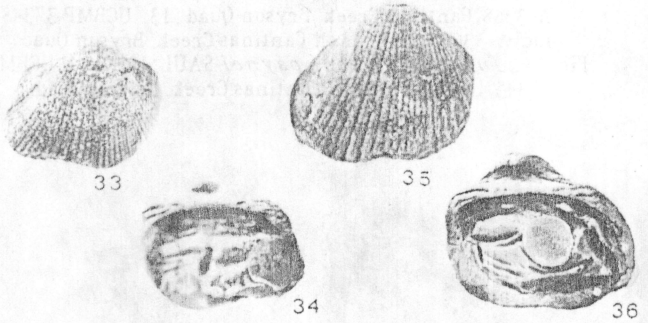
DIP CREEK

The Dip Creek fauna is both fascinating and frustrating. Taliaferro (1944, p. 516) credits B. L. Clark, H. G. Schenck, C. W. Merriam, and A. Myra Keen with the identifications for his check list. Although he does not so state, material from the ridge west of Godfrey Road is apparently included. The Dip Creek fauna contains some mollusks that resemble genera or species usually considered to indicate a Paleocene age, as well as some indicative of a Cretaceous age. Identification is impeded by the hard, light colored matrix that does not contrast strongly with the specimens and the broken and somewhat etched nature of most specimens. Taliaferro did not construe the mixture of ages to indicate closeness to the Cretaceous-Tertiary boundary. He apparently interpreted the mixture as redeposition of Cretaceous rocks into Paleocene age sediments as evidenced by his "print of a Cretaceous ammonite . . . . in a block of Asuncion" in the Dip Creek conglomerate (Taliaferro, 1944, p. 514). Within these sediments there is not, however, a segregation of "Cretaceous forms" from "Paleocene forms". Part of a *Neophylloceras?* was found in a shared matrix jumbled with *Calva* cf. *C. varians* and *Turritella peninsularis adelaidana*. All indicators suggest that these beds are very late Cretaceous. The Cretaceous/Tertiary boundary may be within the Dip Creek section above the occurrence of the ammonites. Beds containing a similar fauna, except that no ammonite has been recovered, are found low in the San Francisquito Formation on Warm Springs Mountain in Los Angeles County.

Specimens from several localities are included in the following annotated list of fossils from Dip Creek.

Cucullaea mathewsonii GABB, 1864. Figures 33-34. The species is found widely in Paleocene strata of California and Baja California. Not previously known from the Cretaceous.

"Nemodon" morani (WARING, 1917). Figures 35-36. A species found in Paleocene strata of southern California and northern Baja California. Not previously recorded from the Cretaceous.



Figs. 33 - 34. *Cucullaea mathewsonii* GABB, 1864; x 1; LACMIP 7555; UCLA loc. 6525, Dip Creek, Lime Mtn. Quad.

Figs. 35 - 36. *"Nemodon" morani* (WARING, 1917); x 1; LACMIP 7556. UCLA loc. 6525, Dip Creek, Lime Mtn. Quad.

Glycymeris (Glycymeris) n. sp. Figures 37-38. A low, nearly smooth *Glycymeris*.

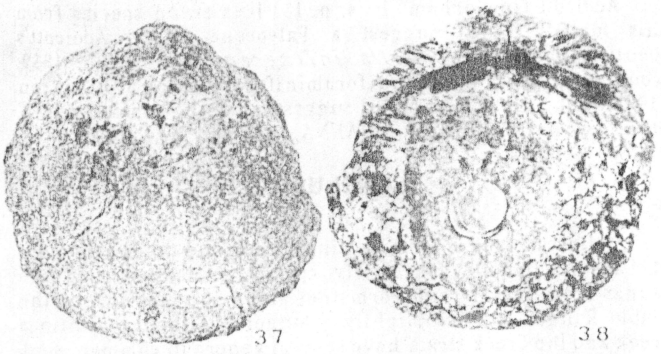
Brachidontes? n. sp.

Ostreidae. Fragments of large thick-shelled oysters.

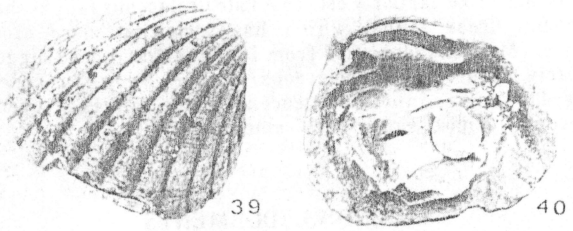
Anomia sp.

