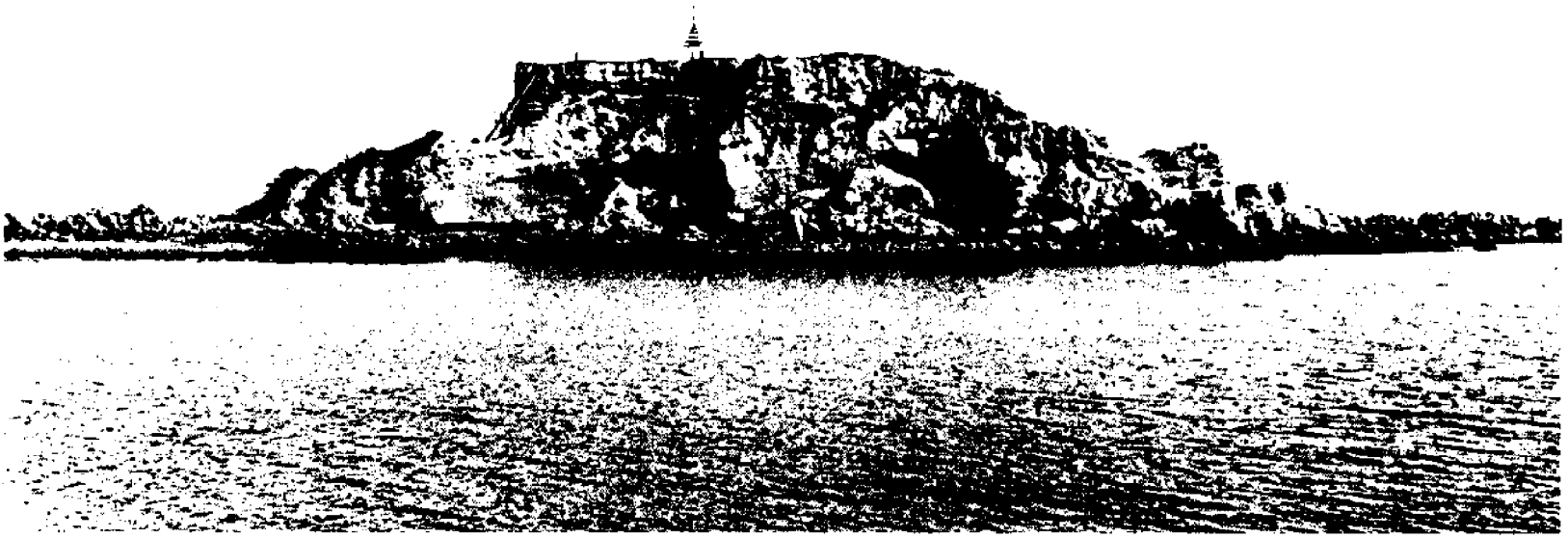
Marine Studies of San Pedro Bay, California

