

NEW PALEOGENE *FIMBRIA* (MOLLUSCA: BIVALVIA) FROM THE PACIFIC COAST OF SOUTHWESTERN NORTH AMERICA

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ABSTRACT—The marine bivalve *Fimbria susanensis* n. sp. is reported from the uppermost Paleocene part of the “Meganos Stage” in the upper Santa Susana Formation, Simi Hills, southern California.

Fimbria pacifica n. sp. is reported from the middle lower Eocene “Capay Stage” strata of the Pacific coast of southwestern North America. The new species is present in the lower Bateque Formation, Baja California Sur, Mexico, and in the lower Juncal Formation, Whitaker Peak area and Santa Ynez Mountains, southern California.

Fimbria susanensis n. sp. and *F. pacifica* n. sp. are the only fimbriids known from the Pacific coast of North America. Previously reported Pacific coast species, which gave a range of Late Cretaceous to late Eocene for this genus in this particular area, do not belong to *Fimbria*.

INTRODUCTION

F*FIMBRIA* ORIGINATED during the earliest Jurassic (Hettlingian Stage) in east Asia (Hallam, 1977) and became widespread in warm oceans thereafter until late Tertiary time when its geographic range slowly contracted. Today, only two species remain. They are in the Indo-Pacific area and have a close association with a reef-coral habitat (Nicol, 1950).

Fimbria, a warm-water bivalve with Old World-Tethyan affinities, did not reach the Pacific coast of western North America until the latest Paleocene. Like many other Old World-Tethyan affinity mollusks, its route of migration was most likely by way of Central America (Squires, 1987). Its arrival approximately coincided with the warmest time of the Cenozoic (Frakes, 1979; Haq, 1981). *Fimbria* did not remain there past the late early Eocene. The Pacific coast geologic range for this genus is based on the stratigraphic distribution of *Fimbria susanensis* n. sp. and *F. pacifica* n. sp. reported in this paper. Previously reported species of *Fimbria* from Upper Cretaceous, middle Eocene, and upper Eocene strata of the Pacific coast of North America are herein reported as not belonging in this genus.

Abbreviations used for catalog and/or locality numbers are: CAS, California Academy of Sciences, San Francisco; CSUN, California State University, Northridge; IGM, Instituto de Geología, Universidad, Nacional Autónoma Museum de México; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; UCLA, University of California, Los Angeles (collections now housed at LACMIP); UCMP, University of California Museum of Paleontology, Berkeley.

STRATIGRAPHIC OCCURRENCES AND GEOLOGIC AGES

Fimbria susanensis n. sp. was found in the upper part of the Santa Susana Formation, south side of Simi Valley, Ventura County, southern California (Figure 1), at localities UCMP 7009, CSUN 1342, and UCMP 3792. Early workers recognized that the upper part of the Santa Susana Formation in Simi Valley contains a distinctive marine molluscan fauna that belongs to the “Meganos Stage” (Clark, 1918, 1921; Nelson, 1925; Merriam, 1941). Although the “Meganos Stage” strata were mostly mismapped by early workers, “Meganos Stage” mollusks are now known to be in the upper 100 m of the Santa Susana Formation (Saul, 1983). Recent field work by the author corroborates Saul’s (1983) work and further delineates the presence of these mollusks to the upper 100 m of the Santa Susana Formation east of the Runkle Canyon fault. This fault, which is in the central part of the south side of Simi Valley (Squires, 1983), juxtaposes different facies of the formation (Parker, 1983). No

macrofossils were found in the upper part of the formation west of the fault. Localities UCMP 7009, CSUN 1342, and UCMP 3792 are all east of the fault.

Saul (1983) showed the lower part of the “Meganos Stage” in Simi Valley to be assignable to the CP8 Zone (late Paleocene) and the upper part to be assignable to the CP9 Zone (early Eocene). Although 15 microfossil samples were collected from throughout the upper 100 m of the Santa Susana Formation in the course of this present study, only three samples (all in the vicinity of locality CSUN 1342) yielded any calcareous nannofossils. They contained CP8 Zone (late Paleocene) species. The other samples, which came from higher in the Santa Susana Formation, were barren of calcareous nannofossils.

Only a single specimen of *F. susanensis* n. sp. was found at locality UCMP 7009. The exact location of this locality is unknown, but it is approximately 200 m stratigraphically below the bottom of the nonmarine basal conglomerate of the Llajas Formation, which disconformably overlies the Santa Susana Formation. This thickness was measured by orthographic means using the geologic map of Squires (1983) for control. At this locality, the gastropod *Velates californicus* Vokes, 1935, has also been reported (Vokes, 1935). Woods and Saul (1986) reviewed the stratigraphic occurrence of *V. californicus* on the south side of Simi Valley, and they reported that in this area the species is probably of late Thanetian (late Paleocene) age.

Locality UCMP 7009 is about 100 m below the “Meganos Stage” strata and about 90 m above the stratigraphically highest localities at which Zinsmeister (1974, Pl. 5b) found “Martinez Stage” mollusks in the lower part of the Santa Susana Formation along the west side of Meier Canyon. Saul (1983) showed the upper part of the “Martinez Stage” to be equivalent to the upper Paleocene Thanetian Stage. Locality 7009, therefore, can be assigned to the Thanetian Stage (late Paleocene) but whether the locality is in the “Martinez Stage” or the “Meganos Stage” part of the late Paleocene cannot be determined. A “Meganos Stage” position for this locality, however, is favored because Zinsmeister (personal commun.) has only found *Velates californicus*, a species associated with *Fimbria susanensis* n. sp., above typical “Martinez Stage” assemblages.

