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SOUTHERN CALIFORNIA CRETACEOUS FORMATIONS AND FAUNAS WITH ESPECIAL REFERENCE TO THE SIMI HILLS AND SANTA MONICA MOUNTAINS

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EXPOSITION PARK

Later Cretaceous fossiliferous beds crop out at intervals near the southern California coast from the vicinity of Point Conception at the north to Arroyo Santa Catarina in Baja California, approximately 500 miles to the southeast. The oldest faunas obtained from these exposures are of Upper Turonian age, and are found in the Santa Ana Mountains, Orange County, and in the Santa Monica Mountains, northwest of Los Angeles. Coniacian and Santonian strata are probably present in the Santa Ana and Santa Monica Mountians sections, but definite evidence thereof is very meager. Campanian beds and faunas are well-developed in the Santa Ana Mountains, Santa Monica Mountains, and in the eastern Simi Hills. Beds of probably Lower Maestrichtian age are found in the western Simi Hills and at Jalama Creek. Locations of the Cretaceous exposures are shown on the Index-Map, Text-Figure 1, whereas the thicknesses, lithologic variety, and the positions of faunal assemblages are shown in columnar section on Text-Figure 2. Common and characteristic species from these localities are shown on Plates 1 to 4.

Emphasis in the discussion following will refer to the Cretaceous of the Simi Hills and the Santa Monica Mountains.

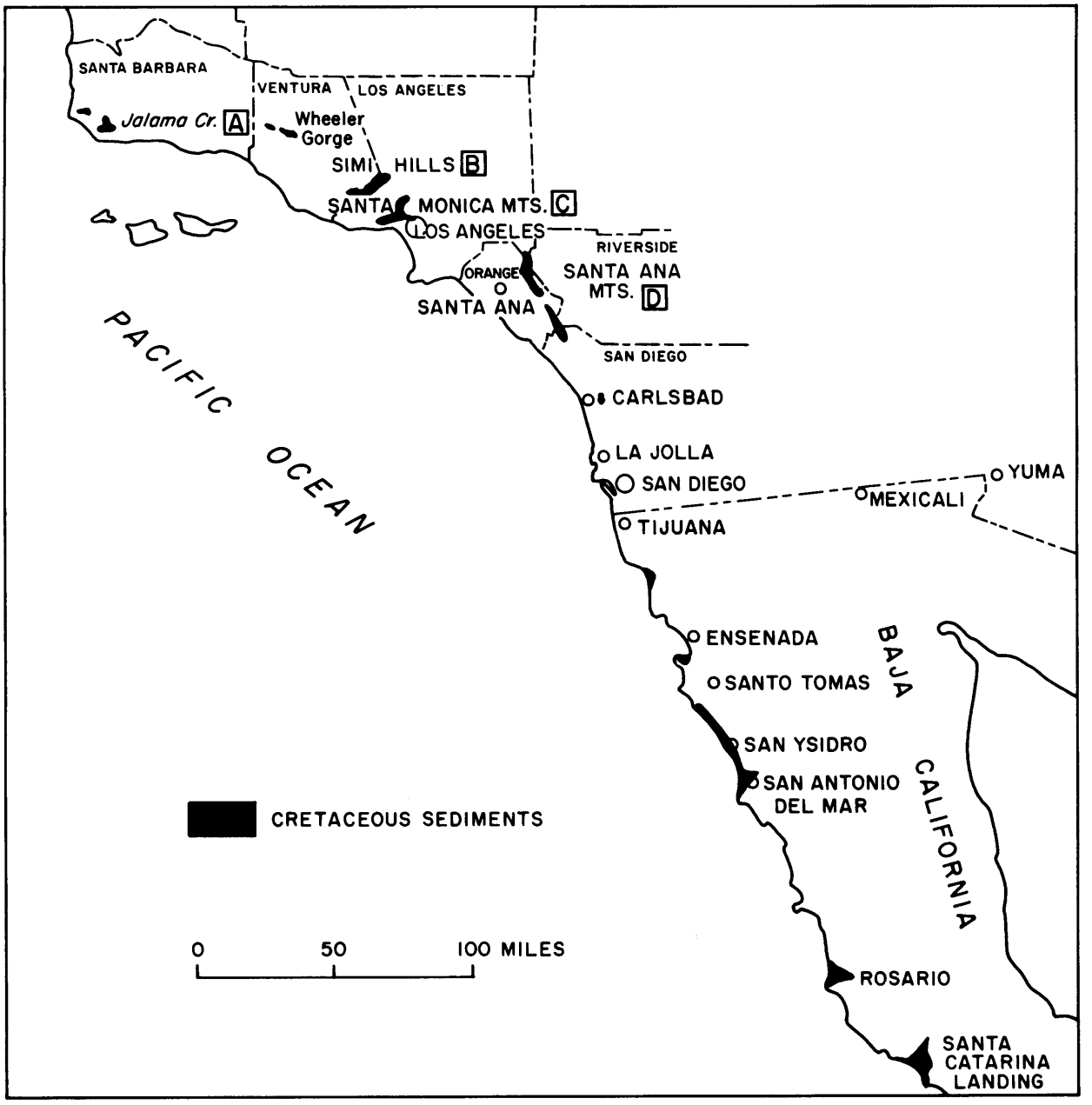
Depositional and Depth Conditions Inferred from the Faunas

