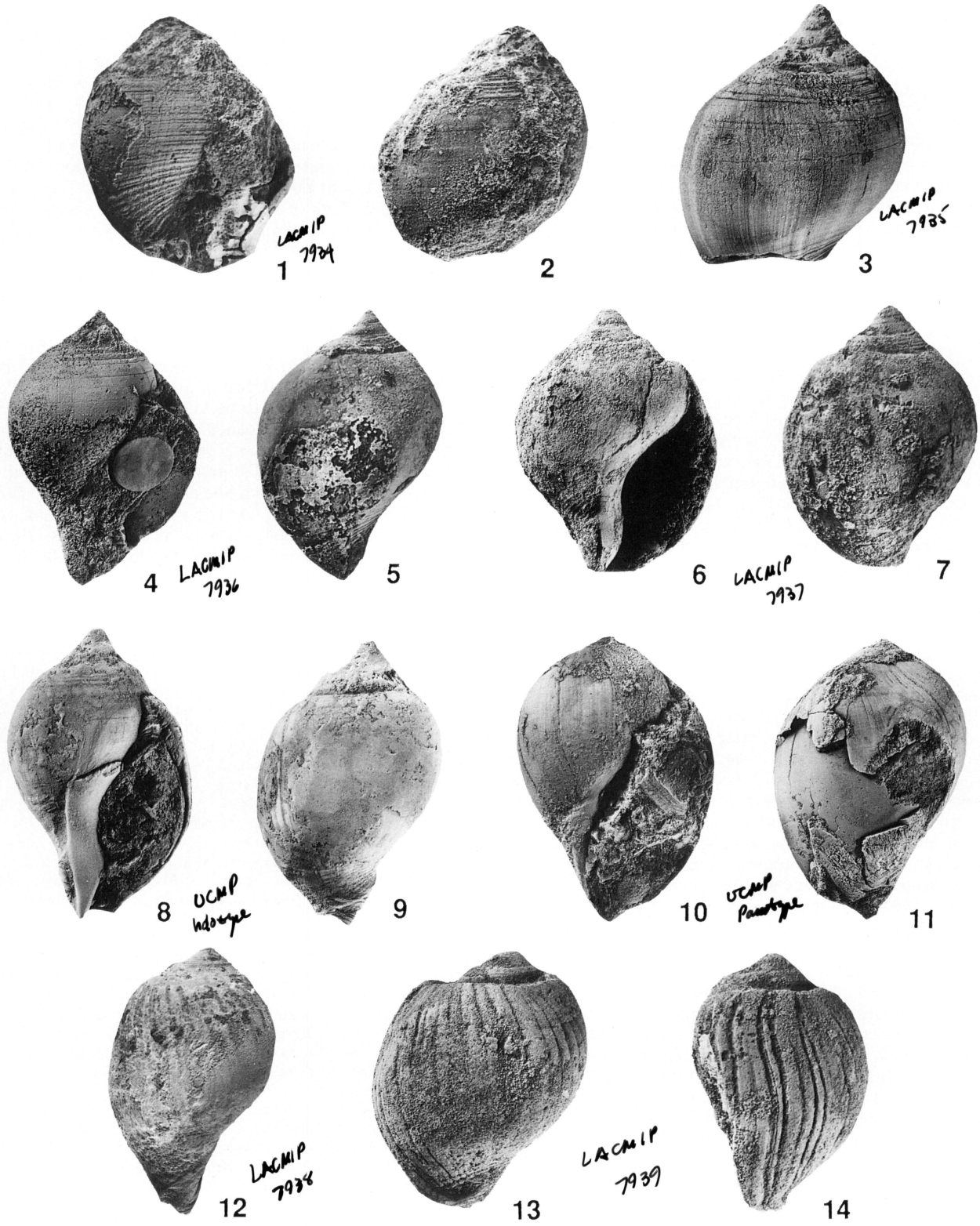

FIGURE 5—*1–14, Brachysphingus mammilatus* Clark and Woodford, 1927. *1, 2,* hypotype, LACMIP 7934, LACMIP loc. 7173, apertural and abapertural views, ×2.5. *3,* hypotype, LACMIP 7935, LACMIP loc. 7173, abapertural view, ×2.4. *4, 5,* hypotype, LACMIP 7936, LACMIP loc. 22387, apertural and abapertural views, ×1.7. *6, 7,* hypotype, LACMIP 7937, LACMIP loc. 26456, apertural and abapertural views, ×1.5. *8, 9,* holotype, UCMP 31234, UCMP loc. 3157, apertural and abapertural views, ×1.5. *10, 11,* paratype, UCMP 31235, UCMP loc. 3159, apertural and abapertural views, ×1.1. *12,* hypotype, LACMIP 7938, LACMIP loc. 7044, abapertural view, ×1.3. *13, 14,* hypotype, LACMIP 7939, LACMIP loc. 7044, abapertural and outer lip views, ×1.6.

from UCMP loc. 3159, paratype UCMP 31238 from UCMP loc. 3577.

Type locality.—UCMP loc. 3157, Margaret Hamilton Sand [=division D of Meganos Formation as used by Clark and Woodford (1927)], Deer Valley, Contra Costa County, northern California.