PART 9

PALEONTOLOGY



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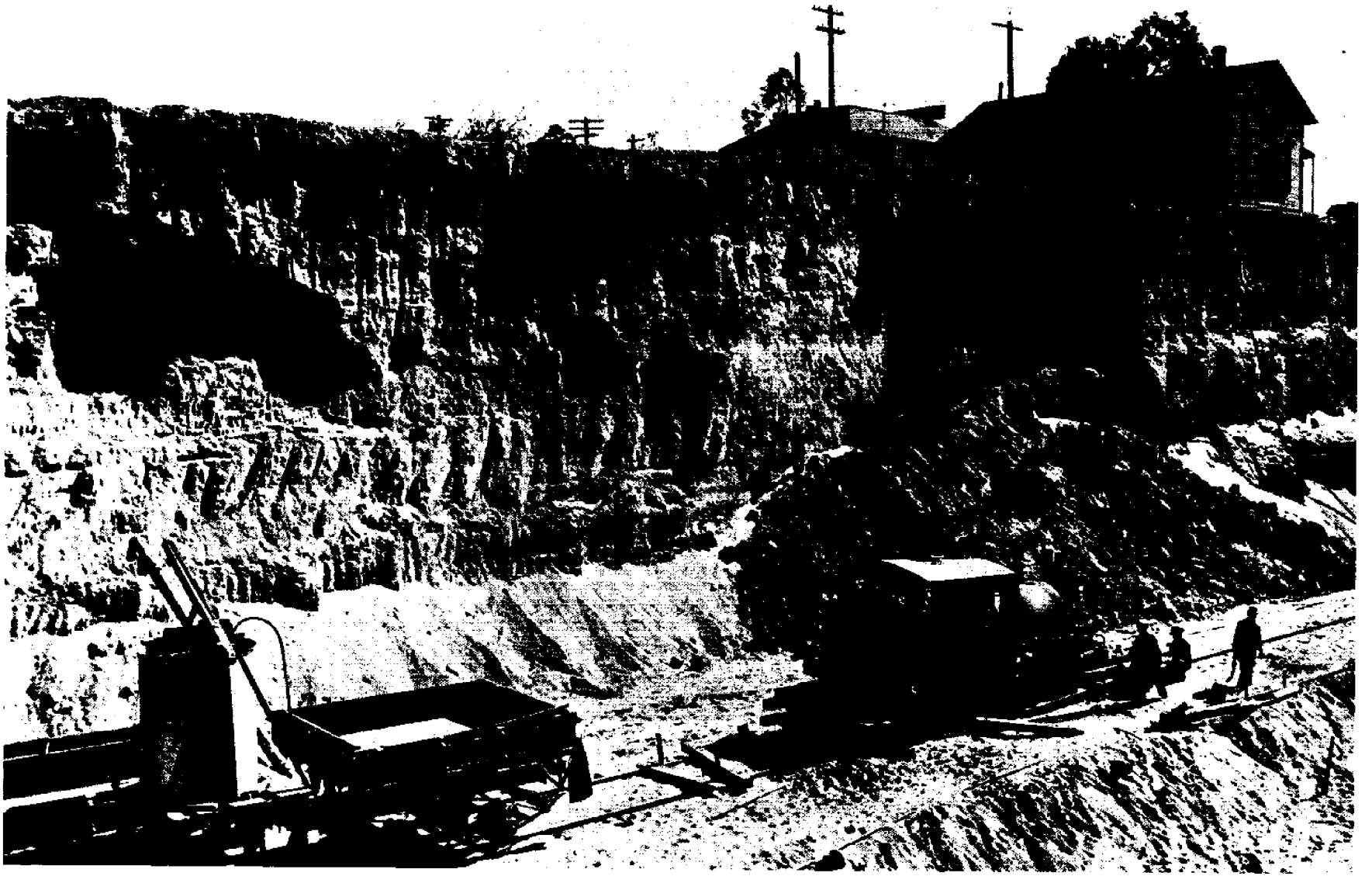

East wall of Orizaba Street cut near 2nd Street, San Pedro (late 1915). *(Photograph by courtesy of Los Angeles County Museum of Natural History.)*

MARINE STUDIES OF SAN PEDRO BAY, CALIFORNIA

PART 9, PALEONTOLOGY

June 1975

PALEONTOLOGIC RECORD OF AREAS ADJACENT TO THE LOS ANGELES AND LONG BEACH HARBORS, LOS ANGELES COUNTY, CALIFORNIA

by

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On the cover: Deadmans Island from across channel, San Pedro Bay, November 4, 1915. *(Photograph by courtesy of Los Angeles County Museum of Natural History.)*

Paleontologic Record of Areas Adjacent to the Los Angeles and Long Beach Harbors, Los Angeles County, California

Abstract. This report deals with the paleontological record of a four-mile wide strip of land immediately adjacent to the Los Angeles and Long Beach Harbors in Los Angeles County, California.

Although the area in and around San Pedro contains the greatest sequence of lower and upper Pleistocene marine invertebrate fauna in western North America, there has never been any attempt to preserve these fossiliferous outcrops. As a consequence, the type localities of the Palos Verdes Sand and the San Pedro Sand at Deadmans Island have been destroyed. The following areas should be preserved: 1) the type locality of the Timms Point Silt, at Timms Point, San Pedro (city of Los Angeles); 2) the type locality of the Lomita Marl, in the vicinity of Lomita Quarry and western extent of the Gaffey Syncline (cities of Torrance and Rolling Hills Estates); and 3) exposures of the Timms Point Silt and Lomita Marl on Second Street between Pacific Avenue and Mesa Street, San Pedro (city of Los Angeles). An annotated bibliography is included reviewing the available literature on the paleontology of the San Pedro, Wilmington, Long Beach, and Signal Hill areas.

Introduction

Paleontological reports are conspicuously absent in most environmental impact studies. In an attempt to remedy this situation for an area approximately four miles wide around the perimeter of San Pedro Bay (Los Angeles and Long Beach Harbors region), published and unpublished reports, supplemented by museum fossil collections, were examined to compile information on the fossil faunas and fossiliferous outcrops of the area. Areas around San Pedro are abundantly fossiliferous and many studies have been based on the fossils from this region. Documentation of the Pleistocene faunas is rather complete in some groups of organisms, such as the mollusks, and incomplete in most others. Few fossiliferous localities are known or

documented from the Wilmington, Long Beach, and Signal Hill areas.