Venericardia (Pacificor) taliaferroi VERASTEGUI, 1953. Figures 39-40. The species is abundant at the base of the San Francisquito Formation along East Fork Fish Creek, Warm Springs Mountain Quadrange. Los Angeles County

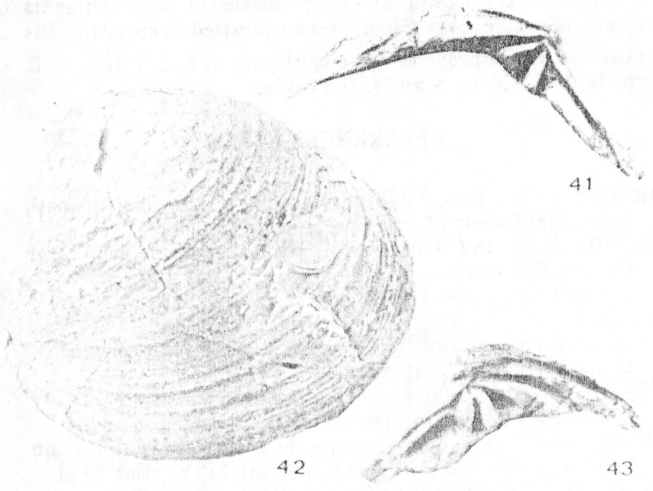
Calva cf. *C. varians* (GABB, 1864). Figures 41-43. Specimens are shorter and have the anterior lateral larger than do the specimens from Cantinas Creek. The genus is endemic to the northeast Pacific and not recorded from the Paleocene.



Figs. 37 - 38. *Glycymeris (Glycymeris)* n. sp.; x 1; LACMIP 7557; UCLA loc. 6528, Dip Creek, Lime Mtn. Quad.



Figs. 39 - 40. *Venericardia (Pacificor) taliaferroi* VERASTEGUI, 1953; x 1; LACMIP 7558; UCLA loc. 6525, Dip Creek Lime Mtn. Quad.



Figs. 41 - 43. *Calva* cf. *C. varians* (GABB, 1864); x 1; UCLA loc. 6526, Dip Creek, Lime Mtn. Quad.; 41 - 42, LACMIP 7559; 43, LACMIP 7560.

Turritella peninsularis adelaidana MERRIAM, 1941. Figures 44-46. The subspecies was described as being of Paleocene age, but Saul (1983a) suggests that it ranges from latest Maastrichtian to earliest Danian.

Turritella webbi SAUL, 1983. Figure 47. The species is of late late Maastrichtian to ?early Danian age. *T. webbi* is longer ranging than *T. p. adelaidana* appearing earlier and occurring with *T. c. orienda* on Warm Springs Mountain Los Angeles County and Chimineas Ranch, San Luis Obispo County. In addition to Dip Creek, *T. webbi* occurs with *T. p. adelaidana* on Warm Springs Mountain and at Machesna Mountain, San Luis Obispo County (Saul, 1983a)

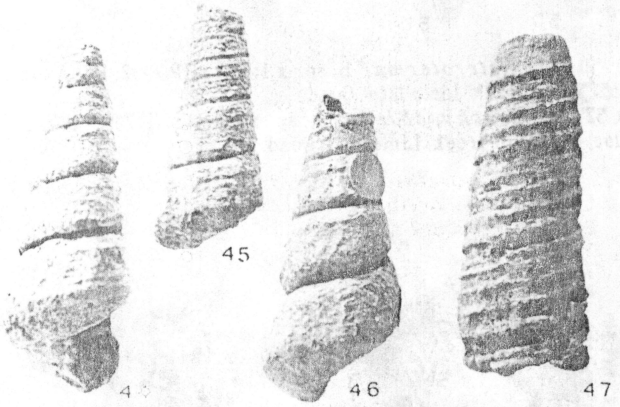
Polinices (Euspira) n. sp. Figures 48 - 49. The specimen resembles *P. (E.) susanaensis* NELSON, 1925 of Paleocene age. it does not resemble any West Coast Cretaceous species.

Gyrineum aff. *G. judithi* ZINSMEISTER, 1983. *G. judithi* is of Paleocene age. no West Coast Cretaceous species resembles this specimen.

