



Explanation of Figures 6 to 11

Figures 6-11. *Campanile dilloni* Hanna & Hertlein, 1949. Figures 6, 7. Hypotype LACMIP 12235, CSUN loc. 1565, upper Santa Susana Formation, Bus Canyon, Simi Valley,  $\times 0.59$ . Figure 6. Apertural view. Figure 7. Abapertural view. Figure 8. Hypotype LACMIP 12236, CSUN loc. 703, Lajas Formation, Bus Canyon, Simi Valley, internal mold, abapertural view,  $\times 0.52$ . Figures 9, 10. Hypotype LACMIP 12237, CSUN loc. 1566, Sierra Blanca Limestone, near Oso Canyon, Santa Barbara County, internal mold,  $\times 0.49$ . Figure 9. Apertural view. Figure 10. Abapertural view. Figure 11. Hypotype LACMIP 12238, CSUN loc. 955 = UCMP loc. A-2990, Sierra Blanca Limestone, Lazaro Creek, Santa Barbara County, internal mold, abapertural view,  $\times 0.47$ .

**Remarks:** The type species of *Campanile* has been much debated, and the reader is referred to HOUBRICK (1981) and SQUIRES & ADVOCATE (1986) for discussions of the difficulties.

The name *Campanile* was used on the Pacific coast of North America until HANNA & HERTLEIN (1949) used *Campanilopa* Iredale, 1917. WENZ (1940) and HOUBRICK (1981) have pointed out, however, that *Campanilopa* is a junior synonym of *Campanile*.

Recent studies (HOUBRICK, 1989) on the anatomy of the extant *Campanile symbolicum* indicate that members of Campanilidae should no longer be considered as cerithioidean gastropods. He argued for a new systematic placement of *Campanile* at the base of, but outside, the cerithioidean clade. In addition, he suggested elevating the family Campanilidae to superfamilial status (as superfamilia Campaniloidea Douvillé, 1904). PONDER & WARÉN (1988) and HOUBRICK (1989) rejected HASZPRUNAR'S (1988) idea that *Campanile* is in any way related to heterobranch gastropods.

*Campanile greenellum* Hanna & Hertlein, 1939

(Figures 3–5)

*Campanile greenellum* HANNA & HERTLEIN, 1939:101–102, fig. 1; KEEN & BENTSON, 1944:137.

**Original description:** "Shell elongate conic, imperfect but with about 8 whorls. The top of each whorl ornamented by a band of elevated nodes, there being about 22 on the last whorl; below each band of nodes there are three revolving cords separated from each other and from the nodose band above and below by incised lines. Length (incomplete) approximately 95 mm, greatest width 64 mm" (HANNA & HERTLEIN, 1939:101).

**Type material and type locality:** Holotype CAS 7233, near Devils Slide along California State Highway 1, south of San Francisco, San Mateo County, northern California.

**Geographic distribution:** Santa Monica Mountains, Los Angeles County, southern California (herein) to Stewarts Point, Sonoma County, northern California.

**Stratigraphic distribution:** "Martinez Stage" (upper Paleocene): Santa Susana Formation, Santa Monica Mountains, southern California (herein, LACMIP locs. 24433 and 27023); lower San Francisco Formation, Redrock Mountain, southern California (herein, LACMIP loc. 24716); unnamed strata near Devils Slide along California State Highway 1, south of San Francisco, northern California (HANNA & HERTLEIN, 1939); German Rancho formation (informal), northern California (WENTWORTH, 1966, 1968).

**Remarks:** The mudstone and siltstone rocks at the type locality of *Campanile greenellum* near Devils Slide are unnamed and have been referred to (MORGAN, 1981) as Paleocene turbidites.

WENTWORTH (1966, 1968) reported a specimen of *Campanile greenellum* from the Paleocene part of the informal German Rancho formation, west of the San Andreas fault, 2 km south of the town of Stewarts Point, northern California. The specimen, which was identified by W. O. Addicott, was found near the base of a sea cliff at Wentworth's field loc. 730 in a bed of pebble conglomerate with a matrix of very poorly sorted clayey sandstone (WENTWORTH, 1966:181). My attempts to find this specimen were unsuccessful. Macrofossils, which are sparse in the German Rancho formation, underwent post-mortem transport by means of turbidity currents into a deep-water environment, and the rocks containing the *Campanile* specimen have undergone right slip of at least 435 km (270 miles) along the San Andreas fault (WENTWORTH, 1968). The German Rancho formation *Campanile* specimen, therefore, originally lived in the vicinity of the southeastern Diablo Range or the Temblor Range, south-central California. The northern limit of the original distribution of *C. greenellum* along the Pacific coast of North America during the Paleocene, therefore, was approximately the same as that for the Eocene-age *C. dilloni*.