Santa Monica Mountains

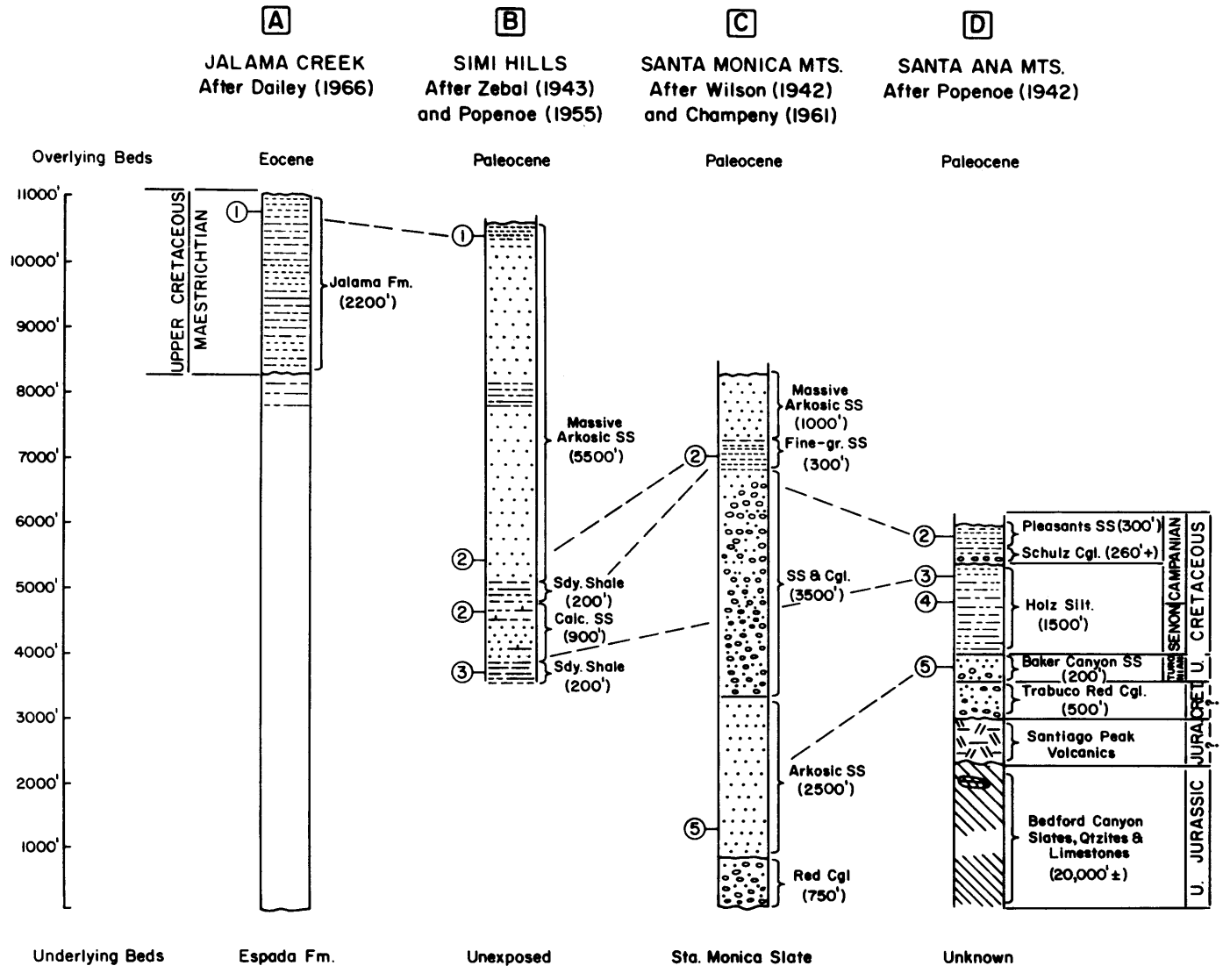
Waring (1917), Hoots (1931), Wilson (1942), and Champeny (1961) discussed the Cretaceous faunas and stratigraphy of the Santa Monica Mountains. As the two latter workers have had advantages of accessibility and better fossil collections, their observations will be used here.

Wilson divided the Cretaceous strata cropping out between Santa Ynez Canyon and a little east of Mandeville Canyon into five members to which he applied informal letter designations. In descending order, these members with thicknesses are as follows:

E.	Upper arkose and conglomerate. Unfossiliferous.	1000'
D.	Fine-grained fossiliferous sandstone.	300'
C.	Cobble conglomerate. Unfossiliferous.	3500'



TEXT - FIGURE 1. INDEX MAP



EXPLANATION

Letters in squares at top of columnar sections show location of section at similarly lettered squares on the index map, Text-figure 1.