Five specimens of *F. susanensis* n. sp. were found in the upper part of the Santa Susana Formation, south side of Simi Valley, at locality CSUN 1342 (=locality UCMP 3791). This locality is 90 m stratigraphically below the bottom of the overlying Llajas Formation. This thickness was measured by means of a Jacob staff and Brunton compass. The specimens were found in a well-cemented lens of gray, very fine-grained sandstone that has a gradational lithology from the immediately underlying

gray mudstone. Most of the specimens are poorly preserved and consist of unabraded fragments. Important associated fossils include the colonial coral *Astrocoenia?* and a large internal mold of the gastropod *Velates californicus?*

The fossiliferous lens at locality 1342 is interpreted to represent a storm deposit in a middle to outer shelf environment, in the sense used by Bottjer and Jablonski (1988). The distance of transport was not great for some of the specimens.

Microfossil samples collected by the author from 6 m below and 2 m above locality 1342 yielded rare and poorly preserved calcareous nannofossils suggestive of the late Paleocene *Discoaster multiradiatus* (CP8) Zone of Okada and Bukry (1980) (M. V. Filewicz, personal commun.).

An additional specimen of *F. susanensis* was obtained from the UCMP collection of Santa Susana Formation macrofossils. The specimen (paratype, UCMP 38569) is from locality UCMP 3792, which is the type locality of the gastropod *Velates californicus*. Also at this locality are moderately large complete internal molds of the bivalve *Miltha?*. This locality, which is mistakenly shown as locality UCMP 3732 by Nelson (1925, Pl. 61), is just upsection and in the immediate vicinity of locality CSUN 1342. Attempts by the author to find locality UCMP 3792 were unsuccessful because the locality is now covered by slope wash.

Fimbria pacifica n. sp. is more widespread than *F. susanensis* n. sp. Four specimens of *F. pacifica* were found between 96 and 145 m above the bottom of a measured section of the Bateque Formation, Baja California Sur, Mexico (Figure 1), at locality CSUN 1220b. The geologic details of this locality and immediate vicinity have been described in Squires and Demetron (1989, 1990). The locality is in very fine-grained sandstone interbedded with fossiliferous lenses containing slightly transported shallow-marine stromatolites, coralline algae, miliolid and discocyclinid foraminifers, pharetronid sponges (Squires and Demetron, 1989), colonial corals, branching cheilostome bryozoans, thick-shelled gastropods and bivalves, spatangoids, and sea-urchin spines. Colonial corals and the gastropod *Velates perversus* are particularly abundant. The strata are middle early Eocene ("Capay Stage") in age (Squires and Demetron, 1990).

One specimen of *Fimbria pacifica* n. sp. was found in the lower part of the Juncal Formation, Whitaker Peak area, Los Angeles County, southern California (Figure 1), at locality CSUN 830. The geologic details of this locality have been described in Squires (1987). The locality is one of many channel-lag storm accumulations of slightly transported fossils in transition-zone siltstone that formed in shelf-like depths. Important associated fossils at this locality are *Velates perversus* and *Miltha packi*. This part of the Juncal Formation is middle early Eocene ("Capay Stage") in age (Squires, 1987).

Ten specimens of *Fimbria pacifica* n. sp. were found in an unnamed unit, Agua Caliente Canyon, central Santa Ynez Mountains, Santa Barbara County, southern California (Figure 1), at three closely spaced localities (UCLA 6593, 7192, and 7193). These localities plot on Dibblee's (1966, 1986) geologic maps in his "unnamed" strata of Late Cretaceous age. No detailed geologic work has been done on these particular strata. The localities are in fossiliferous lenses in silty sandstone. Fossils are molds and casts and, except for one complete specimen of *Fimbria*, are fragmental. Important associated fossils are *Pycnodonte* (*Phygraea*) sp. and *Spondylus* sp. Based on the presence of specimens of *Fimbria pacifica* n. sp., which is found elsewhere only in middle lower Eocene ("Capay Stage") strata, these localities are assigned to the middle lower Eocene. These *Fimbria*-bearing strata should be mapped as the basal part of the Juncal Formation or, possibly, as the Sierra Blanca Limestone, which directly underlies the Juncal Formation in this region.