Except for foraminifera from the local oil fields, most of the documentation in this report summarizes previously published material. However, unpublished faunal lists of ostracods from the Pleistocene of San Pedro, mollusks from the Pliocene and Pleistocene of Long Beach, and vertebrates from the Miocene, Pliocene, and Pleistocene of San Pedro, Wilmington, and Long Beach areas are added.

Within the project area, fossiliferous surface exposures exist for the Palos Verdes Sand (upper Pleistocene); San Pedro Sand, Timms Point Silt, and Lomita Marl (lower Pleistocene); Fernando Formation (upper Pliocene); "Repetto" Formation (lower Pliocene); and the Malaga Mudstone, Valmonte Diatomite, and Altamira Shale (middle and upper Miocene).

Maps of the project area have been compiled to show the general outcrop pattern of the local formations, and of known fossil localities represented by material preserved in the following museums and universities: San Diego Society of Natural History (SDSNH), Natural History Museum of Los Angeles County, Los Angeles (LACM), California Institute of Technology, Pasadena, (CIT), University of California, Los Angeles (UCLA), U.S. Geological Survey, Menlo Park (USGS-M), California Academy of Sciences, San Francisco (CAS), and University of California Museum of Paleontology, Berkeley (UCMP).

An annotated bibliography, reviewing the available literature on the paleontology of the project area, includes about 400 citations.

ACKNOWLEDGMENTS

This project could not have been completed without the help of numerous people. I am indebted to Paul E. Langenwalter, Natural History Museum of Los Angeles County, Los Angeles, for preparing the section on vertebrate fossils, and for discussions on the paleontology of the region. I should like to thank the following for courtesies extended during this endeavor: W. O. Addicott, USGS-M; L. G. Barnes, LACM; J. T. Carlton, University of California, Davis (UCD); R. E. Casey, Rice University, Houston; Bert Draper, LACM; Helen DuShane, LACM; J. T. Gregory, UCMP; R. W. Huddleston, LACM; E. M. Kennedy, Grossmont College, El Cajon; Bruce Lander, UCMP; J. H. Lipps, UCD; Heinz Lowenstam, CIT; William Mason, LACM; R. M. McCall, University of Southern California, Los Angeles (USC); R. M. McKenzie, LACM; P. G. Owen, LACM: J. H. Peck, Jr., UCMP; Frank Peska; P.U. Rodda, CAS; M. A. Roeder, LACM; Arnold Ross, SDSNH; Barry Roth, CAS; L. R. Saul, UCLA; D. F. Soule, USC, Allan Hancock Foundation; Jan Tobiska, SDSNH; J. W. Valentine, UCD; E. C. Wilson, LACM; and W. P. Woodring, USGS-Washington. Cheryl Bridwell drafted Maps 4 & 5.

Special thanks are due Page C. Valentine, USGS-Woods Hole

and John E. Fitch, California State Fish and Game Laboratory, Terminal Island, for the use of their own unpublished data on ostracods and fish remains, respectively, from the Pleistocene deposits of the San Pedro area.

I should also like to express my appreciation to my parents, who, through personal subsidies, prevented this study from suffering an untimely end.

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GEOGRAPHIC AREA

The area covered by this report includes the land bordering San Pedro Bay, or the Los Angeles and Long Beach Harbors. On the east it is bounded by the eastern edge of Long Beach and Los Angeles County. Extending westward, the area includes the southern half of Long Beach, Signal Hill, the southernmost part of Carson, the communities of Wilmington and Harbor City, and Lomita. All of San Pedro is included, as well as some presently unincorporated areas of the Palos Verdes Hills immediately to the west. The area extends northward from the Pacific Ocean along a line approximately following Palos Verdes Drive East, including the easternmost portions of Rolling Hills Estates, and the southeast corner of Torrance.

The boundaries set by Langenwalter for inclusion of vertebrate records are esentially the same, except that the northern boundary is Carson Street, and the eastern boundary is Lakewood Boulevard and its projection.

GEOLOGY

There presently exists no single detailed geologic map of the San Pedro and Long Beach area. The Palos Verdes Hills, including San Pedro and north to Bixby Slough (now Harbor Lake), were mapped in detail by Woodring, Bramlette and Kew (1946, pls. 1 and 14). Poland, et al, "and others" (1956) mapped the Wilmington, Long Beach, and Signal Hill area in less detail. The only formations mapped in the latter area are the "San Pedro Formation" and the Palos Verdes Sand. The latter unfortunately is not distinguished from, and is mapped with, the overlying Quaternary terrace cover. Extensive areas of Quaternary alluvium are mapped in the ancient Los Angeles River and San Gabriel River Channels. The geology of the entire region has been discussed by Yerkes, et al., (1965). Each of these reports includes bibliographies of the geology of the region.