Numbers in circles beside the columnar sections show the approximate stratigraphic positions of faunal assemblages on Plates 1 to 4, as follows:

1. Neodesmoceras - Calva varians - Cophocara beds
   MAESTRICHTIAN
2. Metaplacenticeras - Eupachydiscus beds
   UPPER CAMPANIAN
3. Turritella pescaderoensis beds
   MIDDLE CAMPANIAN
4. Turritella chicoensis beds
   LOWER - MIDDLE CAMPANIAN
5. Otoscaphites - Subprionocyclus beds
   UPPER TURONIAN

TEXT - FIGURE 2. COLUMNAR SECTIONS

PLATE 1

TURONIAN FOSSILS

All figures are natural size except where otherwise indicated. All specimens are from the Baker Canyon Formation, Santa Ana Mountains, except where otherwise noted.

1. *Trigonarca californica* Packard. Modjeska Canyon vicinity.

2. *Calva regina* Popenoe. South side of Silverado Canyon, opposite Holz Ranch.

3. *Lima beta* Popenoe. Silverado Canyon, near Holz Ranch.

4. *Clisocolus corrugatus* Popenoe. Holz Ranch, Silverado Canyon.

5. *Pterotrigonia klamathonia* (Anderson). Upper Baker Canyon, Santa Ana Mountains.

6. *Ampullina pseudoalveata* (Packard). Holz Ranch, Silverado Canyon.

7. *Flaventia zeta* Popenoe. Modjeska Canyon region.

8. *Glossus delta* (Popenoe). Holz Ranch, Silverado Canyon.

9. *Idonearca gravida* (Gabb). Holz Ranch, Silverado Canyon.

10. *Otoscaphites puerculus* (Jimbo) = *Scaphites inermis* Anderson. X2. Dry Creek, near Bellavista, Shasta County, California. This form is found also in the Santa Ana and Santa Monica Mountains.

11. *Crassatella gamma* Popenoe. Holz Ranch, Silverado Canyon.

12. *Acteonella oviformis* Gabb. Holz Ranch, Silverado Canyon.

13. *Subprionocyclus* cf. *neptuni* (Geinitz). ?Holz Ranch, Silverado Canyon.

14. *Opis* sp. Holz Ranch, Silverado Canyon.