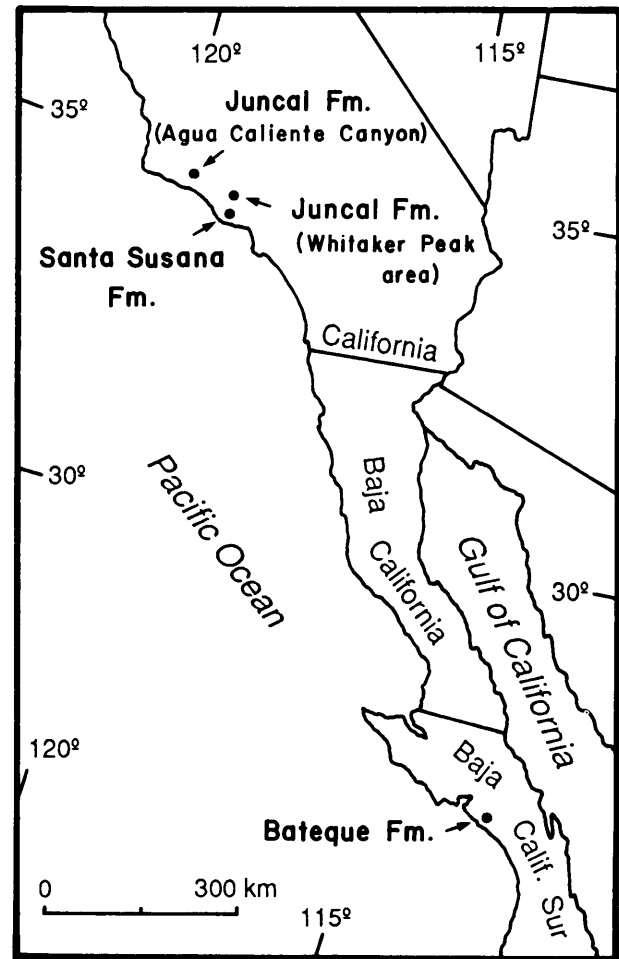


FIGURE 1—Stratigraphic occurrences of the new Paleogene fimbriids from the Pacific coast of southwestern North America.

SPECIES PREVIOUSLY ASSIGNED TO,
BUT NOT BELONGING TO, *FIMBRIA*

- Corbis peninsularis* Anderson and Hanna (1935, p. 31, Pl. 10, fig. 1). Upper Cretaceous, midway between Ensenada and San Quintin, Baja California, Mexico. Work in progress by Saul (personal commun.) shows that this species, which has an ovate shape and no radial ribs, belongs in genus *Calva*.
- Fimbria* n. sp. Dawson (1978, p. 54–55, Pl. 1, figs. 15–17). Upper Cretaceous, Cabrillo Formation, Point Loma, San Diego, San Diego County, southern California. The elongate shell, very fine cancellate ornamentation, and dentition are similar to the tellinid *Palaeomoera dyskritos* Dailey and Popenoe (1966, p. 18–19, Pl. 5, figs. 1, 2, 5) from the Upper Cretaceous Jalama Formation, Santa Barbara County, southern California.
- Corbis mclellani* Hanna (1927, p. 283–284, Pl. 37, figs. 3–6). Middle Eocene, lower La Jolla Group, San Diego County, southern California. The very small size, subtriangular shape, concave anterior dorsal margin, widely spaced commarginal ribs with very closely spaced radial striae, and dentition are characteristic of the cardiniid *Tellidorella*. *Tellidorella interlacina* Dockery (1982, p. 69, Pl. 20, figs. 9–10), from the lower Oligocene of Mississippi, is strikingly similar to Hanna's species.
- Corbis washingtoniana* Clark (1925, p. 90, Pl. 20, figs. 1–4, Pl. 21, figs. 1, 2; Weaver, 1943, p. 152–153, Pl. 37, figs. 1–3; Durham, 1944, p. 144). Upper Eocene, Marrowstone Shale,

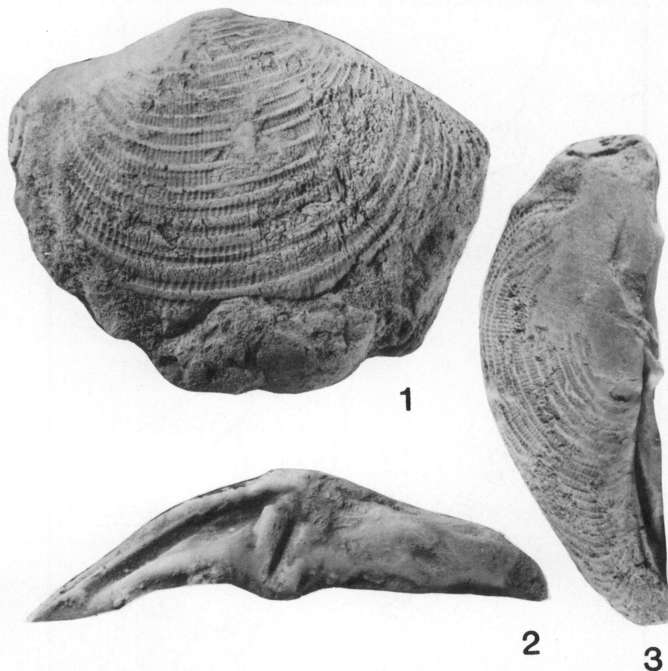


FIGURE 2—1-3, *Fimbria susanensis* n. sp., holotype, UCMP 38568, locality UCMP 7009, left valve, exterior, interior, and dorsal views, $\times 1.2$.

Killisut Harbor, Quimper Peninsula, Jefferson County, Washington. The dentition, strong posterior truncation, closely spaced commarginal ribs, and lack of radial ribs are characteristic of the lucinid *Codakia* (*Epilucina*). The formation in which this bivalve is present was determined by Durham (1944), and the most currently reported geologic age of it is given in Armentrout et al. (1983). In an attempt to confirm the stratigraphic position of this bivalve, the type locality was recollected during the course of this present investigation. One additional specimen was found.