SEIDERS & JOYCE (1984:table 1) found a specimen of ?*Campaniliopa* [sic] n. sp. from an unnamed mudstone unit at LACMIP loc. 27203 in the northern Santa Lucia Range, central California coastal area. The specimen was associated with a few other mollusks and some brachiopods. The *Campanile* specimen and its associated fauna are stored at LACMIP. SEIDERS & JOYCE (1984) assigned a tentative late Paleocene age to the fossils. I examined the *Campanile* specimen from loc. 27203 and found it to be a deeply weathered fragment of an internal mold that shows only a small part of the body whorl. The specimen can be identified only as *Campanile* sp. indet.

*Campanile dilloni* (Hanna & Hertlein, 1949)

(Figures 6–11)

*Campanilopa dilloni* HANNA & HERTLEIN, 1949:393, pl. 77, figs. 2, 4, text-fig. 1; GIVENS, 1974:69, pl. 7, fig. 10; SQUIRES & ADVOCATE, 1986:853, 855, fig. 2.1.

*Campanile dilloni* Hanna & Hertlein: SQUIRES, 1991b:pl. 1, fig. 18.

**Original description:** "Shell elongate, 4 whorls present (shell incomplete on type); whorls rather flat-sided but slightly concave; top of each whorl sculptured with a projecting carina which bears about 14 to 16 pointed nodes, the sides of the whorls are ornamented by about a half dozen spiral lirae. Paratypes in longitudinal section reveal the presence internally of two strong plaits on the columella and a rounded ridge on both the top and bottom of the cavity. Dimensions of holotype: height (incomplete), 72.5 mm; diameter, 44.0 mm. Some specimens, poorly preserved, indicate a height of approximately 300 mm" (HANNA & HERTLEIN, 1949:393).

SQUIRES & ADVOCATE (1986:853) gave a supplementary description: "Turreted-elongate shell of very large size;

protoconch and upper spire missing; whorls slightly concave, becoming flat sided in later whorls; posterior portion of each whorl with a very projecting, greatly thickened carina with eight to ten pointed nodes, sides of whorls with three to four swollen spiral cords; groove along inside of carina in later whorls; outer lip missing and aperture obscured by matrix."

**Type material and type locality:** Holotype CAS 9425 and paratypes CAS 9428 and 9429, all from CAS loc. 30667; Mabury Formation, Agua Media Creek, Temblor Range, Kern County, south-central California.

**Geographic distribution:** Orocochia Mountains, Riverside County, southern California, to Agua Media Creek, Temblor Range, Kern County, south-central California.

**Stratigraphic distribution:** California "Meganos Stage" (uppermost Paleocene to lower lower Eocene) to "Capay Stage" (middle lower Eocene). "MEGANOS STAGE": Uppermost Santa Susana Formation, Bus Canyon, south side of Simi Valley, Ventura County, southern California (herein, CSUN loc. 1565). "CAPAY STAGE": Lower Maniobra Formation, Orocochia Mountains, Riverside County, southern California (SQUIRES & ADVOCATE, 1986; SQUIRES, 1991b); lower Llajas Formation, Bus Canyon, south side of Simi Valley, Ventura County, southern California (herein, CSUN loc. 703); lower Juncal Formation, Sespe Hot Springs, Ventura County, southern California (GIVENS, 1974); Mabury Formation, Agua Media Creek, Temblor Range, Kern County, south-central California (HANNA & HERTLEIN, 1949). LOWER EOCENE (no differentiation as to stage): Sierra Blanca Limestone, near Oso Canyon, Santa Ynez River Valley, Santa Barbara County, southern California (herein, CSUN loc. 1566); Sierra Blanca Limestone, Lazaro Canyon, near Lake Cachuma, Santa Barbara County, southern California (NELSON, 1925; herein, CSUN loc. 955 = UCMP loc. A-2990).