Geologic cross-sections, based on oil and water well data, exist for much of the Wilmington, Long Beach, and Signal Hill

areas. The Wilmington oil field is an extension of the Torrance oil field and is probably related to the Palos Verdes Fault, which trends in a NW-SE direction along the northern border of the Palos Verdes Hills. The Long Beach oil field (Signal Hill) and the Seal Beach oil field to the immediate southeast lie along the extensive Newport-Inglewood Fault zone. In the Signal Hill area these faults have been individually named.

Cross-sections of Signal Hill and northward, and of Terminal Island and north by northeastward can be found in Poland, et al. (1956, pl. 1). A less detailed (lithologically) cross-section from the Palos Verdes Hill to Signal Hill is in Yerkes, et al. (1965, pl. 4). Geologic sections, trending approximately north by northwest through the Palos Verdes Hills, are shown on the geologic map of Woodring, Bramlette, and Kew (1946, pl. 1). Generalized columnar sections of the stratigraphy, with correlations by formation, of the Palos Verdes Hills, Wilmington oil field, and the Long Beach oil field (Signal Hill) have been compiled by Poland, et al. (1956, pl. 6) and by Yerkes, et al. (1965, pls. 1 and 2). Additional subsurface geology for the Wilmington and Long Beach areas can be found in more detailed reports of the individual oil fields which occur in these areas.

FOSSILIFEROUS FORMATIONS WITH SURFACE EXPOSURES

The fossiliferous sediments in the San Pedro and Long Beach areas which are present in surface outcrops are discussed in detail in subsequent sections of the present paper. Terminology for the subsurface rocks in the area is not standardized. Names that have been assigned to these subsurface units were derived from similar sediments which lie on the margins, or outside of, the present Los Angeles Basin. Although the nomenclature for these subsurface formations is somewhat confused, their structure, stratigraphy, and foraminiferal zonation are well documented. They have not been treated separately in the following discussions.

UPPER PLEISTOCENE

Palos Verdes Sand

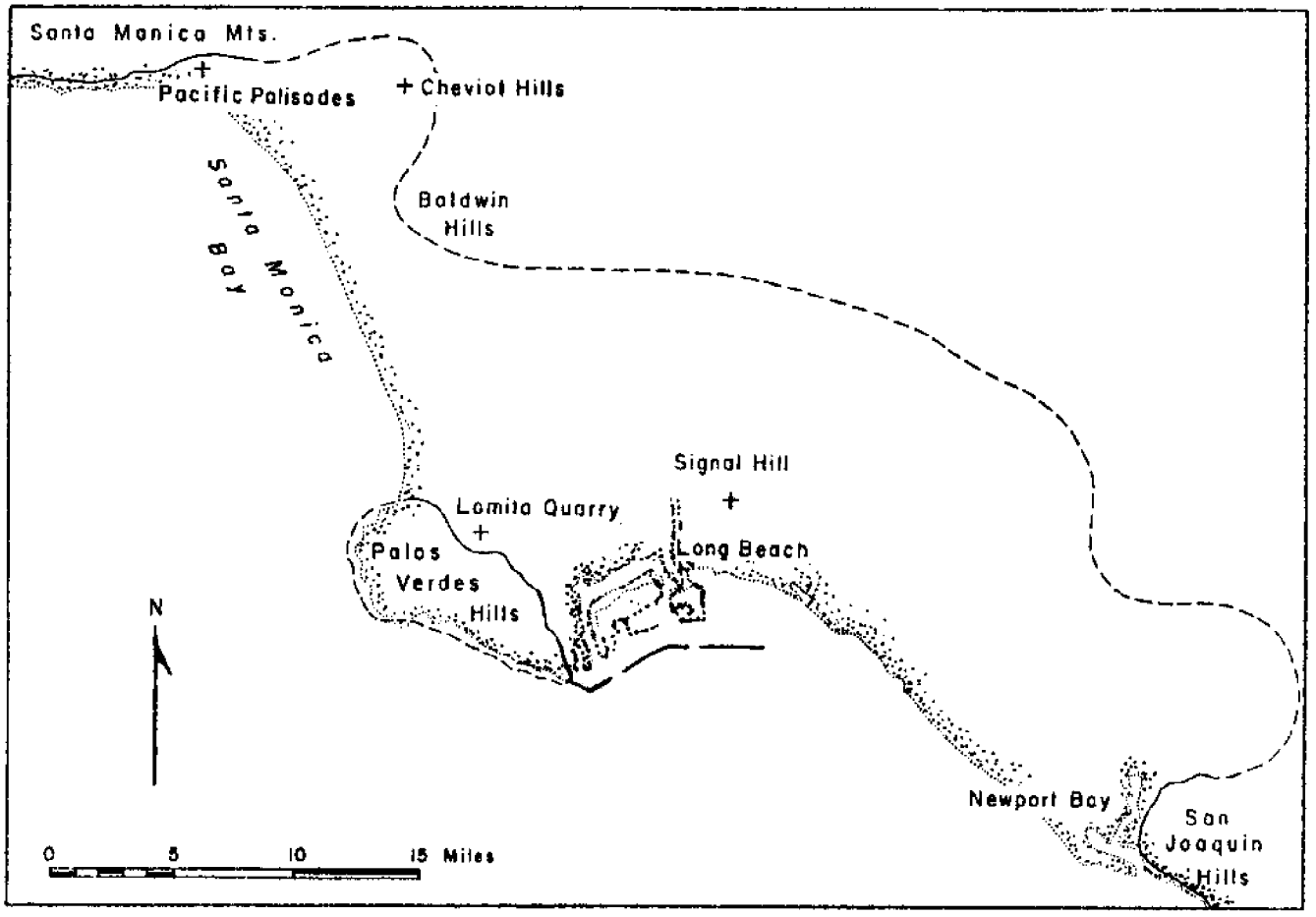
Historical Aspects. The first significant mention of late Pleistocene sediments at San Pedro was made by Blake (1856), in the Pacific Railroad Surveys. He assigned the fossils, described by T. A. Conrad (1855c), to a "Recent formation" exposed on the thirty foot high bluffs at San Pedro. These sediments were later described and referred to as the upper part of the "San Pedro Series" by Arnold and Arnold (1902). The entire "San Pedro Series" (the upper now being the Palos Verdes Sand, the lower the San Pedro Sand) was represented by good exposures "at Deadman Island (since destroyed), and it is this section which is taken as the type." (Arnold and Arnold, 1902: 119). However, later in the same paper the authors (p. 126) cite