PLATE 1 - TURONIAN FOSSILS

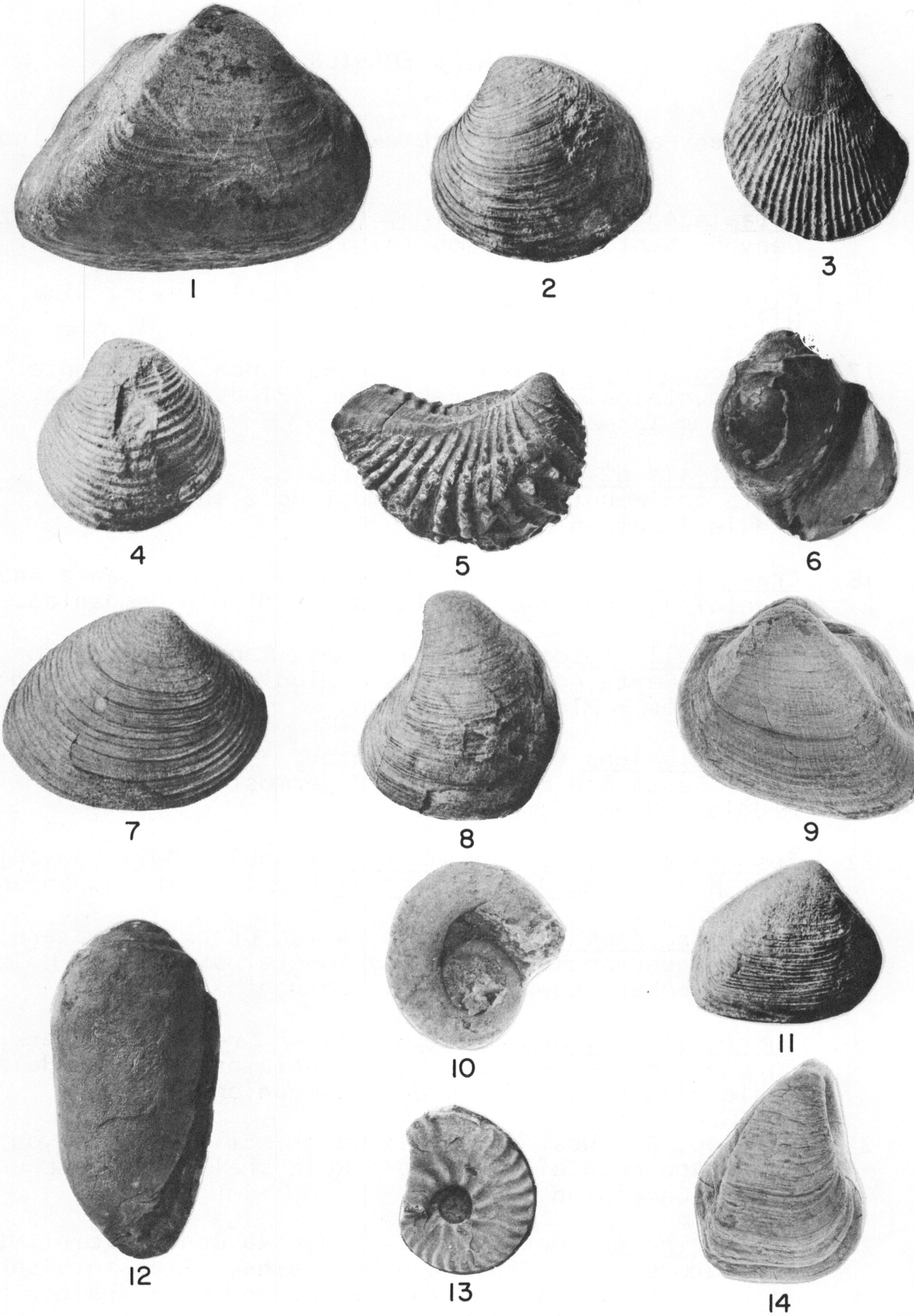


PLATE 2

CAMPANIAN FOSSILS

All specimens are natural size except where otherwise indicated.

15. Metaplacenticeras pacificum (Smith), X½. Santa Ynez Canyon, Santa Monica Mountains. Upper Campanian.

16. Perissitys brevirostris (Gabb). Bell Canyon, Simi Hills. Upper Campanian.

17. Legumen ooides (Gabb). Modjeska Ranch area, Santa Ana Mountains. Upper Campanian, Pleasants Member, Williams Formation.

18. Turritella pescaderoensis ? Arnold. Schultz Ranch, Santa Ana Mountains. Uppermost Holz shale member, Middle ? Campanian.

19. Crassatella n. sp. Harding Canyon region, Santa Ana Mountains. Uppermost Holz shale, Middle Campanian.

20. Crassatella tuscana (Gabb). Holz Ranch, Silverado Canyon, Santa Ana Mountains. Middle Holz shale member, Lower - Middle Campanian.

21. Flaventia lens (Gabb). Silverado - Baker Canyon divide, Santa Ana Mountains. Uppermost Holz shale, Middle - Upper Campanian.

22. Euspira sp. cf. E. shumardiana (Gabb). Bell Canyon, Simi Hills. Metaplacenticeras beds, Upper Campanian.

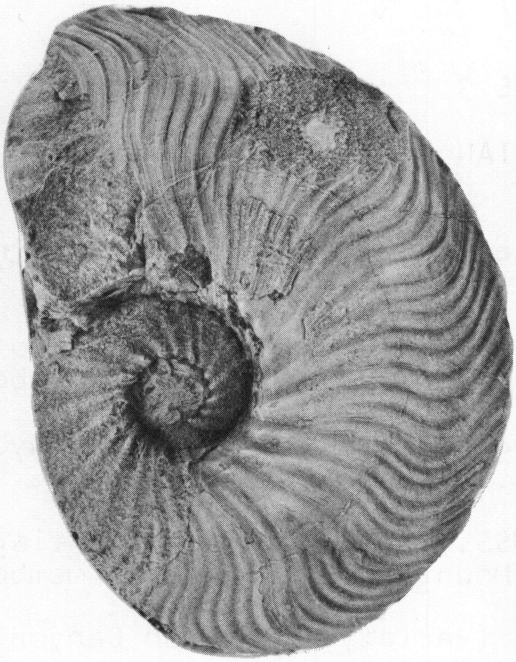
23. Ampullina packardi Popenoe. Aliso Creek headwaters, Corona quadrangle, Santa Ana Mountains. Middle Holz shale member, Lower - Middle Campanian.

24. Turritella chicoensis Gabb. Aliso Creek headwaters, Corona quadrangle, Santa Ana Mountains. Middle Holz shale member, Lower - Middle Campanian.

25. Opis sp. B. West side Holz Ranch, Silverado Canyon, Santa Ana Mountains. Middle Holz shale member, Lower - Middle Campanian.

26. Trinacria cor Popenoe, X2. Modjeska Ranch vicinity, Santiago Canyon, Santa Ana Mountains. Pleasants sandstone member, Williams Formation, and Holz shale. Middle and Upper Campanian.

PLATE 2 - CAMPANIAN FOSSILS



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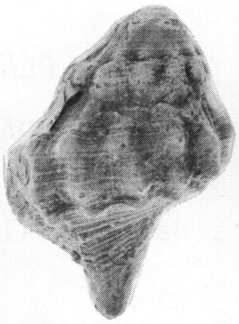

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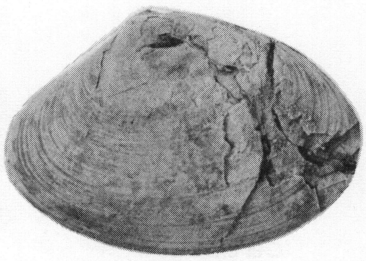

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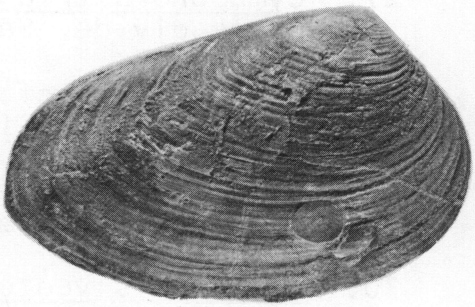