Remarks.—A total of 174 specimens were found in museum collections. Juvenile specimens are very rare, and no specimens were less than about 15 mm high. Adults are common, but gerontic specimens, like paratype UCMP 31325 (Figure 5.10, 5.11) are extremely rare. Preservation is generally good to very good. Specimens from the basal Lodo Formation in the Silver Creek–Panoche Creek intersection, Fresno County, are the most numerous of any locality, but they are badly weathered.

The primary type specimens are not fully representative of the species because they consist of only adults. One of these, paratype UCMP 31235, is 43.9 mm high and is the largest known specimen of any *Brachysphingus.* Other than its large size, it is unusual because of its very low spire and lack of sculpture. Although the primary type specimens are from three different localities, the localities are near each other and along strike of the same stratigraphic interval in the Deer Valley area, Contra Costa County. This stratigraphic interval was referred to as "division D of the Meganos Formation" by Clark and Woodford (1927). Almgren et al. (1988, Figure 4) assigned "division D strata of the Meganos Formation" to the CP9 Zone (lowest Eocene) of the standard calcareous nannoplankton zonation. These strata are now referred to as the Margaret Hamilton Sand (Edmondson, 1984).

The presence of spiral ribbing on much of the body whorl on juveniles (Figures 5.1, 5.2) and the presence of fine incised spiral ribs separating wide and low bands on the shoulder whorl of many adult specimens (Figure 5.3, 5.4) represent new and very useful information about this species.

At LACMIP loc. 7044 in the basal Lodo Formation (Thanetian age) at the junction of Silver and Panoche Creeks, Fresno County, north–central California, there are specimens that are intermediate in morphology between *B. sinuatus* and *B. mammilatus.* Like most adult specimens of *B. sinuatus,* these specimens of *B. mammilatus* have a somewhat elongate shape with a moderately elevated and somewhat concave-profiled spire. These intermediate specimens also have weak axial ribs on the dorsal part of the body whorl. Two representative specimens are illustrated in Figure 5.12–5.14. These intermediate specimens are very important because they establish that *B. mammilatus* evolved from *B. sinuatus.*

Some of the specimens of *B. mammilatus* at LACMIP loc. 7044 are smooth forms. The presence of this species in late Paleocene-age rocks (Thanetian) is new information. Prior to this present report, the species was only known from Eocene-age rocks (e.g., Clark and Woodford; 1927; Givens, 1974).

Some specimens of *B. mammilatus* resemble *B. gibbosus. Brachysphingus mammilatus* differs from *B. gibbosus* by having a concave-appearing upper spire; fine, incised spiral ribs on the body whorl shoulder of adults (except late-stage ones or weathered specimens); and a globose adult body whorl whose maximum diameter is located posteriorly and measured perpendicularly (rather than obliquely for *B. gibbosus*) to the axis of coiling. This latter feature is very useful in identifying poorly preserved specimens of *B. mammilatus* whose spire might be mostly missing or whose surface sculpture has been obliterated.

Occurrence.—Late Paleocene (Thanetian) to early Eocene (Ypresian = "Meganos" and "Capay" "Stages" =*Turritella infragranulata* to T. *andersoni* Zones. Thanetian (*T. infragranulata* Zone): Basal Lodo Formation, junction of Silver and Panoche Creeks, Fresno County (new stratigraphic occurrence, LACMIP loc. 7044). "Meganos" (*T. meganosensis* Zone): "Meganos" Formation, south of Round Valley, Middle Fork of Eel River, Mendocino County (Merriam and Turner, 1937; Clark, 1940); Margaret Hamilton Sand [=division D of Meganos Formation as used by Clark and Woodford (1927)], Deer Valley, Contra Costa County (Clark and Woodford, 1927); uppermost Santa Susana Formation, north side of Simi Valley, Ventura County (new stratigraphic occurrence, CSUN loc. 958). "Capay" (*T. andersoni* Zone): "Capay" Formation, south of Round Valley, Middle Fork of Eel River, Mendocino County (Merriam and Turner, 1937, as *Brachysphingus* very similar to *B. mammilatus*; Clark, 1940, as *Bracysphingus* very similar to *B. mammilatus*); lower Juncal Formation, Sespe Hot Springs, Ventura County (Givens, 1974).

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L. T. Groves (LACMIP), M. Kooser (UCR), D. R. Lindberg (UCMP), and P. Rodda (CASG), allowed access to collections and arranged for material to be loaned. E. Benamy (ANSP) allowed for material to be loaned. M. C. Perriallit (IGM) made high-quality resin replicas of specimens from Baja California, Mexico. L. R. Saul (LACMIP) informed me about the Dip Creek specimens and cleaned them. She also identified many *Turritella* species that were crucial for age control. A. Oleinik (Purdue University) shared his knowledge of neogastropods. The manuscript benefited by reviews of C. R. Givens (Nicholls State University, Lousiana) and L. R. Saul.

REFERENCES

ALLMON, W. D. 1990. Review of the *Bullia* Group (Gastropoda: Nassariidae) with comments on its evolution, biogeography, and phylogeny. Bulletins of American Paleontology, 99, 179 p.