SYSTEMATIC PALEONTOLOGY

Family FIMBRIIDAE Nicol, 1950

Genus FIMBRIA Megerle von Mühlfeld, 1811

Type species.—By original designation, *Fimbria magna* Megerle von Mühlfeld, 1811 [= *Venus fimbriata* Linné, 1758].

FIMBRIA SUSANENSIS n. sp.

Figure 2.1-2.3

Diagnosis.—A *Fimbria* with strong cardinal teeth, strong commarginal ribs that become broader ventrally, very closely spaced radial riblets.

Description.—Medium to large size, shell height up to 75 mm, transversely elliptical, thick, subequilateral, prosogyrate, well-defined lunule, narrow escutcheon, ligamental area external but sunken, left-valve hinge plate wide with protruding nymph area, left-valve hinge with two cardinals, posterior one larger, anterior lateral area worn but apparently fairly strong, posterior lateral area missing; exterior with cancellate sculpture, commarginal ribs much stronger than the very closely spaced (3 to 4 per mm) radial riblets; commarginal ribs become broader and more irregularly spaced ventrally.

Remarks.—Nicol (1950) explained the International Com-

mission of Zoological Nomenclature decision that allowed substitution of the generic name *Fimbria* for the name *Corbis*.

Paratype UCMP 38569 of *Fimbria susanensis* n. sp. is a large (height 79 mm, length 95 mm) articulated specimen, but it is very poorly preserved. The exterior has been badly weathered.

Fimbria susanensis n. sp. is most like *F. subpectunculus* (d'Orbigny, 1850, p. 387; Deshayes, 1824-1837, Pl. 13, figs. 5, 6; Cossmann and Pissarro, 1904-1906, Pl. 22, fig. 78-4) from middle Eocene (Lutetian Stage) strata, Paris Basin, France. A comparison between *F. susanensis* and three specimens of *F. subpectunculus* from the UCMP Cloez collection of Paris Basin Paleogene mollusks revealed that *F. susanensis* differs in the following features: radial riblets same strength everywhere and finer, lunule area much better defined, and posterior cardinal in left valve stronger and more elongate.

Fimbria susanensis n. sp. differs from *F. pacifica* n. sp. in the following features: commarginal ribs broader ventrally, radial riblets more closely spaced, nymph area protrudes, cardinal teeth and anterior lateral tooth much stronger.

Fimbria susanensis n. sp. is the earliest occurrence of *Fimbria* from North America. Other than *Fimbria pacifica* n. sp., the only other species of *Fimbria* known from North America are four species from upper middle and upper Eocene strata in the southeastern United States (Palmer and Brann, 1965, p. 90-91, 143-144).

Etymology.—The specific name is for the Santa Susana Formation.

Material.—Seven specimens.

Occurrence.—Pacific coast uppermost Paleocene part of the "Meganos Stage," equivalent to the uppermost Thanetian Stage: upper Santa Susana Formation, south side of Simi Valley, southern California, localities CSUN 1342 (=UCMP 3791) and UCMP 3792. "Meganos Stage?": Santa Susana Formation, south side of Simi Valley, southern California, locality UCMP 7009.

Repository.—Holotype, UCMP 38568, locality UCMP 7009; paratype, UCMP 38569, locality UCMP 3792.

FIMBRIA PACIFICA n. sp.

Figure 3.1-3.3

Fimbria n. sp.? SQUIRES, 1987, p. 61-62, fig. 103.

Diagnosis.—A *Fimbria* with small cardinal teeth, moderately strong commarginal ribs that become flat topped and more closely spaced from area of maximum curvature of umbo to venter, with fairly prominent radial riblets.

Description.—Medium size, shell height up to 40 mm, transversely elliptical, thick, subequilateral, prosogyrate, small but well-defined lunule, narrow escutcheon, ligamental area external but sunken, nymph extends from beak almost to posterior lateral, separated from escutcheon by narrow groove, right-valve hinge with two small cardinals, posterior one larger, posterior to it is a very weak swelling resembling a tooth, anterior lateral near beak, posterior lateral remote, slightly smaller; exterior with prominent cancellate sculpture, commarginal ribs moderately strong becoming more flat topped and more closely spaced from area of maximum curvature of umbo to venter (approximately 1 rib per 1.5 mm in area of maximum curvature of umbo and approximately 1 rib per mm ventral of this area), radial riblets closely spaced (approximately 2-3 per mm), most prominent in anterior and posterior regions.

Remarks.—The tip of the anterior cardinal in Figure 3.2 is missing. Radial ribs become more apparent in weathered specimens of *Fimbria pacifica* n. sp.

The *Fimbria* sp. material reported by Page et al. (1951, p.