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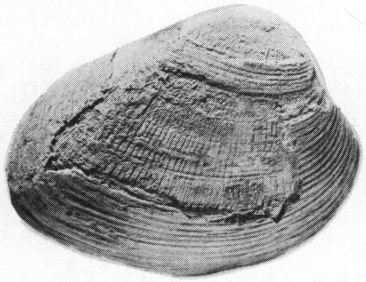

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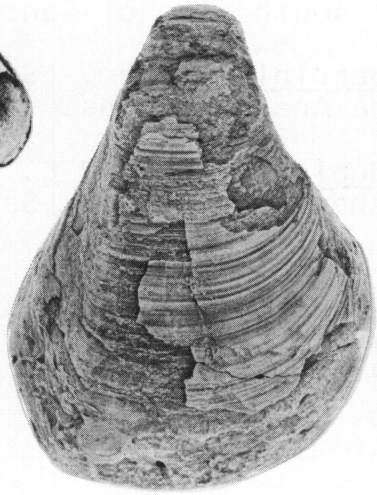

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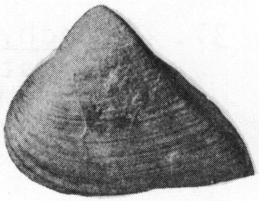

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PLATE 3

UPPER CAMPANIAN FOSSILS

All specimens are natural size except where otherwise indicated.

27. Cymbophora triangulata (Waring). Aliso - Santiago Creek divide, Santa Ana Mountains. Pleasants member.

28. Parallelodon cf. vancouverensis Meek. Dayton Canyon, south side of Simi Hills.

29. Cymbophora "popenoei" (MSS.) Saul. Aliso - Santiago Creek divide, Santa Ana Mountains. Pleasants member.

30. Glycymeris veatchii Gabb (variety). Dayton Canyon, Simi Hills.

31. Biplica obliqua (Gabb), X2. Bell Canyon, south side of Simi Hills.

32. Calva bowersiana (Cooper). Old Pleasants Ranch, Williams Canyon, Santa Ana Mountains. Pleasants member.

33. Idonearca youngi (Waring). Dayton Canyon, south side of Simi Hills.

34. Metaplacenticeras sanctaemonicae (Waring), X$\frac{3}{5}$. Santa Ynez Canyon, south side of Santa Monica Mountains.

35. Turritella perrini Merriam. Santiago - Aliso Creek divide, Santa Ana Mountains. Pleasants member.

36. Clisocolus dubius ? Gabb =? C. cordatus Whiteaves. Bee Canyon, southeast of Tustin, Santa Ana Mountains foothills.

37. Eupachydiscus sp. aff. E. lamberti (Collignon). Scale indicated by ruler. Santa Ynez Canyon, south slope of Santa Monica Mountains.