Heteroterma? n. sp. Figures 50 - 51. The species resembles *Heteroterma gabbi* STANTON, 1896, but the aperture differs posteriorly. It is very similar to the Late Cretaceous genus *Rhombopsis* of the western Interior and Gulf Coast (Sohl, 1964).

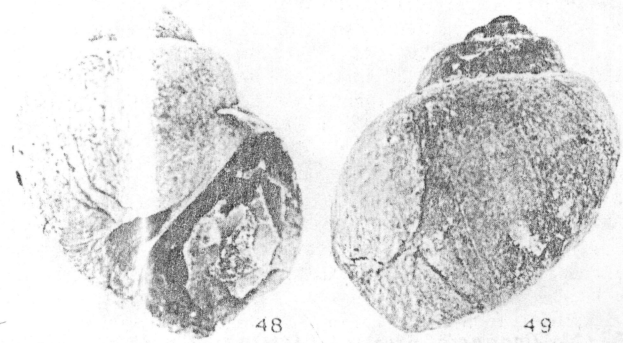
Brachysphingus n. sp. Figure 52 - 53. The Paleocene species *B. sinuata* GABB, 1869, is rounder, less elongate. The genus is not recorded from the Cretaceous.

Deussensia? n. sp. Figure 53 - 54. *Deussensia* is represented by several species in the Late Cretaceous of the Western Interior and Gulf Coast (Sohl, 1964).



Figs. 44 - 46. *Turritella peninsularis adelaidana* MERRIAM. 1941; x 1; 44, UCLA 58849; UCLA loc. 6526, Dip Creek, Lime Mtn. Quad.; 45, UCLA 58855; UCLA loc. 6527, Dip Creek, Lime Mtn. Quad.; 46, UCLA 58846, UCLA loc. 6525, Dip Creek, Lime Mtn. Quad.

Fig. *urritella webbi* SAUL, 1983; x 1; UCLA 58797; UCLA lo 6525, Dip Creek, Lime Mtn. Quad.



Figs. 48 - 49. *Polinices (Euspira)* n. sp.; x 1; LACMIP 7561; UCLA loc. 6526, Dip Creek, Lime Mtn. Quad.

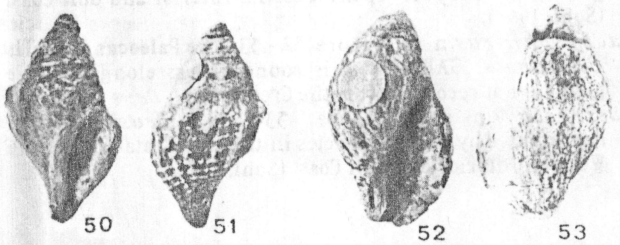
"Fusus (Levifusus?)" cf. *"F. (L.)" calabasensis* NELSON, 1925. Figure 56. *"F. (L.?)" calabasensis* is of Paleocene age. No described West Coast Cretaceous species resembles this specimen.

Ornopsis? n. sp. Figures 57 - 58. This is apparently the *Trachytriton titan* WARING, 1917, of Taliaferro's list, but the columella has a strong fold like that of the Western Interior and Gulf Coast Cretaceous genus *Ornopsis* (Sohl, 1964).

Cryptochorda n. sp. Figure 59 - 60. The genus is not recorded from the Cretaceous and has been considered indicative of Early Tertiary.

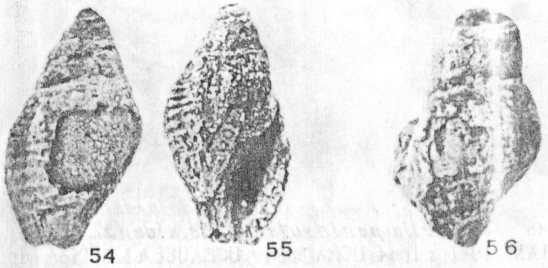
Cinulia? n. sp.

Neophylloceras? sp. Taliaferro's (1944, p. 514) print of an ammonite was found "about 150 feet above the base of the Dip Creek formation". The fragment of *Neophylloceras?* is from UCLA loc. 6526: east side of narrows of Dip Creek, at approximate elevation of 740', 1500'S, 400'W of NE cor. sec. 30, T25S, R10E, Lime Mountain Quadrangle. It was intimately associated with other Dip Creek species. That portion of the Dip Creek section below and including these occurrences is Cretaceous, based on the ammonites.