ALMGEN, A. A. 1978. Timing of Tertiary submarine canyons and marine cycles of deposition in the southern Sacramento Valley, California, p. 276–291. *In* D. J. Stanley and G. Kelling (eds.), Sedimentation in Submarine Canyons, Fans and Trenches. Dowden, Hutchinson and Ross, Stroudsberg, Pennsylvania.

——, M. V. FILEWICZ, AND H. L. HEITMAN. 1988. Lower Tertiary foraminiferal and calcareous nannofossil zonation of California: an overview and recommendations, pp. 83–105. *In* M. V. Filewicz and R. L. Squires (eds.), Paleogene Stratigraphy, West Coast of North America. Pacific Section, Society of Economic Paleontologists and Mineralogists, West Coast Paleogene Symposium, Volume 58. Los Angeles, California.

BAILEY, T. L. 1930. The geology of the Potrero Hills and Vacaville region, Solano County, California. University of California Publications Bulletin of the Department of Geological Sciences, 19:321–333.

BERGGREN, W. A., D. V. KENT, C. C. SWISHER, AND M.-P. AUBRY. 1995. A revised Cenozoic geochronology and chronostratigraphy, p. 129–212. *In* W. A. Berggren, D. V. Kent, M.-P. Aubry, and J. Hardenbol (eds.), Geochronology, Time Scales, and Global Stratigraphic Correlation. SEPM (Society for Sedimentary Geology) Special Publication, 54.

BRIART, A., AND F.-L. CORNET. 1871. Description des fossiles du Calcaire Grossier de Mons. Part 1. Gastéropodes. Ordre 1. Prosobranches. Section A. Siphonostomes. Mémoires Couronnés et Mémoires des Savants Étrangers l'Académie Royale des Sciences des Lettres et des Beaux-Arts de Belgique, 36, 76 p.

CERNOHORSKY, W. O. 1984. Systematics of the family Nassariidae (Mollusca: Gastropoda). Bulletin of the Auckland Institute and Museum, 14, 343 p.

CLARK, B. L. 1929. Stratigraphy and Faunal Horizons of the Coast Ranges of California with Illustrations of Index fossils of Tertiary Horizons. Privated published, 30 p.

——, AND A. O. WOODFORD. 1927. The geology and paleontology of the type section of the Meganos Formation (lower middle Eocene) of California. University of California Publications Bulletin of the Department of Geological Sciences, 17:63–142.

CLARK, S. G. 1940. Geology of the Covelo district Mendocino County,

California. University of California Publications Bulletin of the Department of Geological Sciences, 25:119–142.

CONRAD, T. A. 1832. Fossil shells of the Tertiary Formations of North America, Illustrated by Figures Drawn on Stone by T. A. Conrad. 1(2):21–28. [Reprinted by G. D. Harris (1893) and by the Paleontological Research Institution, Ithaca, New York (1963)].

COSSMANN, A. E. M. 1901. Essais de Paléoconchologie Comparée. Volume 4. Published by the author: Paris. 293 p.

——, AND G. PISSARRO. 1904–1913. Iconographie complète des coquilles de l'Éocène des environs de Paris. 2 Volumes Socíété Geologique de la France, Paris.

DESHAYES, G.–P. 1835. *In* J. B. Lamarck, Histoire Naturelle des Animaux sans Vertèbres. 2nd ed., Paris, Volume 1.

DICKERSON, R. E. 1914a. Fauna of the Martinez Eocene of California. University of California Publications Bulletin of the Department of Geology, 8:61–180.

——. 1914b. The Martinez Eocene and associated formations at Rock Creek on the western border of the Mohave Desert area. University of California Publications Bulletin of the Department of Geology, 8: 289–298.

EDMONDSON, W. F. 1984. The Meganos gorge and the geologic effects produced by compaction of the gorge fill, p. 37–51. *In* A. A. Almgren and P. D. Hacker (eds.), Paleogene Submarine Canyons of the Sacramento Valley, California. Pacific Section, American Association of Petroleum Geologists, Symposium Volume 1.

EVANS, J. R., AND R. V. MILLER. 1978. Geology of the southwestern part of the Oat Mountain Quadrangle, Los Angeles County. California Division of Mines and Geology, Map Sheet 33.

FANTOZZI, J. H. 1955. The stratigraphy and biostratigraphy of a portion of the Simi Hills on the south side of the Simi Valley, Ventura County, California. Unpublished M. A. thesis, University of California at Los Angeles, Los Angeles, 68 p.

GABB, W. M. 1864. Description of the Cretaceous fossils, California Geological Survey, Palaeontology, 1:57–243.

——. 1869. Cretaceous and Tertiary fossils. California Geological Survey, Palaeontology, 2:1–299.

GIVENS, C. R. 1974. Eocene molluscan biostratigraphy of the Pine Mountain area, Ventura County, California. University of California Publications in Geological Sciences, 109:1–107.

GROVE, K. 1986. Field trip boat log: depositional environments of Upper Cretaceous and lower Tertiary strata around Lake Nacimiento, central California Coast Ranges, p. 43–59. *In* K. Grove and S. Graham (eds.), Geology of Upper Cretaceous and Lower Tertiary Rocks Near Lake Nacimiento, California. Pacific Section, Society of Economic Paleontologists and Mineralogists, Book Number 49.