PLATE 3 - UPPER CAMPANIAN FOSSILS

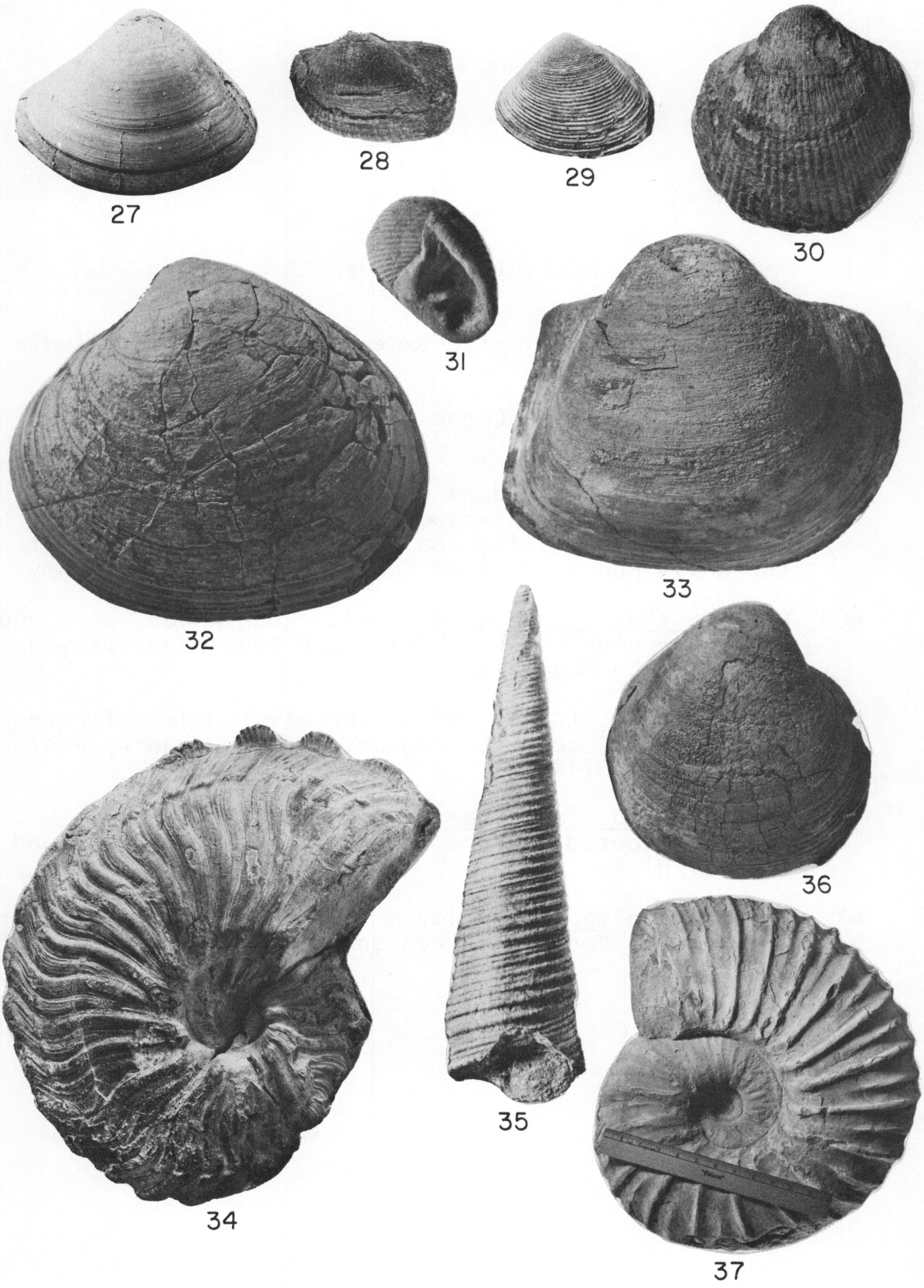

PLATE 4

MAESTRICHTIAN FOSSILS

All figures are natural size except where otherwise indicated.

38. Crassatella lomana Cooper. Lang Ranch, west end of the Simi Hills.

39. Cophocara n. sp. Santa Catarina Landing, Baja California, Mexico. This species occurs at the Lang Ranch, "Ragged Valley shale," near Coalinga, and at the Kelly Ranch, east of Carlsbad, San Diego County.

40. Lispodesthes rotundus (Waring). Lang Ranch, west end and south side of Simi Hills; and Santa Ynez Canyon, Santa Monica Mountains.

41. Calva varians (Gabb), giant variety. Jalama Formation, Point Conception region, and Lang Ranch, west end of Simi Hills.

42. Neodesmoceras catarinae ? (Anderson and Hanna). Scale indicated by foot ruler. Lang Ranch, west end of Simi Hills.

43. Crassatella saulae Dailey and Popenoe. Jalama Formation, Point Conception region, west of Santa Barbara.

PLATE 4 - MAESTRICHTIAN FOSSILS

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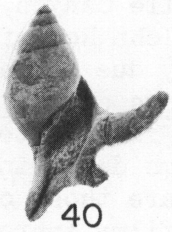

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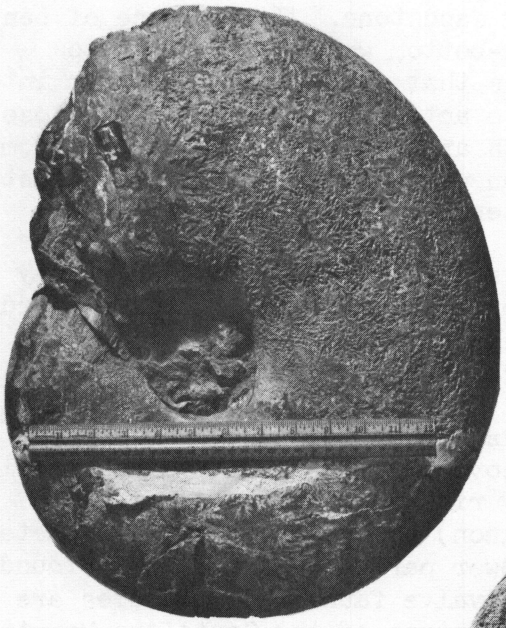

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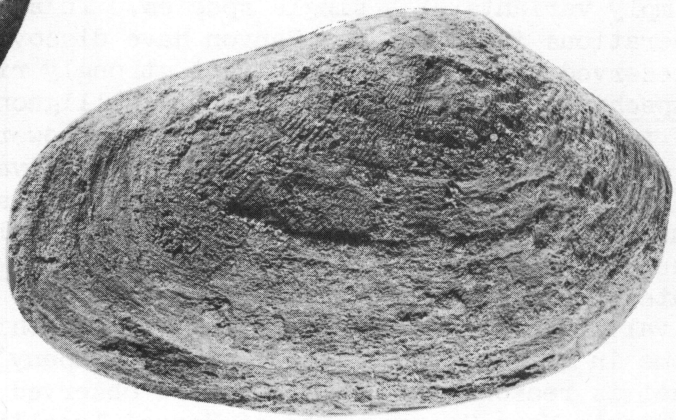

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B. Coarse arkose with interbedded shale and conglomerate. Sparingly fossiliferous.	2500'
A. Red, deeply weathered, unsorted, unfossiliferous conglomerate.	750'
Total thickness	8050'

Champeny recognized and accepted Wilson's five members, but applied the name "Trabuco" to member A, and grouped the four upper members into the "Temescal" Formation (name preoccupied), with B-C and D-E grouped into lower and upper members of the "Temescal Formation."