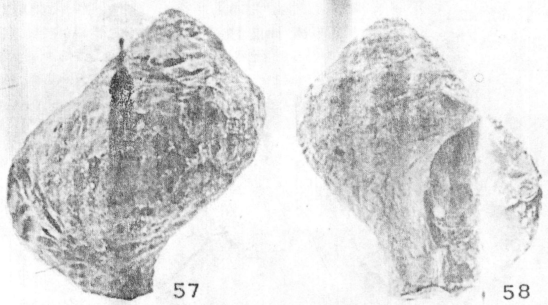
Figs. 50 - 51. *Heteroterma?* n. sp.; x 1; LACMIP 7562; UCLA loc. 6525, Dip Creek, Lime Mtn. Quad.

Figs. 52 - 53. *Brachysphingus* n. sp.; x 1; LACMIP 7563; UCLA loc. 6525, Dip Creek, Lime Mtn. Quad.



Figs. 54 - 55. *Deussensia?* n. sp.; x 1; CAS 61598; Dip Creek, Lime Mtn. Quad.

Fig. 56. *"Fusus (Levifusus?)"* cf. *"F. (L.?)" calabasasensis* NELSON, 1925; x 1; CAS 61599; Dip Creek, Lime Mtn. Quad.



Figs. 57 - 58. *Ornopsis?* n. sp.; x 1; LACMIP 7564; UCLA loc. 6525, Dip Creek, Lime Mtn. Quad.

Figs. 59 - 60. *Cryptochorda?* n. sp.; x 1; LACMIP 7565; UCLA loc. 6525, Dip Creek, Lime Mtn., Quad.

RIDGE WEST OF GODFREY ROAD

Addicott (in Durham, 1974, p. 18) lists seven species from this locality. All suggest a Paleocene age. Addicott's identification of *Turritella infragranulata* GABB, 1869, would place the fauna in the foraminiferal P4 Zone of Berggren (1972), but Saul (1983a p. 30) suggests that the turritella is *T. peninsularis* ANDERSON & HANNA, 1935, and the zone P3.

CONCLUSIONS

Molluscan faunas from Cantinas Creek and the north shore of Lake Nacimiento are closely related to Maastrichtian age faunas from the Moreno Formation along the east side of the Diablo Range, but are slightly younger. Although Cantinas Creek and Dip Creek strata have several genera in common, most are represented by different species, and there is no evidence for redeposition and mixing of faunas of disparate ages. Inferred habitats for some species, especially for some from Cantinas Creek, suggest downslope movement of shallower water forms into somewhat deeper water. The Cantinas Creek fauna is more like earlier West Coast Late Cretaceous faunas than is the Dip Creek fauna, which has somewhat more exotic affinites. Mollusks identified from Dip Creek do indeed suggest both early Paleocene and Cretaceous. Either *Neophylloceras* managed to survive into the Paleocene or the ranges of several "Paleocene" forms began in the Cretaceous.

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REFERENCES CITED

ANDERSON, F. M., 1958, Upper Cretaceous of the Pacific Coast: Geological Society of America, Memoir 71, 378 p., 75 pl.

ANDERSON, F. M., and G. D. HANNA, 1935, Cretaceous geology of Lower California: California Academy of Sciences, Proceedings, Series 4, v. 23, p. 1-34, pl. 1-11, 2 fig.

BERGGREN, W. A., 1972, A Cenozoic time-scale -- some implications for regional geology and paleobiogeography: Lethaia, v. 5, p. 195-215, 9 fig.

COOPER, J. G., 1894, Catalogue of Californian fossils (Part 2-5): California State Mining Bureau, Bulletin 4, 65 p., 6 pl.

COQUAND, Henri, 1869, Monographie du genre *Ostrea*: Terrain Crétacé: Paris, J.-B. Baillière & fils, text, 215 p., atlas, 74 pl.

DURHAM, D. L., 1974, Geology of the southern Salinas Valley area, California: United States Geological Survey, Professional Paper 819, 111 p., 4 pl., 46 fig.

GABB, W. M., 1864, Description of the Cretaceous fossils: California Geological Survey, Palaeontology, v. 1, p. 57-243, 32 pl.