HANNA, G. D., AND L. G. HERTLEIN. 1941. Characteristic fossils of California, p. 165–182. *In* O. P. Jenkins (ed.), Geologic Formations and Economic Development of the Oil and Gas Fields of California. Part 2. Geology of California and the Occurrence of Oil and Gas. California Division of Mines Bulletin, 118.

HEITMAN, H. L. 1983. Paleoecological analysis and biostratigraphy of the lower Paleogene Santa Susana Formation, northern Simi Valley, Ventura County, California, p. 33–44. *In* R. L. Squires and M. V. Filewicz (eds.), Cenozoic Geology of the Simi Valley Area, Southern California. Pacific Section, Society of Economic Paleontologists and Mineralogists, Fall Field Trip Volume and Guidebook, Book Number 35.

KEEN, A. M., AND H. BENTSON. 1944. Check list of California Tertiary marine Mollusca. Geological Society of America Special Papers, 56: 1–280.

KEW, W. S. W. 1924. Geology and oil resources of a part of Los Angeles and Ventura Counties, California. U.S. Geological Survey Bulletin, 753:1–202.

KIRBY, M. X. 1991. Macropaleontology and biostratigraphy across the Cretaceous/Tertiary boundary, San Francisquito Formation, Warm Springs Mountain, Los Angeles County, southern California. Unpublished M.S. thesis, California State University, Northridge, 134 p.

KOOSER, M. A. 1980. Stratigraphy and sedimentology of the San Francisquito Formation, Transverse Ranges, California. Unpublished Ph.D. dissertation, University of California, Riverside, 201 p.

——. 1982. Stratigraphy and sedimentology of the type San Francisquito Formation, southern California, p. 53–61. *In* J. C. Crowell and M. H. Link (eds.), Geologic History of Ridge Basin, Southern California. Pacific Section, Society of Economic Paleontologists and Mineralogists, Los Angeles.

MARTYN, T. 1784–1786. The Universal Conchologist. 4 Volumes London.

MERRIAM, C. W., AND F. E. TURNER. 1937. The Capay middle Eocene of northern California. University of California Publications Bulletin of the Department of Geological Sciences, 24:91–114.

MERRIAM, J. C. 1897. The geologic relations of the Martinez group. Journal of Geology, 5:767–775.

NELSON, R. N. 1925. A contribution to the paleontology of the Martinez Eocene of California. University of California Publications Bulletin of the Department of Geological Sciences, 15:397–466.

NESBITT, E. A. 1995. Paleoecological analysis of molluscan assemblages from the middle Eocene Cowlitz Formation, southwestern Washington. Journal of Paleontology, 69:1060–1073.

NUTTALL, C. P., AND J. COOPER. 1973. A review of some English Palaeogene Nassariidae, formerly referred to *Cominella.* Bulletin of the British Museum (Natural History) Geology 23:179–219.

PAREDES-MEJIA, L. M. 1989. Late Cretaceous–Early Cenozoic stratigraphy and paleontology (Mollusca: Gastropoda) of the Sepultura Formation, Mesa San Carlos, Baja California Norte, Mexico. Unpublished M.S. thesis, Purdue University, 527 p.

PARKER, J. D. 1983. Lower Paleocene to lower Eocene, nonmarine to deep-marine strata of the Simi Hills, Ventura County, California, p. 3–22. *In* R. L. Squires and M. V. Filewicz (eds.), Cenozoic Geology of the Simi Valley Area, Southern California. Pacific Section, Society of Economic Paleontologists and Mineralogists, Fall Field Trip Volume and Guidebook, Book Number 35.

PONDER, W. F. 1973. The origin and evolution of the Neogastropoda. Malacologia, 12:295–338.

——, AND A. WARÉN. 1988. Classification of the Caenogastropoda and Heterostropha—a list of the family-group names and higher taxa. Malacological Review, 1988, supplement 4:288–326.

RAFINESQUE, C. S. 1815. Analyse de la nature, ou tableau de l'univers et des corps organisées. Palermo, 224 p.

SAUL, L. R. 1983a. *Turritella* zonation across the Cretaceous–Tertiary boundary, California. University of California Publications Geological Sciences, 125:1–165.

——. 1983b. Notes on Paleogene turritellas, venericardias, and molluscan stages of the Simi Valley area, California, p. 71-80. *In* R. L. Squires and M. V. Filewicz (eds.), Cenozoic Geology of the Simi Valley Area, Southern California. Pacific Section, Society of Economic Paleontologists and Mineralogists, Fall Field Trip Volume and Guidebook, Book Number 35.

——. 1986. Mollusks of latest Cretaceous and Paleocene age, Lake Nacimiento, California, p. 25–31. *In* K. Grove and S. Graham (eds.), Geology of Upper Cretaceous and Lower Tertiary Rocks Near Lake Nacimiento, California. Pacific Section, Society of Economic Paleontologists and Mineralogists. Los Angeles.

SCHENCK, H. G., AND A. M. KEEN. 1940. California Fossils for the Field Geologist. Preliminary edition. Stanford University: Stanford, California. 86 p.