Member B has yielded three species of Invertebrates as listed by Hoots (1931, p. 91, Calif. Inst. Tech. locality numbers 16 and 18), fossil leaves were found by Wilson on the ridge west of Mandeville Canyon, and Champeny mentions specimens collected by C. Durrell and John Rosenfeld on the ridge between Sullivan and Mandeville Canyons, nearly due north of the Will Rogers ranch. Hoots' collections contained Inoceramus sp., Baculites sp., Otoscaphites ("Scaphites cf. gillisi Anderson") sp. The latter species dates the containing beds as Turonian, and all three forms determine the localities as marine. By far the most abundant remains are those of Otoscaphites, which are almost exclusively preserved as filmy impressions of specimens mashed flat upon the bedding planes of the enclosing fine-grained, thin-bedded sandy shale or shaly sandstone. The absence of benthonic fossil types suggests that the sea-bottom was inhospitable to Turonian shelled mollusks and possibly was that of a stagnant lagoon into which the specimens were drifted from more active waters outside. Close association of the fossiliferous beds with arkosic sandstone and conglomerate, and the fossil leaves found by Wilson would seemingly argue against interpretation of the shale as a deep water deposit.

Wilson's member D is described as a fine-grained, massive, tawny sandstone, friable and easily eroded generally, but being in places hard-cemented. It is usually in these hard-cemented layers that fossils are found. Two of the most common species are Metaplacenticeras sanctaemonicae (Waring) and M. pacificum (J. P. Smith). It is possible that these are simply variants of a single species. In addition, extensive quarrying operations in Santa Ynez Canyon have discovered perhaps half-a-dozen well-preserved specimens of the giant strongly ribbed pachydiscid ammonite Eupachydiscus sp. cf. E. lamberti (Collignon) which may attain a diameter of twenty inches. In addition, in the lower part of the member is found a considerable and varied gastropod and bivalve fauna whose species are almost all found also in the Pleasants Sandstone of the Santa Ana Mountains, and in the localities later discussed in Bell and Dayton Canyons on the south side of the Simi Hills. Presence of Metaplacenticeras definitely dates these beds as Upper Campanian in age. The associated gastropod-bivalve specimens are largely of robust, thick-shelled types that are at home in fairly active water; hence Champeny's estimate of a depth of 120 feet is reasonable. Champeny also observes that the rocks of this member in Santa Ynez Canyon, site of Hoots' locality CIT 54, which yielded by far the greatest variety of species, show (Champeny, 1961, p. 17) "pebble

lenses, large angular erratic shale chips up to 6 inches long in a fine-grained matrix and exhibits graded bedding. Grains are angular and the rock is fairly poorly sorted. The above mentioned evidence suggests that these massive sandstones are turbidites." If this be the case, many of the fossils in this member may have been transported from their regular habitat into somewhat deeper water.

Simi Hills

Cretaceous fossiliferous strata crop out over a wide east-west belt along the crest and southern slopes of the Simi Hills and around the east end of the Simi Valley. Presence of fossils in these exposures and discussions of the faunas are found in papers by Anderson (1902, p. 26), Waring (1917), Kew (1924), Popenoe (1936, 1942), Zebal (1943) and Popenoe (1955, p. 212). The approximately 6,000 feet of strata are now known to contain fossils representing at least three distinct faunal horizons, respectively of Middle Campanian, Upper Campanian, and early Maestrichtian age. The most comprehensive and critical discussion of the Campanian strata and faunas is found in Zebal's excellent paper. Middle Campanian faunas are represented by Calif. Inst. Tech. catalogue numbers 1157 and 1158, from a bluff on the north slope of Bell Canyon about 1 mile due west of the Los Angeles-Ventura County line. The fossils are found in thick calcareous lenses in a siltstone unit which composes the oldest so-far recognized beds in the Simi Hills. The lenses, which may reach a thickness of ten feet are practically a coquina of shell fragments amongst which are found numerous worn and commonly more or less broken specimens of thick-shelled mollusks. So far, these localities have yielded no ammonites but have furnished numerous specimens of Turritella pescaderoensis ? Arnold and are therefore probably correlative with the uppermost beds of the Holz Shale in the Santa Ana Mountains, which also abounds in specimens of this gastropod species. The occurrence and preservation of the specimens suggest deposition of transported shells in a depression in the sea-bottom in shallow water within the zone of fairly strong wave or current action. The limy sandstones including the fossiliferous lenses may be traced for a distance of four or five hundred feet along the strike, and appear to pinch out at both ends into the siltstone.

Upper Campanian fossils occur in several localities (CIT nos. 1154, 1155, 1156, 1159, 1534, 1535, 1537) stratigraphically closely spaced on the ridge between the forks of Dayton Canyon adjacent to the Ventura-Los Angeles County line. Commonly the fossils are found here in definite beds, or as lenses in beds that can be followed for some distance along the strike. The fossiliferous beds are generally of calcareous sandstone stratigraphically above the Bell Canyon beds, and below a belt of siltstone about 200 feet thick, which in turn underlies the massive arkosic sandstone member that composes by far the greatest areal extent of the Cretaceous members. The calcareous sandstone localities practically all yield specimens of Metaplacenticeras californicum (?) (Anderson) which definitely dates the faunas as Upper Campanian, correlative with the Pleasants Sandstone of the Santa Ana Mountains and probably also with Wilson's member D in the Santa Monica Mountains.