_____, 1869, Cretaceous and Tertiary fossils: California Geological Survey, Palaeontology, v. 2, 299 p.

HAYAMI, Itaru, 1975, A systematic survey of the Mesozoic Bivalvia from Japan: University of Tokyo, University Museum, Bulletin 10, 249 p., 10 pl. 3 fig.

HOWELL, D. G., J. G. VEDDER, Hugh McLEAN, J. M. JOYCE, S. H. CLARKE, JR., and Greg SMITH, 1977, Review of Cretaceous geology, Salinian and Nacimiento blocks, Coast Ranges of Central California, p. 1-46, *in* HOWELL, D. G., J. G. VEDDER, & K. McDOUGALL [eds.], Cretaceous geology of the California Coast Ranges, west of the San Andreas Fault: Society of Economic Paleontologists & Mineralogists, Pacific Section, Pacific Coast paleography field guide 2.

MEEK, F. B., 1858, Descriptions of new organic remains from the Cretaceous rocks of Vancouver's Island: Albany Institute, Transactions, v. 4, p. 37-49.

MERRIAM, C. W., 1941, Fossil turritellas from the Pacific Coast region of North America: University of California Publications, Department of Geological Sciences, Bulletin v. 26, p. 1-214, pl. 1-41, 19 text-figs., 1 map.

NELSON, R. N., 1925, A contribution to the paleontology of the Martinez Eocene of California: University of California Publications, Department of Geological Sciences, Bulletin v. 15, p. 397-466, pl. 49-61.

POPENOE, W. P., 1937, Upper Cretaceous Mollusca from Southern California: Journal of Paleontology, v. 11, p. 379-402, pl. 45-49.

_____, 1983, Cretaceous Aporrhaidae from California: Aporrhainae and Arrhoginae: Journal of Paleontology, v. 57, p. 742-765, 6 fig.

SAUL, L. R., 1983a, *Turritella* zonation across the Cretaceous-Tertiary Boundary: University of California Publications in Geological Sciences, v. 125, 164 p., 7 pl., 27 text-fig.

_____, 1983b, Notes on Paleogene turritellas, venericardias, and molluscan stages of the Simi Valley area, California, p. 71-80, *in* SQUIRES, R. L., and M. V. FILEWICZ [eds.], Cenozoic geology of the Simi Valley area, Southern California: Society of Economic Paleontologists and Mineralogists, Pacific Section Fall field trip volume and guide book.

SOHL, N. G., 1964, Neogastropoda, Opisthobranchia and Basommatophora from the Ripley, Owl Creek, and Prairie Bluff Formations: United States Geological Survey, Professional Paper 331-B, p. 153-344, pl. 19-52, fig. 12-18.

SPEDEN, I. G., 1970, The type Fox Hills Formation, Cretaceous (Maestrichtian), South Dakota. Part 2. Systematics of the Bivalvia: Yale University, Peabody Museum of Natural History, Bulletin 33, 222 p., 42 pl., 19 fig.

STANTON, T. W., 1896, The faunal relations of the Eocene and Upper Cretaceous on the Pacific Coast: United States Geological Survey, 17th Annual Report, part 1, p. 1005-1060, pl. 63-67.

STEWART, R. B., 1927, Gabb's California fossil type gastropods: Academy of Natural Sciences of Philadelphia, Proceedings, v. 78, p. 287-447, pl. 20-32.

TALIAFERRO, N. L., 1944, Cretaceous and Paleocene of Santa Lucia Range, California: American Association of Petroleum Geologists, Bulletin v. 28, p. 449-521, 18 fig.

VERASTEGUI, Pedro, 1953, The pelecypod genus *Venericardia* in the Paleocene and Eocene of western North America: Paleontographica Americana, v. 3 (#25), p. 396-507 (1-113), pl. 40-61 (1-22), 3 charts.

WARING, C. A., 1917, Stratigraphic and faunal relations of the Martinez to the Chico and Tejon of Southern California: California Academy of Sciences, Proceedings, Ser. 4, v. 7, p. 41-124, pl. 7-16.

WHITE, C. A., 1889, On invertebrate fossils from the Pacific Coast: United States Geological Survey, Bulletin, v. 51, p. 439-532, pl. 1-14.

ZINSMEISTER, W. J., 1983, New late Paleocene molluscs from the Simi Hills, Ventura County, California: Journal of Paleontology, v. 57, p. 1282-1303, 4 fig.

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