"The best development of the upper San Pedro series is found in the bluff at the lumberyard north of San Pedro,..., where the alternating fossiliferous beds of gravel and sand obtain a thickness of twenty feet." Both Deadmans Island and the bluff area have since been destroyed, and there presently exists no abundantly fossiliferous outcrops of the Palos Verdes Sand along the San Pedro waterfront which could be considered equivalent to the type exposures of the "upper San Pedro series."

The term "Palos Verdes Formation" was first used in published form by Tieje (1926) for late Pleistocene sediments in the Baldwin Hills. He apparently got the name from an unpublished manuscript by W. S. W. Kew on the geology of the Palos Verdes Hills. According to Woodring, Bramlette and Kew (1946: 56), Kew restricted the term "San Pedro" to Arnolds' lower San Pedro series and adopted the name "Palos Verdes formation" for Arnolds' upper San Pedro series. In 1946, Woodring, Bramlette and Kew designated the formation the "Palos Verdes sand" because of its dominant lithology. This terminology, properly capitalized Palos Verdes Sand, is still in use.

The Palos Verdes Sand was restricted by Woodring, et al., (1946) to the sand and gravels, exclusive of any non-marine cover, which occurred on the lowest emergent terrace and were best exposed along the northern and eastern slopes of the Palos Verdes Hills (see their pl. 1 for map). Subsequently, the name has been applied to the latest Pleistocene fossiliferous sands on the lowest emergent terrace on the present coastal borders of the Los Angeles Basin, from Pacific Palisades in the north to Newport Beach in the south. Lithologically it is dominated by coarse terrace sands and some gravels. Marincovich (1970:18), in the latest study of the Pleistocene of the Palos Verdes Hills, has restricted the use of the term Palos Verdes Sand to the Palos Verdes Hills, but includes all the upper Pleistocene marine deposits on all of the emergent and submergent terraces.

Exposures. In the present paper, the Palos Verdes Sand includes all of the upper Pleistocene marine terrace deposits in the project area, and especially those of the lowest emergent terrace exposed around the perimeter of the Palos Verdes Peninsula. In the Wilmington area (Yerkes, et al., 1965; pl. 1), late Pleistocene sediments, probably assignable to the Palos Verdes Sand, occur below about 49 meters of alluvium and fluvial gravels of the ancient Los Angeles River. Outcrops are not common in the Long Beach area, but have been found along the bluffs on the ocean (Arnold, 1903), along the terrace slope near the ancient San Gabriel River channel, and on Signal Hill, which is draped by these late Pleistocene sediments (Arnold, 1903; DeLong, 1941). Fossiliferous deposits of the Palos Verdes Sand can be expected to occur anywhere on the Long Beach plain, or in the Palos Verdes Hills where they may truncate or cap Pleistocene or Miocene "basement" sediments. See Map 1, from Valentine (1961) of inferred shoreline.



Map 1. Sketch map of the Los Angeles basin showing the inferred position of the shore line during high sea stand on terrace 1 at Palos Verdes Hills, on the Dume terrace in the north, and on an unnamed low terrace in the San Joaquin Hills to the south; this is dashed where covered. Dotted line is present coast line. Lower Pleistocene localities have no relation to coast lines shown. (After Valentine, 1961, p. 366, fig. 6).