The majority of the localities in this member suggest that the contained faunas did not experience marked dispersal or concentration after death, but probably were buried not far from where they lived, in shallow water along an open coast. The reason for this inference lies in the fairly uniform distribution of the faunas in thin but fairly extensive beds, and the preservation of the shells which is relatively good. An exception to this is furnished by CIT locality 1159 = UCLA locality 2336. This has yielded a large and varied fauna from a limestone lens perhaps 10 to 15 feet thick cropping out over an area of several hundred square feet. The lens is packed with shells and shell fragments with a predominance of large thick-shelled species. The conditions of preservation and occurrence are similar to those described at the Bell Canyon localities, but the specimens are on the whole much better preserved and are less worn and fragmental. The lens thins rapidly and becomes less fossiliferous as it is traced southward but may be followed for a quarter-mile or more. It probably represents concentration of dead shells in a relatively quiet and possibly depressed area of sea bottom, by waves and currents, adjacent to an especially favorable feeding ground.

The Metaplacenticeras fauna has been collected from a locality 1500 feet stratigraphically above the base of the arkosic sandstones overlying the Dayton Canyon localities. Zebal describes and interprets this occurrence as follows: "Approximately 1500 feet above the base of the exposed sections of the massive sandstone lies fossil locality CIT 1538. The fauna of this locality was found in a coarse cobble conglomerate near the crest of the eastern portion of the Simi Hills. The occurrence was first viewed as probably being reworked material from the horizon of the sandy member or the lower shale section but during its preparation it was noted that even the minute initial whorls of the Turritella specimens were present. This should delimit the possibility of being water worn through transportation from some other stratigraphic level. Moreover, none of the fossils were included in sandstone cobbles in the conglomerate, but were definitely contained in the matrix between rock fragments. Their relation to the bedding plane of the fragments was in a manner that betokened primary deposition at this horizon." Zebal's observation shows that at least the lower third or fourth of the massive sandstone section is Upper Campanian in age, and is at least so far as known, marine.

The youngest known Cretaceous beds of the Simi Hills are best displayed at the west end and north side of the Simi Hills situated in the western part of the old Lang Ranch approximately along the line between the northeast and southeast quarters of Sec. 36, T2N, R19W, Thousand Oaks quadrangle. Here, above the massive arkosic sandstone member cropping out to the south, and the basal Paleocene conglomerate member to the north is a rather meager exposure of perhaps 250 feet thickness of fine-grained, micaceous, gritty, well-cemented sandstone that contains a fairly large and varied but generally badly leached molluscan fauna. Among the better preserved fossils are specimens of Neodesmoceras aff. catarinae (Anderson and Hanna), Crassatella lomana Cooper, a giant variant of Calva varians (Gabb), and a small undescribed species of Cophocara. These species are all found at other localities generally accepted to be early Maestrichtian in age, and correlative in general with the "Ragged Valley Shale" member of the Panoche Formation in the Coalinga region, with the Jalama Formation

of the Point Conception area, and with the Rosario Formation as exposed on the Kelly ranch 7 miles east of Carlsbad, at Point Loma peninsula, San Diego, and at numerous localities along the Pacific side of Baja California as far south as Santa Catarina Landing. From the appearence of the Neodesmoceras beds it is inferred that they are normal shallow-water neritic-marine sandstone deposited along the open shore of the Cretaceous sea. Lines of well-rounded cobbles cropping out parallel to the sandstone bedding-planes in places may represent seaward-borne beach cobbles transported down-slope during storms.

There is no evidence known, in the southern California Cretaceous, of the presence of any beds as young as the base of the Moreno Group of the San Joaquin Valley.

In summary, the faunas of the Santa Monica Mountains and Simi Hills Cretaceous are groupable into two facies: a Turonian shale facies, barren of sessile benthonic animals, and composed almost exclusively of the probably nektonic scaphitoid ammonite Otoscaphites. The assemblage is thus a thanatocoenose. All of the other localities discussed contain normal marine shallow-water open coast types of animals, which in two places--Bell Canyon and locality CIT 1159 in Dayton Canyon--definitely imply transport, concentration, and attrition after death of the shells, but do not imply bottom living conditions alien to the nature of the rock types in which they are buried. For reasons mentioned above, most of the Dayton Canyon faunas are believed to be essentially biocoenoses.

Surmises as to the sea-water temperature based on the faunas are in my opinion but little better than guesses. Nevertheless, the presence in the faunas of robust Turritella, Idonearca, Volutoderma, and Crassatella, to quote only a few genera, are suggestive of warmer seas than those that now wash the California coast at the same latitudes. Similar and related forms in the Recent seas are usually confined to subtropical or tropical waters.

References cited by author and number are listed in full in the bibliography accompanying the guidebook.