SCHOELLHAMER, J. E., J. G. VEDDER, R. F. YERKES, AND D. M. KINNEY. 1981. Geology of the northern Santa Ana Mountains, California. U.S. Geological Survey Professional Paper, 420-D:1–109.

SCHULER, M., AND SEVEN OTHERS. 1992. The Paleogene of the Paris and Belgian Basins. Standard-stages and regional stratotypes. Cahiers de Micropaléontologie, Nouvelle Série, 7:29–92.

SMITH, J. T. 1975. Age, correlation, and possible Tethyan affinities of mollusks from the Lodo Formation of Fresno County, California, p. 464–483. *In* D. W. Weaver, G. R. Hornaday and A. Tipton (eds.), Future Energy Horizons of the Pacific Coast. Paleogene Symposium and Selected Technical Papers. Pacific Sections, American Assocation of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, and Society of Exporation Geologists. Annual Meeting.

SQUIRES, R. L. 1988. Geologic age refinement of west coast Eocene marine mollusks, p. 107–112. *In* M. V. Filewicz and R. L. Squires (eds.), Paleogene Stratigraphy, West Coast of North America. Pacific Section, Society of Economic Paleontologists and Mineralogists, West Coast Paleogene Symposium, Volume 58.

——. 1989. A new pseudolivine gastropod genus from the lower Tertiary of North America. Journal of Paleontology, 63:38–47.

——, AND L. R. SAUL. 1993. A new species of *Otostoma* (Gastropoda:

Neritidae) from near the Cretaceous/Tertiary boundary at Dip Creek, Lake Nacimiento, California. The Veliger, 36:259–264.
STANTON, T. W. 1896. The faunal relations of the Eocene and Upper Cretaceous on the Pacific coast. U.S. Geological Survey Annual Report, 17:1005–1060.
STEWART, R. B. 1927. Gabb's California fossil type gastropods. Proceedings of the Academy of Natural Sciences of Philadelphia, 57: 287–447.
STOLCIZKA, F. 1868. The Gastropoda of the Cretaceous rocks of southern India. Memoirs of the Geological Survey of India, Palaeontologis Indica, Series 5, 2:1–498.
TRYON, G. W., JR. 1881. Manual of Conchology, Structural and Systematic, with Illustrations of the Species. Series 1., Volume 3. Philadelphia.
——. 1883. Structural and Systematic Conchology: an Introduction to the Study of the Mollusca. Volume 2. Published by the author: Philadelphia. 430 p.
WARING, C. A. 1917. Stratigraphic and faunal relations of the Martinez to the Chico and Tejon of southern California. Proceedings of the California Academy of Sciences, 4th series, 7:41–124.
——, AND R. P. MCLAUGHLIN. 1914. Fossils characteristic of California formations. Pl. 1 in map folio (oversized) accompanying Petroleum Industry of California. California State Mining Bureau Bulletin, 69.
WEAVER, C. E. 1912. A preliminary report on the Tertiary paleontology of western Washington. Washington Geological Survey Bulletin, 15:1–80.
——. 1942. Paleontology of the marine Tertiary formations of Oregon and Washington. University of Washington Publications in Geology, 5(1–3):1–789.
——. 1953. Eocene and Paleocene deposits at Martinez, California. University of Washington Publications in Geology, 7:1–102.
WENZ, W. 1943. Familia Nassariidae, Pp. 1224–1240. *In* O. H. Schindewolf (ed.), Handbuch der Paläozoologie, Band 6, Prosobanchia, Teil 5. Gebruuder Borntraeger: Berlin [reprinted 1960–1961].
ZINSMEISTER, W. J. 1983. Late Paleocene ("Martinez Provincial Stage") molluscan fauna from the Simi Hills, Ventura County, California, p. 61–70. *In* R. L. Squires and M. V. Filewicz (eds.), Cenozoic Geology of the Simi Valley Area, Southern California. Pacific Section, Society of Economic Paleontologists and Mineralogists, Fall Field Trip Volume and Guidebook, Book Number 35.
——, AND L. M. PAREDES-MEJIA. 1988. Paleocene biogeography of the west coast of North America: a look at the molluscan fauna from Sepultura Formation, Mesa San Carlos, Baja California Norte, p. 9–22. *In* M. V. Filewicz and R. L. Squires (eds.), Paleogene Stratigraphy, West Coast of North America. Pacific Section, Society of Economic Paleontologists and Mineralogists, West Coast Paleogene Symposium, Book Number 58.

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LOCALITIES CITED

All quadrangles are U.S. Geological Survey quadrangles, and unless otherwise noted, are 7.5-minute.

CASG

2296. From cut along "Santa Fe" Railway where it cuts the north part of Vine Hill, 5.6 km (3.5 mi.) S76°E of the mouth of Arroyo del Hombre, Vine Hill Quadrangle, 1959 (photorevised 1980), Contra Costa County, northern California. Collected by H. G. Schenck, October 19, 1929. Middle Vine Hill Sandstone; Selandian (*Turritella infragranulata pachecoensis* Zone).