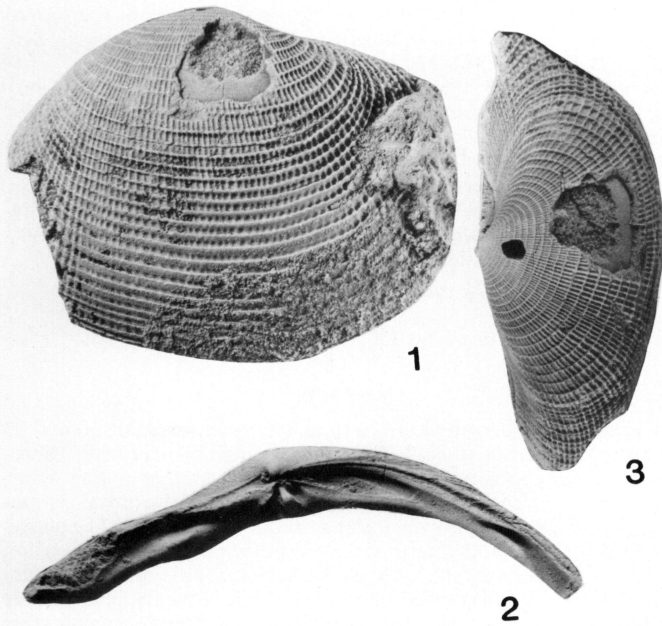


FIGURE 3—1-3, *Fimbria pacifica* n. sp., holotype, IGM 5104 = plastoholotype, LACMIP 8097, locality CSUN 1220b, right valve, exterior, interior, and dorsal views, $\times 1.4$.

1754) and reiterated by Dibblee (1966, p. 24) from the basal calcareous sandstone bed in the lower shale strata of the lower Juncal Formation east of Agua Caliente Canyon, central Santa Ynez Mountains, could not be found in the Stanford University collections (now at the CAS). New material from what is undoubtedly the same horizon at localities UCLA 6593, 7192, and 7193 was found by L. R. Saul and is incorporated into this present report.

Fimbria pacifica n. sp. most closely resembles *F. davidsoni* (Deshayes, 1860, p. 607, Pl. 48, figs. 33-35; Cossmann and Pissarro, 1904-1906, Pl. 22, fig. 78-3; Pomerol and Feugueur, 1974, Pl. 2, fig. 6) from upper Paleocene (Thanetian Stage) strata, Paris Basin, France. *Fimbria pacifica* n. sp. differs from *F. davidsoni* in the following features: more prominent radial riblets (especially in umbo area), commarginal ribs flat topped ventrally, commarginal ribs not spinose anteriorly, and cardinals weaker.

Fimbria pacifica n. sp. and the slightly older *F. susanensis* n. sp. are the first actual occurrences of this genus from the Pacific coast of North America.

Etymology.—The specific name is for the Pacific Ocean.

Material.—Seventeen specimens; most are molds and casts.

Occurrence.—Pacific coast "Capay Stage," equivalent to middle lower Eocene (Ypresian Stage): Bateque Formation, Baja California Sur, Mexico, locality CSUN 1220b; lower Juncal Formation, Whitaker Peak area, southern California, locality CSUN 830; lower Juncal Formation (or possibly Sierra Blanca Limestone), Agua Caliente Canyon, central Santa Ynez Mountains, southern California, locality UCLA 6593, 7192, and 7193.

Repository.—Holotype, IGM 5104=plastoholotype, LACMIP 8097, locality CSUN 1220b; paratype, LACMIP 7519 (formerly hypotype, LACMIP 7519), locality CSUN 830.

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R. Demetron helped in collecting the Baja specimens. L. R. Saul (Natural History Museum of Los Angeles County) collected the Agua Caliente Eocene specimens, discovered the holotype of *F. susanensis* n. sp. in the UCMP collections, and provided a great deal of in-depth knowledge about the Cretaceous material. She also gave many valuable insights and comments regarding identifications. J. L. and G. H. Goedert confirmed and recollected the type locality of *Corbis washingtoniana*. R. L. Hanson allowed them access to private property.

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REFERENCES

- ANDERSON, F. M., AND G. D. HANNA. 1935. Cretaceous geology of lower California. *Proceedings of the California Academy of Sciences*, 4th series, 23:1-34.
- ARMENTROUT, J. M., D. A. BEAULIEU, AND W. W. RAU. 1983. Correlation of Cenozoic stratigraphic units of western Oregon and Washington. *Oregon Department of Geology and Mineral Industries, Oil and Gas Investigation*, 7:1-90.
- BOTTJER, D. J., AND D. JABLONSKI. 1988. Paleoenvironmental patterns in the evolution of post-Paleozoic benthic marine invertebrates. *Palaios*, 3:540-560.
- CLARK, B. L. 1918. Meganos Group, a newly recognized division in the Eocene of California. *Geological Society of America Bulletin*, 29: 281-296.
- . 1921. The stratigraphic and faunal relationships of the Meganos Group, middle Eocene of California. *Journal of Geology*, 29:125-165.
- . 1925. Pelecypoda from the marine Oligocene of western North America. *University of California Publications, Bulletin of the Department of Geological Sciences*, 15:69-136.
- COSSMANN, A. E. M., AND G. PISSARO. 1904-1906. *Iconographie complétée des coquilles fossiles de l'Éocène des environs de Paris*. Vol. 1. H. Bouillant, Paris, 45 pls.
- DAILEY, D. H., AND W. P. POPENO. 1966. Mollusca from the Upper Cretaceous Jalama Formation, Santa Barbara County, California. *University of California Publications in Geological Sciences*, 65:1-27.
- DAWSON, M. K. 1978. The paleontology of the Cabrillo Formation. Unpubl. M.S. thesis, San Diego State University, 87 p.
- DESHAYES, M. G. P. 1824-1837. *Description des coquilles fossiles des environs de Paris*. Vol. 1 (Conchifères):1-392 (1824-1832). Atlas (Pt. 1):pls. 1-65 (1837). Chez l'auteur and others, Paris.
- . 1856-1866. *Description des animaux sans vertèbres découverts dans le bassin de Paris*. 3 vols. J.-B. Baillière et fils, Paris, 2536 p. Atlas (2 vols.), 107 pls.
- DIBBLEE, T. W., JR. 1966. Geology of the central Santa Ynez Mountains, Santa Barbara County, California. *California Division of Mines and Geology, Bulletin* 186, 99 p.
- . 1986. Geologic map of the Hildreth Peak quadrangle, Santa Barbara County, California. Dibblee Foundation Map, No. DF-03.
- DOCKERY, D. T., III. 1982. Lower Oligocene Bivalvia of the Vicksburg Group in Mississippi. *Mississippi Department of Natural Resources Bureau of Geology, Bulletin* 123, 261 p.
- DURHAM, J. W. 1944. Megafaunal zones of the Oligocene of north-