Environment and Fauna. Paleoecological reconstructions of the San Pedro and Long Beach areas, based on molluscan evidence, have been made by J. W. Valentine (1961: 368-380). Chart 1 is a summary of inferred paleoecology, based on estimates of various authors.

From the ocean to Signal Hill, in the Long Beach area, the faunas now assigned to the Palos Verdes Sand are essentially those of Valentine's Tellina bodegensis-Forreria belcheri community; i.e., one inhabiting the shallow, inner sublittoral (0 to 27 meters) on a chiefly sandy bottom. Included, however, are species which represent protected shore, rocky shore, and exposed sandy beach habitats. Several southern extra-limital (warm water) species are also present, although no Oregonian (cooler water) forms have been found. DeLong (1941) considered the Palos Verdes Sand fauna from Signal Hill to be a warm water one.

In the San Pedro and Palos Verdes Hills area, J. W. Valentine (1961) characterized the molluscan fauna as an exposed beach community of the Tivela stultorum-Donax gouldii type; i.e., exposed sandy shore, at depths of 5.5 to 9 meters. Typical rocky shore faunas did not develop because the terrace is cut into poorly consolidated lower Pleistocene and Miocene sedimentary rocks. In addition, Valentine says, "At times shallow embayments must have developed along the shore, supporting tidal flat communities at their heads. Protected faunas graded into and interfingered with those of the shallow, inner sublittoral zone, inhabited by a Tellina bodegensis-Forreria belcheri community".

In northern San Pedro and along the northern border of the Palos Verdes Hills a large, warm water, shallow, inner sublittoral and protected shore fauna developed in the lee of Palos Verdes Island (now Palos Verdes Hills) and in embayments on the northeastern side. The deposits on the southern, exposed face, including the upper terraces, have been assigned to the Palos Verdes Sand by Marincovich (1970). These represent mostly exposed rocky shore and tide pool associations and are not significantly different from the faunas on the lower, and lowest, terrace in San Pedro proper, except in the nature of the predominant habitat (Marincovich, 1970). Both northern and southern extra-limital species of offshore communities are present in the older terrace deposits (J. W. Valentine, 1961).

The invertebrate faunas of the Palos Verdes Sand and of other late Pleistocene terrace deposits in southern California, are usually considered to represent warmer water conditions than prevail off the local coast today. Evidence given for this is usually the presence of several southern, extra-limital species in the faunas. Paleotemperatures determined by Valentine and Meade (1961) using oxygen isotope ratios on Pleistocene mollusks from two localities in San Pedro were: 18.2°, 15.2°, 12.3°, and 11.3°, 12.3°, 12.3°, 12.6°C. Minimum and maximum temperatures thought necessary to support these species

Paleoecology

INFERRED MARINE ENVIRONMENT
(abstracted from various sources)

AGE	FORMATION	DEPTH	TEMPERATURE (^{o}C)	OTHER
Pleistocene	Palos Verdes Sand	0-27m	11^{o}-21^{o}(mollusks) 13^{o}-18^{o}(ostracods)	Contains Surian (Warm water) mollusks
	San Pedro Sand	18-27m at top 92m at base	11^{o}-14^{o}(mollusks) (7^{o} at 92m)	
	Timms Point Silt	137-183m at top 46-92m at base	11^{o}-14^{o}(mollusks) (5^{o}-8^{o} at 92m) 13^{o}-18^{o}(ostracods)	
	Lomita Marl	46-92m at top 92-183m at base	11^{o}-21^{o}(mollusks) 13^{o}-18^{o}(ostracods)	Contains both northern and southern species
Pliocene	Fernando Formation	0(?)-46m	similar(?) to southern California now	Mollusks chiefly sandy bottom
	"Repetto" Formation	2000-2500m		
Miocene	Malaga Mudstone	>915m	similar(?) to southern California now	
	Valmonte Diatomite	"bathyal"	similar(?) to southern California now	
	Altamira Shale	180-915m		Contains tropical mollusks

CHART 1

found at the two localities sampled for isotope data were 14° to 21°C and 11° to 21°C (Valentine and Meade, 1961). Grant (1936) has suggested a temperature of 21.1°C for the Palos Verdes Sand. Temperature tolerances suggested by modern geographic ranges of 31 species of Holocene ostracods found in the Palos Verdes Sand indicate a range of 13° to 18°C for the formation (P.C. Valentine, 1973).