2692. In siltstone on west side of Temescal Canyon, 4,862 m (15,950 ft.) south and 3,962 m (13,000 ft.) west of northeast corner of Topanga Quadrangle, 1952 (photorevised 1967), east-central Santa Monica Mountains, Los Angeles County, southern California. Collected by R. R. Compton, Dec., 1941. Santa Susana Formation; Thanetian.

2693. In siltstone overyling coralline-algal limestone in Quarry Canyon, 4,145 m (13,600 ft.) south and 5,456 m (17,900 ft.) west of northeast corner of Topanga Quadrangle, 1952 (photorevised 1967), east-central Santa Monica Mountains, Los Angeles County, southern California. Collected by R. R. Compton, Dec., 1941. Santa Susana Formation; Thanetian.

CSUN

123c. At elevation of 381 m (1,250 ft.) on west side of Meier Canyon, 358 m (1175 ft.) south and 3,103 m (10,180 ft.) east of the northwest corner of Calabasas Quadrangle, 1952 (photorevised 1967), south side of Simi Valley, Ventura County, southern California. Collected by R. L. Squires, May 25, 1996. Float derived from lower Santa Susana Formation, "Martinez marine member," Selandian (*Turritella peninsularis* Zone).

354. On the east bank of the south fork of Garapito Creek, 518 m (1,700 ft.) S20°E from the intersection of the San Bernardino base line and Los Angeles City boundary, Topanga Quadrangle, 1952 (photorevised 1967), east of Sylvia Park, Santa Monica Mountains, Los Angeles County, southern California. Collected by R. L. Squires, 1978. Upper Santa Susana Formation; Thanetian.

958. On edge of valley floor [now filled], 381 m (1250 ft.) S and 107 m (350 ft.) east of section 5, T2N, R17, Santa Susana Quadrangle, 1951 (photorevised 1969), north side of Simi Valley, Ventura County, southern California. Collected by R. L. Squires, 1989. Uppermost part of Santa Susana Formation; "Meganos."

LACMIP

7044. Road cut on east bank of Silver Creek 0.4 km (0.25 mi.) south of its junction with Panoche Creek, SE ¼ of section 20, T15S, R12E, Tumey Hills Quadrangle, 1956 (photorevised 1971), west side of San Joaquin Valley, Fresno County, north-central California. Collected by C. E. Weaver, 1949. Basal Lodo Formation; Thanetian. [Same as Stanford University (LSJU) loc. 2073 (collections now housed at CASG) and same as UCMP locs. A-1284, A-8394, A-4657, A-9717].

7047. A thin but richly fossiliferous layer of limonite-stained white sandstone, 0.9 km (0.75 mi.) east of Lower Lake, 366 m (1,200 ft.) south from bridge over Copsey Creek, in gully on W side of creek, SE ¼ of NE ¼ of section 11, T12N, R7W, Lower Lake Quadrangle, 1975, Lake County, northern California. Collected by D. W. Scharf and W. P. Popenoe, August 26, 1930. Martinez Formation; latest Danian or earliest Selandian.

7051. Same as LACMIP loc. 7047. Collected by W. P. Popenoe, May, 12, 1944.

7062. On top of ridge on west side of Temescal Canyon at edge of fire road, 2,743 m (9,000 ft.) N30°W of Pacific Palisades/Assembly Park, Topanga Canyon Quadrangle, 1952 (photorevised 1967), east-central Santa Monica Mountains, Los Angeles County, southern California. Collected by H. D. B. Wilson, June, 1941. Upper Santa Susana Formation; Thanetian.

7079. Concretionary sandstone outcop on hilltop N50°E and 4.4 km (2.75 mi.) from Bench Mark 610, Black Star Canyon Quadrangle, 1949, north of Irvine Lake, Santa Ana Mountains, Orange County, southern California. Collected by B. N. Moore, September, 1929. Silverado Formation; Selandian (*Turritella infragranulta pachecoensis* Zone).

7142. Fossiliferous boulder in conglomerate bed along ridge, 785 m (2575 ft.) south and 305 m (1,000 ft.) west of northeast corner of section 5, T2N, R17W, Santa Susana Quadrangle, 1951 (photorevised 1969), north side of Simi Valley, Ventura County, southern California. Collected by A. Clark and L. Hookway, June 17, 1929. Reworked [Selandian (undifferentiated)] fossils in Santa Susana Formation.

7173. From crest of first ridge north of Deer Valley at a point about 0.3 km (0.2 mi.) west of the main Deer Valley-Horse Valley road, NW ¼ of section 20, T1N, R2E, Antioch South Quadrangle, 1980, Contra Costa County, northern California. Collected by D. W. Scharf and W. P. Popenoe, August, 1930. Meganos Formation; "Meganos."

11980. Spheroidally weathering siltstone and fine sandstone in canyon botton (now filled) about 250 m (820 ft.) N88°W of hill 1672, near head of Pulga Canyon, northwest side of Pulga Canyon about at northeast tip of second "E" in "FIREBREAK," Topanga Quadrangle, 1952 (photorevised 1067), east-central Santa Monica Mountains, Los Angeles County, southern California. Collected by J. Alderson, October, 1988. Upper Santa Susana Formation; Thanetian.