- western Washington. University of California Publications, Department of Geological Sciences Bulletin, 27:101-212.
- FRAKES, L. A. 1979. Climate Throughout Geologic Time. Elsevier, Amsterdam, 310 p.
- HALLAM, A. 1977. Jurassic bivalve biogeography. *Paleobiology*, 3:58-73.
- HANNA, M. A. 1927. An Eocene invertebrate fauna from the La Jolla quadrangle, California. University of California Publications, Department of Geological Sciences Bulletin, 16:247-398.
- HAQ, B. U. 1981. Paleogene paleoceanography: early Cenozoic oceans revisited. *Oceanologia Acta. Proceedings, 26th International Geological Congress, Geology of Oceans Symposium*, Paris, p. 71-82.
- LINNE, C. 1758. *Systema naturae per regna tria naturae. Editio decima, reformata, Regnum animale*, Vol. 1. Holmiae, 1327 p.
- MEGERLE VON MÜHLFELD, J. K. 1811. Entwurf eines neuen System's der Schalthiergehause. *Magazin Gesellschaft Naturforschung Freunde Berlin*, 5:38-72.
- MERRIAM, C. W. 1941. Fossil turritelas from the Pacific coast region of North America. University of California, Publications in Geological Sciences, 26:1-214.
- 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.
- NICOL, D. 1950. Recent species of the lucinoid pelecypod *Fimbria*. *Journal of the Washington Academy of Sciences*, 40:82-87.
- OKADA, H., AND D. BUKRY. 1980. Supplementary modification and introduction of code numbers to the low-latitude coccolith biostratigraphic zonation. *Marine Micropaleontology*, 5:321-325.
- ORBIGNY, A. D. D'. 1850. *Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnés*. Vol. 2. Paris, 427 p.
- PAGE, B. M., J. G. MARKS, AND G. W. WALKER. 1951. Stratigraphy and structure of the mountains northeast of Santa Barbara, California. *American Association of Petroleum Geologists Bulletin*, 35:1717-1780.
- PALMER, K. V. W., AND D. C. BRANN. 1965. Catalogue of the Paleocene and Eocene Mollusca of the southern and eastern United States. Part 1. Pelecypoda, Amphineura, Pteropoda, Scaphopoda, and Cephalopoda. *Bulletins of American Paleontology*, 48:1-466.
- 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, Volume and Guidebook.
- POMEROL, C., AND L. FEUGUEUR. 1974. Bassin de Paris. 2nd ed. Guides Géologiques Régionaux. Masson et Cie, Paris, 216 p.
- SAUL, L. R. 1983. Notes on Paleogene turritelas, venericardias, 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, Volume and Guidebook.
- SQUIRES, R. L. 1983. Geologic map of the Simi Valley area, southern California, insert. *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, Volume and Guidebook.
- . 1987. Eocene molluscan paleontology of the Whitaker Peak area, Los Angeles and Ventura Counties, California. *Los Angeles County Natural History Museum Contributions in Science*, 388, 93 p.
- SQUIRES, R. L., AND R. DEMETRION. 1989. An early Eocene pharetronid sponge from the Bateque Formation, Baja California Sur, Mexico. *Journal of Paleontology*, 63:440-442.
- , AND —. 1990. New early Eocene marine gastropods from Baja California Sur, Mexico. *Journal of Paleontology*, 64:99-103.
- VOKES, H. E. 1935. The genus *Velates* in the Eocene of California. University of California Publications, Department of Geological Sciences Bulletin, 23:381-390.
- WEAVER, C. E. 1943. Paleontology of the marine Tertiary formations of Oregon and Washington. University of Washington, Publications in Geology, 5(1-3), 789 p.
- WOODS, A. J. C., AND L. R. SAUL. 1986. New Neritidae from southwestern North America. *Journal of Paleontology*, 60:636-655.
- ZINSMEISTER, W. J. 1974. Paleocene biostratigraphy of the Simi Hills, Ventura County, California. Unpubl. Ph.D. dissertation, University of California, Riverside, 236 p.

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APPENDIX

CSUN 830. At elevation of 716 m (2,350 ft) on ridge top, 30 m (100 ft) east of SW corner of sec. 1, T5N, R18W, and 808 m (2,650 ft) north along a line perpendicular to the southern east-west section line, Whitaker Peak quadrangle, Los Angeles County, California. Juncal Formation. Age: middle early Eocene ("Capay Stage"). Collector: R. L. Squires.