**Remarks:** HANNA & HERTLEIN (1949) reported that the type locality (CAS loc. 30667) of *Campanile dilloni* extended along the outcrop for a distance of approximately 0.8 km. In 1992, I visited the type locality and found outcrops to be only moderately well exposed and consisting of a relatively thin section of conglomeratic sandstone that grades upward into very fine sandstone. I found macrofossils only in one small area that is equivalent to the middle of their reported band of outcrop. Very sparse macrofossil fragments of colonial corals and a few naticid gastropods were found in the basal sandstone. These fragmentary fossils have undergone considerable post-mortem transport. No new specimens of *C. dilloni* were found. Overlying and underlying the sandstone are thick sequences of mudstones. MALLORY (1970) interpreted the mudstones as bathyal deposits and the intervening sandstone (his middle member of the Lodo Formation) as a littoral deposit. ALMGREN *et al.* (1988) referred to the intervening sandstone as the Mabury Formation, and on the basis of

calcareous nannofossil biostratigraphy, assigned an age that is equivalent to the "Capay Stage."

NELSON (1925:348) reported numerous casts of *Campanile* sp., some of which, if unbroken, would be over 40 cm in length, from white limestone near Lake Cachuma, along Cachuma Creek, Santa Barbara County, southern California. He did not mention a specific locality, nor did he mention whether or not any specimens were stored at UCMP (the institution he was affiliated with). While going through the UCMP collections, I came across several large, poorly preserved casts of *Campanile* from UCMP loc. A-2990 (Cachuma Creek area). According to locality records at UCMP, this locality is the same as UCMP loc. 4124. KEENAN (1932:79, fig. 1) noted that UCMP loc. 4124 is the same as LSJU locality 1106 (in the Sierra Blanca Limestone). The specimens from UCMP loc. A-2990 = LSJU 1106, therefore, must be the ones that NELSON (1925) reported. Unfortunately, the exact location of this locality is not available in the register of localities at UCMP. The description given in these records mentions only nearness to Cachuma Creek. The description given by KEENAN (1932:79) mentions the "east fork of Cachuma Creek" but also mentions a longitude and latitude that are equivalent to the Pacific Ocean off the coast of Baja California. On an index map in KEENAN (1932:fig. 1), however, LSJU loc. 1106 is shown to be on a prominent east fork of Cachuma Creek.

I visited the area of UCMP loc. A-2990 and found four large, poorly preserved internal molds of *Campanile* at CSUN loc. 955 along the west side of Lazaro Creek, which is a prominent east fork of Cachuma Creek. Locality 955, which must be the same as UCMP loc. A-2990, coincides with the easternmost exposure of a thin band of Sierra Blanca Limestone on DIBBLEE's (1966:pl. 3) geologic map of the area. On this map, the thin band of outcrop is labelled "Tsb" for the Sierra Blanca Limestone, but the graphic pattern on the map corresponds to the Pliocene Careaga Sandstone. The specimens at CSUN loc. 955 have the diagnostic narrow pleural angle and large shell size of *C. dilloni*, and they are virtually identical to the specimen (Figure 8) of *C. dilloni* from the lower Llajas Formation and the specimen (Figures 9, 10) of *C. dilloni* from the Sierra Blanca Limestone near Oso Canyon. Because the campanilid from CSUN loc. 955 has never been illustrated before, the best preserved specimen is shown in Figure 11.

*Campanile* n. sp.? SQUIRES (1987:31-32, figs. 32, 33) from the lower Juncal Formation ("Capay Stage") in the Whitaker Peak area, Los Angeles County, southern California, may be *C. dilloni* but poor preservation prevents a positive identification.

SQUIRES & DEMETRION (1992:28, fig. 65) reported a specimen of *Campanile* sp. from the lower Eocene ("Capay Stage") part of the Bateque Formation, Baja California Sur, Mexico, but the specimen is so poorly preserved that no species identification is possible. SQUIRES (1992) reported *Campanile* sp. from the "Capay Stage" part of the

Tepetate Formation, Baja California Sur, Mexico, but poor preservation prevents species identification.