20343. On a ridge just W of Stone Canyon Reservoir, Beverly Hills Quadrangle, 1966 (photorevised 1981, minor revision 1994), eastern Santa Monica Mountains, Los Angeles County, southern California. Collected by Bryson and Curry, 1933. Santa Susana Formation; Selandian (*Turritella infragranulata pachecoensis* Zone).

20894. In tributary canyon of Big Rock Creek, approximately 244 m

(800 ft.) SW of center of SW ¼ of section 16, T4N, R9W, Valyermo Quadrangle, 1958, north side of San Gabriel Mountains, Los Angeles County, southern California. San Francisquito Formation; Selandian (*Turritella peninsularis* Zone).

21579A. South of East Fork Fish Canyon, Warm Springs Mountain Quadrangle, 1958 (photorevised 1974), Los Angeles County, southern California. Collected by R. W. Webb and E. H. Quayle, 1941. San Francisquito Formation; late Danian.

21581. Black nodular shale and conglomerate on road 1.78 km (1.1 mi) E from Cienaga Camp on northwest side of ravine, north side of East Fork Fish Canyon, approximately 625 m (2050 ft.) north and 229 m (750 ft.) east of BM 2205, T6N, R16W, Warm Springs Mountain Quadrangle, 7.5-minute, 1958 (photorevised 1974), Los Angeles County, southern California. Collected by R. W. Webb and E. H. Quayle, June 23–24, 1941. San Francisquito Formation; late Danian.

22330. Beds cropping out on nose of spur on west side of Meier Canyon, approximately 183 m (600 ft.) north of second "n" in Meier Canyon, Calabasas Quadrangle, 1952 (photorevised 1967), south side of Simi Valley, Simi Hills, Ventura County, southern California. Collected by W. P. Popenoe, April 3, 1946. Lower Santa Susana Formation, "Martinez marine member," Selandian (*Turritella peninsularis* Zone).

22374. On west side of low ridge 290 m (950 ft.) S and 2,423 m (7950 ft.) east of northwest corner of Calabasas Quadrangle, 1952 (photorevised 1967), south side of Simi Valley, Simi Hills, Ventura County, southern California. Collected by W. P. Popenoe, April 3, 1946. Middle Santa Susana Formation, in strata stratigraphically above "Martinez marine member," Selandian (*Turritella peninsularis* Zone).

22387. On low ridge 579 m (1,900 ft.) south and 1463 m (4,800 ft.) east of northwest corner of sec. 28, T1N, R2E, Antioch South Quadrangle, 1980, Contra Costa County, northern California. Collected by W. P. Popenoe, April 13, 1947. Meganos Formation; "Meganos."

22701. On long ridge immediately west of summit of Simi Hills (=hill 2160), Calabasas Quadrangle, 1952 (photorevised 1967), Ventura County, southern California. Collected by J. H. Fantozzi, June, 1951. Lower Santa Susana Formation, "Martinez marine member," Selandian (*Turritella peninsularis* Zone).

22702. In saddle at elevation of 602 m (1,975 ft.), 229 m (750 ft.) S13°E of summit of Simi Hills (=hill 2160), Calabasas Quadrangle, 1952 (photorevised 1967), Ventura County, southern California. Collected by J. H Fantozzi, June, 1951. Lower Santa Susana Formation "Martinez marine member," Selandian (*Turritella peninsularis* Zone).

23110. Silty sandstone at elevation 625 m (2,050 ft.), 3406 m (11,175 ft.) south and 914 m (3,000 ft.) east of northwest corner of Calabasas Quadrangle, 1952 (photorevised 1967), Ventura County, southern California. Collected by J. H Fantozzi, July, 1953. Lower Santa Susana Formation "Martinez marine member," Selandian (*Turritella peninsularis* Zone).

25281. Sandstone at elevation of 305 m (1,000 ft.), about 122 m (400 ft.) south and 305 m (1,000 ft.) west of northeast corner of section 5, T1S, R17W, Malibu Beach Quadrangle, 1950 (photorevised 1967), on west side of northern tributary to Stokes Canyon, western Santa Monica Mountains, Ventura County, southern California. Collected by J. Stark and T. Susuki, May 21, 1965. Reworked [Selandian (undifferentiated)] fossils in middle Miocene Calabasas Formation, Stokes Canyon Breccia Member.

26364. At elevation of 186 m (610 ft.), about 5.6 km (4 mi.) south of Santa Catarina Landing near top of pass through mesas; top of basalt mesa is about 46 m (150 ft.) above locality, northern Baja California, Mexico. Collected by G. Weir and H. Stager, January, 1949. Sepultura Formation; Selandian (*Turritella peninsularis* Zone).

26456. Slope on abrupt hill on S side of road, south side of Panoche Creek, about 1.2 km (0.75 mi) E of Silver Creek, 1052 m (3,450 ft.) south and 152 m (500 ft.) east of northwest corner of section 21, T15S, R12E, Tumey Hills Quadrangle, 1956 (photorevised 1971), west side of San Joaquin Valley, Fresno County, north-central California. Collected by L. R. Saul, June 10, 1977. Lodo Formation; Selandian (*Turritella infragranulata pachecoensis* Zone).