CSUN 1220b. On the north side of a minor canyon, at an elevation of 120 m, on the west side of Mesa La Salina, approximately 1.25 km southeast of the intersection of 113°00'W and 26°45'N, San Jose de Gracia, Baja California Sur, Mexico, 1:50,000 quadrangle map (number G12A64), issued in 1983 under the authority of the Dirección General de Geografía. Bateque Formation. Age: middle early Eocene ("Capay Stage"). Collectors: R. L. Squires and R. Demetron.

CSUN 1342. At the south end of a small hill at 427 m (1,400 ft) elevation, 900 m (3,000 ft) south and 30 m (100 ft) west of the NE corner of sec. 22, T2N, R17W, Calabasas quadrangle (7.5 minute), 1952, photorevised 1967, Simi Hills, Ventura County, southern California. This locality = UCMP 3791. Upper Santa Susana Formation. Age: late Paleocene ("Meganos Stage"). Collector: R. L. Squires.

UCLA 6593. Stream-cut bank 1.8 m high on north side of spur bounding first canyon north of Pendola Debris Dam, west side of Agua Caliente Canyon approximately 670 m (2,200 ft) north of Pendola Guard Station just below "N" of Najalayegua, Hildreth Peak quadrangle (7.5 minute), 1964, photorevised 1988, Santa Barbara County, southern California. Juncal Formation. Age: middle early Eocene ("Capay Stage"). Collector: L. R. Saul.

UCLA 7192. Stream cut on west side of Agua Caliente Canyon, 777 m (2,550 ft) north and 214 m (700 ft) east of Pendola Guard Station, Hildreth Peak quadrangle (7.5 minute), 1964, photorevised 1988, Santa Barbara County, southern California. Juncal Formation. Age: middle early Eocene ("Capay Stage"). Collector: L. R. Saul.

UCLA 7193. Float?, west side of Agua Caliente Canyon, approximately 747 m (2,450 ft) north and 91 m (300 ft) east of Pendola Guard Station, Hildreth Peak quadrangle (7.5 minute), 1964, photorevised 1988, Santa Barbara County, southern California. Juncal Formation. Age: middle early Eocene ("Capay Stage"). Collector: L. R. Saul.

UCMP 3792. About 30 m northwest of CSUN 1342, sec. 22, T2N, R17W, Calabasas quadrangle (7.5 minute), 1952, photorevised 1967, Simi Hills, Ventura County, southern California. Locality is now covered with slope wash. Upper Santa Susana Formation. Age: late Paleocene ("Meganos Stage"). Collector: R. N. Nelson.

UCMP 7009. At elevation of 378 m (1,240 ft) in a small gully, in sandy shale, about 100 m north of UCMP locality 3759 (7,000 ft south of BM 961 at Santa Susana well, flank of 1,500-ft hill) east side of Meier Canyon, Santa Susana quadrangle, 1903, reprinted 1924, south side of Simi Valley, Ventura County, southern California. Santa Susana Formation. Age: late Paleocene ("Meganos Stage?"). Collector: R. B. Stewart. Information for this locality is mainly from Woods and Saul (1986, p. 655).

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gray mudstone. Most of the specimens are poorly preserved and consist of unabrased fragments. Important associated fossils include the colonial coral *Astrocoenia?* and a large internal mold of the gastropod *Velates californicus?*

The fossiliferous lens at locality 1342 is interpreted to represent a storm deposit in a middle to outer shelf environment, in the sense used by Bottjer and Jablonski (1988). The distance of transport was not great for some of the specimens.

Microfossil samples collected by the author from 6 m below and 2 m above locality 1342 yielded rare and poorly preserved calcareous nannofossils suggestive of the late Paleocene *Discoaster multiradiatus* (CP8) Zone of Okada and Bukry (1980) (M. V. Filewicz, personal commun.).

An additional specimen of *F. susanensis* was obtained from the UCMP collection of Santa Susana Formation macrofossils. The specimen (paratype, UCMP 38569) is from locality UCMP 3792, which is the type locality of the gastropod *Velates californicus*. Also at this locality are moderately large complete internal molds of the bivalve *Miltha?*. This locality, which is mistakenly shown as locality UCMP 3732 by Nelson (1925, Pl. 61), is just upsection and in the immediate vicinity of locality CSUN 1342. Attempts by the author to find locality UCMP 3792 were unsuccessful because the locality is now covered by slope wash.

Fimbria pacifica n. sp. is more widespread than *F. susanensis* n. sp. Four specimens of *F. pacifica* were found between 96 and 145 m above the bottom of a measured section of the Bateque Formation, Baja California Sur, Mexico (Figure 1), at locality CSUN 1220b. The geologic details of this locality and immediate vicinity have been described in Squires and Demetron (1989, 1990). The locality is in very fine-grained sandstone interbedded with fossiliferous lenses containing slightly transported shallow-marine stromatolites, coralline algae, miliolid and discocylinid foraminifers, pharetronid sponges (Squires and Demetron, 1989), colonial corals, branching cheilostome bryozoans, thick-shelled gastropods and bivalves, spatangoids, and sea-urchin spines. Colonial corals and the gastropod *Velates perversus* are particularly abundant. The strata are middle early Eocene ("Capay Stage") in age (Squires and Demetron, 1990).