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Antony J. Marro (CSUN) collected and donated the specimen of *Campanile dilloni* from the upper Santa Susana Formation. Fen Yan (CSUN) collected and donated the specimen of *C. dilloni* from the Sierra Blanca Limestone in Oso Canyon. Michael P. Gring (CSUN) obtained permission for access to private property (type section of *C. dilloni*). Michael P. Gring and Martin Jackson (CSUN) and Lindsey T. Groves (Natural History Museum of Los Angeles County, Malacology Section) helped in field work. Carl Twisselman (Buttonwillow, California) kindly allowed access to private property (type section of *C. dilloni*). Carl M. Wentworth (U.S. Geological Survey, Menlo Park) provided locality information, and he and Chuck Powell, Jr., (U.S. Geological Survey, Menlo Park) tried to find the specimen of *Campanile greenellum* from the German Rancho formation. LouElla Saul (LACMIP) allowed access to collections, provided casts of the primary type material of *C. greenellum* and *C. dilloni*, and shared her knowledge about new Paleocene occurrences of *Campanile* in California. She and an anonymous reviewer critically read the manuscript.

#### LOCALITIES CITED

- CAS loc. 30667. "SW corner of sect. 27, T28S, R19E, through the NE ¼ of the SE ¼ of section 28, T28S, R19E, south side of headwaters of Media Agua Creek, Kern County, California" (HANNA & HERTLEIN, 1949: 393). A visit by the author resulted in the following refinement of this description: at elevation 2650 ft. (800 m) on a lowly resistant ridge formed by conglomeratic sandstone along the crest of the north side of Media Agua Creek, 442 m (1450 ft.) N and 183 m (600 ft.) E of SW corner of section 27, T28S, R19E, U.S. Geological Survey, 7.5-minute, Las Yeguas Ranch Quadrangle, 1959, Temblor Range, Kern County, south-central California. Mabury Formation. Age: Middle early Eocene ("Capay Stage"). Collectors: Earl Dillon and R. L. Hewitt, 1940s?. = ~~LACMIP 46~~
- CSUN loc. 703. At elevation of 1430 ft. (420 m) along a ridge on east side of Bus Canyon, S side of Simi Valley, 238 m (780 ft.) S and 177 m (580 ft.) W of NE corner of section 28, T2N, R18W, U.S. Geological Survey, 7.5-minute, Thousand Oaks Quadrangle, 1950 (photorevised 1967), Ventura County, southern California. Lower Llajas Formation, lowermost part of shallow-marine (transgressive) facies of SQUIRES (1984). Age: Middle early Eocene ("Capay Stage"). Collector: R. L. Squires, October 1988. = LACMIP loc. 16199
- CSUN loc. 955. At elevation of 2160 ft. (650 m), just below top of resistant hill formed by a 20-m-thick gray algal limestone along the west side of Lazaro Canyon, 533 m (1750 ft.) S and 91 m (300 ft.) W of the SE corner of section 23, T7N, R29W, U.S. Geological Survey, 7.5-minute, Figueroa Mtn. Quadrangle, 1959, Santa Barbara County, southern California. Sierra Blanca Limestone. Age: Early Eocene. Collectors: R. L. Squires and L. T. Groves, October 1985. Same as UCMP loc. A-2990, see below. = LACMIP loc. 16506
- CSUN loc. 1565. At elevation of 1100 ft. (340 m), along west side of Bus Canyon, S side of Simi Valley, on north bank of an unnamed tributary that enters Bus Canyon from the W, 274 m (900 ft.) S and 503 m (1650 ft.) W of NE corner of section 28, T2N, R18W, U.S. Geological Survey, 7.5-minute, Thousand Oaks Quadrangle, 1950 (photorevised 1967), Ventura County, southern California. Uppermost Santa Susana Formation. Age: Latest Paleocene or early early Eocene ("Meganos Stage"). Collector: A. J. Marro, 1985. = LACMIP loc. 16505
- CSUN loc. 1566. At elevation of 1919 ft. (600 m), approximately 1.15 km E of Oso Canyon, on hillside on north side of Santa Ynez River, 175 m (575 ft.) E and 191 m (625 ft.) S of NW corner of section 6, T5N, R27W, U.S. Geological Survey, 7.5-minute, San Marcos Pass Quadrangle, 7.5 minute, 1959 (photorevised 1988), Santa Barbara County, southern California. Sierra Blanca Limestone. Age: Early Eocene. Collector: F. Yan, 1986. = LACMIP loc. 16507.
- LACMIP 24433. 150 m (500 ft.) NE of the end of the entry road to quarry in Trailer Canyon, stratigraphically just below white algal limestone, U.S. Geological Survey, 7.5-minute, Topanga Quadrangle, 1952 (photorevised 1967), Santa Monica Mountains, Los Angeles County, southern California. Santa Susana Formation. Age: Late Paleocene ("Martinez Stage"). Collector: J. Champeny, June 1961. Same as UCLA loc. 4433.
- LACMIP 24716. Approximately 3160 ft. (1000 m) elevation, on dip slope of Redrock Mountain, about 415 m (1400 ft.) S17 W of hill 3991, sec. 1, T6N, R17W, U.S. Geological Survey, 7.5-minute, Liebre Mountain Quadrangle, 1958 (photorevised 1974), NW San Gabriel Mountains, Los Angeles County, California. San Francisquito Formation. Age: Late Paleocene ("Martinez Stage"). Collector: E. C. Jestes, August 1963. Same as UCLA loc. 4716.
- LACMIP 27023. Above drop off at about 1275 ft. (400 m) elevation, 100 m (325 ft.) NE of quarry symbol in Trailer Canyon, below white algal limestone, U.S. Geological Survey, 7.5-minute, Topanga Quadrangle, 1952 (photorevised 1967), Santa Monica Mountains, Los Angeles County, southern California. Santa Susana Formation. Age: Late Paleocene ("Martinez Stage"). Collectors: L. R. Saul and J. Alderson, June 1982. Same as UCLA loc. 7023.
- LACMIP 27203. West-flowing tributary to Arroyo Seco, approximately 160 m W of the Indians Road, approximately 3.5 km N and 0.5 km E of the SW corner of U.S. Geological Survey, 7.5-minute, Junipero Serra Peak