The invertebrate fauna of the Palos Verdes Sand in San Pedro and Long Beach area is large and is dominated by mollusks which have been well studied. However, most of the non-molluscan phyla are represented by few species. Arthropod groups appear to be next in abundance. Thirty-nine species of ostracods have been found in the Palos Verdes Sand of the San Pedro area by P.C. Valentine (1973) listed herein, and several papers have dealt with the fossil crabs of the area. Fish remains are cited by Fitch (1970), and other vertebrates are listed by W. E. Miller (1971), and by Langenwalter in the present paper.

The following papers cite 20 or more species of Pleistocene mollusks from localities considered in the present paper to be from the Palos Verdes Sand, including some from the upper terraces of the Palos Verdes Hills: Arnold (1903, 1906); Chace (1966); Chace and Chace (1919); E. M. Clark (1943); Cook and Clark (1943); Crickmay (1929b); DeLong (1941); Gabb (1869); Marincovich (1970); Meals (1973); Mount (1970a,b); Natland (1957); T. S. Oldroyd (1914); Peska (1975); J. W. Valentine (1961, 1962a); Valentine and Meade (1961); Watts (1900(1901)); Woodring, Bramlette, and Kew (1946); and a list herein.

LOWER PLEISTOCENE

San Pedro Sand Formation

Minor variances of opinion exist as to whether the Timms Point Silt and Lomita Marl should be given full formational status or be considered formal members (with the San Pedro Sand, s.s.) of the San Pedro Formation(s.l.). Without judging on either the validity or heirarchy of the above, I use each in its restricted sense whenever possible.

San Pedro Sand

Historical Aspects. The term "San Pedro beds" was first used by Dall (1898a:335)for ..."the extensive beds of unconsolidated Pleistocene sand replete with molluscan shells in very perfect condition, best exhibited at Harbor Hill, at the head of San Pedro Harbor, California." Arnold and Arnold (1902) divided their "San Pedro series," which they credited to Dall, into an upper unit (now the Palos Verdes Sand) and a lower one (the San Pedro Sand of today). They distinctly set the type section (p. 119) to be that "represented at Deadman Island." Ralph Arnold (1903) later cited the type region to be the San Pedro waterfront. In 1926, Tieje separated the "upper San Pedro

series" and named it the Palos Verdes formation, retaining "San Pedro" for the lower beds. Grant and Gale (1931) referred to these beds as the "typical San Pedro zone." Woodring, et al. (1946) formalized the name "San Pedro sand" for these deposits. They regarded the type region to be "along the San Pedro waterfront." The San Pedro Sand is the currently accepted name for these deposits in the Palos Verdes Hills, but has not gained as much acceptance as the "San Pedro Formation" in the Wilmington, Long Beach, and Signal Hill areas (Poland, et al.,1956; Yerkes, et al., 1965).

Exposures. In the Palos Verdes Hills, the San Pedro Sand occurs from the central San Pedro waterfront area toward the northwest, where it is exposed in most of the stream valleys which transect the late Pleistocene terrace plain. The outcrops continue in patches along the northern border of the hills (see maps in Woodring, et al., 1946, pls. 1, 14, 21). Presently the only major area in conflict with these maps, in the San Pedro area, is where the terrace cover has been removed from south of the Union Oil Company refinery, between Gaffey Street and San Pedro and Wilmington Road. Exposures of the San Pedro Sand in Wilmington, Long Beach, and Signal Hill areas have been mapped by Poland, et al., (1956: pl. 3). Outcrops, as in the area north of San Pedro, occur in stream and river channel cuts in the terrace. Additional areas of outcrop are present in the Signal Hill area(DeLong, 1941) where the late pleistocene sediments have been removed by erosion. (The Signal Hill uplift occurred after deposition of the overlying sediments (Yerkes, et al., 1965:20).

Woodring, et al., (1946) believed the maximum thickness of the San Pedro Sand (s.s.)exposed in the Palos Verdes Hills to be about 61 meters, with an additional 91 meters of Timms Point and Lomita below that. Poland, et al., (1956) estimated the thickness for the entire San Pedro Formation (s.l.) from well data to be about 245 meters in the vicinity of Bixby Slough (now Harbor Lake), thinning to about 200 meters on the south flank of the Wilmington anticline. The San Pedro Formation is about 150 meters thick on the southwest flank of the Long Beach oil field (Yerkes, et al., 1965).

Environment and Fauna. The paleoecologic setting for deposition of the San Pedro Sand has been worked out largely on the basis of fossil mollusks, the dominant fauna, by Valentine, (1961: 400-404) and by Valentine and Meade (1961). The San Pedro Sand was probably deposited at depths of from 92 meters near the base, to about 18-27 meters at the top, and represents a shoaling condition during sedimentation. According to Poland, et al., (1956), the San Pedro Sand, in the subsurface of the Long Beach plain, probably represents strata both older and younger than those along the San Pedro waterfront. This is due to interruption of near shore deposition, while sedimentation was continuous in deeper parts of the basin.