One specimen of *Fimbria pacifica* n. sp. was found in the lower part of the Juncal Formation, Whitaker Peak area, Los Angeles County, southern California (Figure 1), at locality CSUN 830. The geologic details of this locality have been described in Squires (1987). The locality is one of many channel-lag storm accumulations of slightly transported fossils in transition-zone siltstone that formed in shelf-like depths. Important associated fossils at this locality are *Velates perversus* and *Miltha packi*. This part of the Juncal Formation is middle early Eocene ("Capay Stage") in age (Squires, 1987).

Ten specimens of *Fimbria pacifica* n. sp. were found in an unnamed unit, Agua Caliente Canyon, central Santa Ynez Mountains, Santa Barbara County, southern California (Figure 1), at three closely spaced localities (UCLA 6593, 7192, and 7193). These localities plot on Dibblee's (1966, 1986) geologic maps in his "unnamed" strata of Late Cretaceous age. No detailed geologic work has been done on these particular strata. The localities are in fossiliferous lenses in silty sandstone. Fossils are molds and casts and, except for one complete specimen of *Fimbria*, are fragmental. Important associated fossils are *Pycnodonte* (*Phygraea*) sp. and *Spondylus* sp. Based on the presence of specimens of *Fimbria pacifica* n. sp., which is found elsewhere only in middle lower Eocene ("Capay Stage") strata, these localities are assigned to the middle lower Eocene. These *Fimbria*-bearing strata should be mapped as the basal part of the Juncal Formation or, possibly, as the Sierra Blanca Limestone, which directly underlies the Juncal Formation in this region.

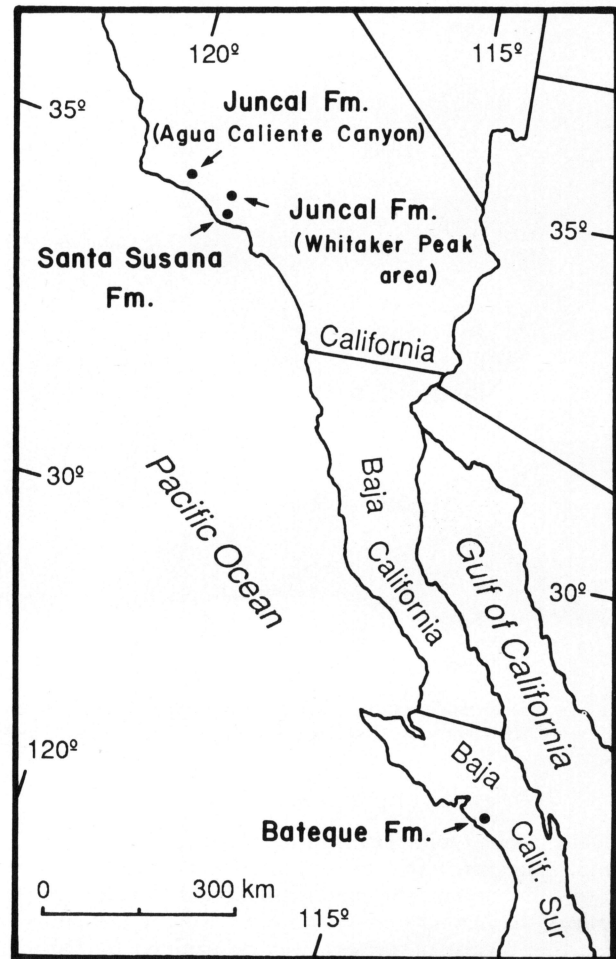


FIGURE 1—Stratigraphic occurrences of the new Paleogene fimbriids from the Pacific coast of southwestern North America.

SPECIES PREVIOUSLY ASSIGNED TO,
BUT NOT BELONGING TO, *FIMBRIA*

- Corbis peninsularis* Anderson and Hanna (1935, p. 31, Pl. 10, fig. 1). Upper Cretaceous, midway between Ensenada and San Quintin, Baja California, Mexico. Work in progress by Saul (personal commun.) shows that this species, which has an ovate shape and no radial ribs, belongs in genus *Calva*.
- Fimbria* n. sp. Dawson (1978, p. 54–55, Pl. 1, figs. 15–17). Upper Cretaceous, Cabrillo Formation, Point Loma, San Diego, San Diego County, southern California. The elongate shell, very fine cancellate ornamentation, and dentition are similar to the tellinid *Palaeomoera dyskritos* Dailey and Popenoe (1966, p. 18–19, Pl. 5, figs. 1, 2, 5) from the Upper Cretaceous Jalama Formation, Santa Barbara County, southern California.
- Corbis mcllellani* Hanna (1927, p. 283–284, Pl. 37, figs. 3–6). Middle Eocene, lower La Jolla Group, San Diego County, southern California. The very small size, subtrigonal shape, concave anterior dorsal margin, widely spaced commarginal ribs with very closely spaced radial striae, and dentition are characteristic of the cardiniid *Tellidorella*. *Tellidorella interlacina* Dockery (1982, p. 69, Pl. 20, figs. 9–10), from the lower Oligocene of Mississippi, is strikingly similar to Hanna's species.
- Corbis washingtoniana* Clark (1925, p. 90, Pl. 20, figs. 1–4, Pl. 21, figs. 1, 2; Weaver, 1943, p. 152–153, Pl. 37, figs. 1–3; Durham, 1944, p. 144). Upper Eocene, Marrowstone Shale,