- Quadrangle, 1949, northern Santa Lucia Range, Monterey County, California. Unnamed mudstone. Age: Tentatively, late Paleocene ("Martinez Stage"). Collector: V. M. Seiders, 1982. Same as loc. 1 of SEIDERS & JOYCE (1984:fig. 3).
- LSJU 1106. "Santa Ynez Quad.; west bank of the East Fork of Cachuma Creek, just north of right-angled bend in stream, R28W, T6N, 3½ miles west and ¾ mile south (to scale of U.S.G.S. topographic map) of intersection of Long. 119°49'W and Lat. 34°40'N"(KEENAN, 1932: 79), Sierra Blanca Limestone, Santa Barbara County, southern California. Same as UCMP loc. A-2990 (see below) = UCMP loc. 4124 = CSUN loc. 955.
- UCMP A-2990. "Limestone near Cachuma Canyon." Sierra Blanca Limestone. Age: Early Eocene. Collector: R. N. Nelson, early 1920s. Same as UCMP loc. 4124 = LSJU loc. 1106 = CSUN loc. 955.
- UCMP 4124. Same as UCMP loc. A-2990, see above.
- WENTWORTH field loc. 730. "Near base of the sea cliff in a 3-m-thick bed of pebble conglomerate with a matrix of very poorly sorted clayey sandstone. The bed lies near the top of a section of sandstone and conglomerate which is overlain by mudstone and fine-grained sandstone" (WENTWORTH, 1966:181); 1.35 km N and 1.4 km W of SE corner of U.S. Geological Survey, 7.5-minute, Stewarts Point Quadrangle, 1978, Sonoma County, northern California. German Rancho formation (informal). Age: Late? Paleocene. Collector: C. M. Wentworth, circa 1963.
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#### ADDENDUM

Recent collecting by William P. Elder (U.S. Geological Survey, Menlo Park) near Stewart's Point in northern California has yielded several specimens of *Campanile greenellum* from the Paleocene part of the German Rancho formation in the same area that WENTWORTH (1966, 1968) reported this species. Elder plans to include a discussion and figures of these specimens as part of a paper on the molluscan paleontology of the Cretaceous and Paleocene rocks in this area.