26525. About 232 m (760 ft.) elevation, poorly sorted conglomeratic sandstone exposed on east side of Dip Creek, south side of Lake Nacimiento, 427 m (1,400 ft.) S and 61 m (200 ft) west of northeast corner of section 30, T25S, R10E, U.S. Geological Survey Lime Mountain Quadrangle, 7.5-minute, 1948, San Luis Obispo County, central California. Collectors: R. B. Saul and L. R. Saul, December 31, 1977. Unnamed strata. Age: Maastrichtian (*Turritella peninsularis adelaidana* Zone) or possibly earliest Danian (*Turritella peninsularis qualeyi* Zone).

26526. About 226 m (740 ft.) elevation, poorly sorted conglomeratic sandstone exposed on east side of Dip Creek, south side of Lake Nacimiento, 457 m (1,500 ft.) south and 122 m (400 ft.) west of northeast corner of section 30, T25S, R10E, U.S. Geological Survey Lime Mountains Quadrangle, 1948, San Luis Obispo County, central California. Collectors: R. B. Saul and L. R. Saul, December 31, 1977. Unnamed strata. Age: Maastrichtian (*Turritella peninsularis adelaidana* Zone) or possibly earliest Danian (*Turritella peninsularis qualeyi* Zone).

26583. Near the 320 m (1,050 ft.) contour on east side of the southwest arm of the Encino Reservoir, approximately 549 m (1,800 ft.) S60°E of the intake tower, Canoga Park Quadrangle, 1952 (photorevised 1967), Santa Monica Mountains, Los Angeles County, southern California. Collected by T. Susuki, March 6, 1961. Santa Susana Formation; Selandian (*Turritella infragranulata pachecoensis* Zone).

26897. Float in gully on west side of Temescal Canyon opposite second "e" of Temescal at about 450 m (1,475 ft.) elevation, approximately 1082 m (3,550 ft.) S and 533 m (1,750 ft.) east of hill 2036, Topanga Quadrangle, 1952 (photorevised 1967), east-central Santa Monica Mountains, Los Angeles County, southern California. Collected by J. Alderson, March 9, 1980. Santa Susana Formation; Thanetian.

UCMP

3157. On ridge top on north side of Deer Valley, 792 m (2,600 ft.) S and 411 m (1,350 ft.) west of NE corner of section 20, T1N, R2E, Antioch South Quadrangle, 1980, Contra Costa County, northern California. Collected by B. L. Clark and A. O. Woodford, circa 1923. Margaret Hamilton Sand [=division D of Meganos Formation as used by Clark and Woodford (1927)]; "Meganos."

3159. On same ridge top as UCMP loc. 3157, 1036 m (3,400 ft.) south and 46 m (150 ft.) west of northeast corner of section 20, T1N, R2E, Antioch South Quadrangle, 1980, Contra Costa County, northern California. Collected by B. L. Clark and A. O. Woodford, circa 1923. Margaret Hamilton Sand [=division D of Meganos Formation as used by Clark and Woodford (1927)]; "Meganos."

3577. On ridge top 3399 m (11,150 ft.) north and 610 m (2,000 ft.) east of southwest corner of Brentwood Quadrangle, 1978, Contra Costa County, northern California. Collected by B. L. Clark and A. O. Woodford, circa 1923. Margaret Hamilton Sand [=division D of Meganos Formation as used by Clark and Woodford (1927)]; Meganos Formation; "Meganos."

3768. Elevation of 402 m (1,320 ft.), just south of minor saddle on ridge, NW ¼ of the NW ¼ of section 24, T2N, R18W, and 2,987 m (9,800 ft.) N14°E of hill 2150 in Simi Hills, east of Meier Canyon, Calabasas Quadrangle, 1952 (photorevised 1967), south side of Simi Valley, Ventura County, southern California. Middle Santa Susana Formation; Selandian (*Turritella infragranulata pachecoensis* Zone).

3776. At bottom of "e" in "Runkle," east side of Runkle Canyon at mouth of small tributary, south side of Simi Valley, Calabasas Quadrangle, 1952 (photorevised 1967), south side of Simi Valley, Ventura County, southern California. Collected by R. N. Nelson, circa early 1920's. Lower Santa Susana Formation, "Martinez marine member," Selandian (*Turritella peninsularis* Zone).

3810. Elevation at 518 m (1,700 ft.), at western end of ridge at point where it narrows down and starts to slope abruptly into canyon, SE ¼ of the SE ¼ of section 28, T2N, R18W, and 792 m (2,600 ft.) S86°E of hill 1926 in Simi Hills, east side of Bus Canyon, Thousand Oaks Quadrangle, 1950 (photorevised 1967), south side of Simi Valley, Ventura County, southern California. Lower Santa Susana Formation; Selandian (*Turritella peninsularis* Zone).

A-1523. Same as LACMIP loc. 7047. Collected by B. L. Clark, 1935.

UWBM

1394. From cut along Santa Fe Railway, 762 m (2,500 ft.) N63°E from overpass at intersection of Pacheco Road and Santa Fe Railway, Vine Hill Quadrangle, 1959 (photorevised 1980), west side of Pacheco Creek, Contra Costa County, northern California. Collected by C. E. Weaver, circa 1950. Lower Vine Hill Sandstone; Selandian (*Turritella peninsularis* Zone).