Because of the shoaling sequence within the San Pedro Sand, the molluscan assemblages varied according to the physical nature of the nearshore habitat, as well as to depth and temperature. At the type locality on Deadman Island, the San Pedro Sand was considered by Woodring, et al., (1946) to be a shallow, outer sublittoral fauna. Valentine (1961) found that approximately three quarters of this fauna was divided equally among three molluscan communities, the Tellina bodegensis-Forreria belcheri community (shallow inner sublittoral, 0 to 27 meters, chiefly sand bottom), the Lucinoma annulata-Turcica caffea community (deep inner sublittoral, 18 to 27 meters, silt and clay bottom), and a Mytilus californianus-Littorina planaxis community (exposed rocky shore, 0 to 9 meters). Another 17 percent represented outer sublittoral depths.

In the Signal Hill area, outcrops of the San Pedro Sand have produced faunas similar to those found in the San Pedro area. According to Valentine (1961), the fauna is dominated by a mixture of the Tellina-Forreria and Lucinoma-Turcica communities, with a few outer sublittoral forms and several offshore northern extra-limital species. Water depth was suggested to have been between 27 and 46 meters and was probably cooler at that depth than today.

Paleotemperatures of the ocean during deposition of the San Pedro Sand averaged about 13°C according to Grant (1936). Valentine (1961) notes that all of the faunas representing depths greater than 27 meters require water cooler than those in the area today. Paleotemperatures indicated by oxygen isotope ratios for five species, mostly of deep, inner sublittoral mollusks from two localities in the San Pedro Sand, have given temperatures of 10.4°, 10.7°, and 8.1°, 6.4°, and 9.4°C (Valentine and Meade, 1961).

Comprehensive papers on most animal groups usually have not distinguished formational units in the Pleistocene of the San Pedro area and, as with older paleontological works, the faunas cannot be attributed to the San Pedro Sand with any certainty. Rathbun's (1926) work on the fossil malacostracans is the only extensive list of non-nolluscan species known to have come from the San Pedro Sand. This locality was the Nob Hill exposure of T.S. Oldroyd (1924(1925)). Papers citing molluscan faunas of at least 20 species from the San Pedro Sand are: Arnold (1903, 1906), B. L. Burch (1947), Crickmay (1929b), DeLong (1941), Natland (1957), T.S. Oldroyd (1924(1925)), Valentine (1961), Valentine and Meade (1961), and Woodring, Bramlette and Kew (1946).

A discussion of the vertebrates from the San Pedro Sand can be found in the subsequent section by Langenwalter and includes many previously unpublished records.

Timms Point Silt

Historical Aspects. The Timms Point Silt was first recognized and distinguished from the "San Pedro series" by Delos and Ralph Arnold (1902) as the "brown Pliocene sandstone formation" which underlay their Pleistocene "San Pedro series." This formation was often referred to as "Arnolds' Pliocene" but was not named for some years. Tieje (1926) was apparently the first to recognize that the Timms Point Silt was Pleistocene in age. Crickmay (1929) in a study of the fossils of Deadman Island referred these beds to the "Santa Barbara formation." Gale (Grant and Gale, 1931) referred the beds at Timms Point to the "Timms Point zone." The term "Timms Point formation" was first used by Clark (1931) in a "Check list of fossils from the Timms Point formation at Timms Point." In the same paper he clarified the situation with: "..., the name Timms Point (Formation) is proposed for the silts and sands overlying the Miocene shale and underlying the lower San Pedro sands, with the section described at Timms Point ("on the east face of the bluff just south of the concrete retaining wall," (p. 29)) as the typical section." The terminology "Timms Point silt" was adopted by Woodring, Bramlette and Kew (1946) to indicate the dominant lithology of this unit. The name is still in use today, with proper capitalization.

Exposures. Outside of the San Pedro-Long Beach area, silts that carry faunas somewhat similar to those of the type area at Timms Point crop out in Santa Monica Canyon, the Baldwin Hills, the Cheviot Hills (Valentine and Meade, 1961) and in the Newport Beach area. The silts in the Cheviot Hills were given their own formational names by Rodda (1957). In the area under investigation, the Timms Point Silt occurs at the surface only in San Pedro and along the northern border of the Palos Verdes Hills. As mapped by Woodring, et al., (1946), the Timms Point Silt occurred in San Pedro at the type locality, as well as in the area roughly bordered by Sixth and Ninth Streets and by Mesa and Center Streets; (the only remaining exposure on Nelson Street); and at the corner of Third and Mesa Streets (now destroyed), and on Second Street between Pacific Avenue and Mesa Street. Outside of San Pedro, one tiny exposure has been mapped near Crenshaw Boulevard in Torrance, although additional fossil material from Walteria (Torrance) is present in the UCLA and LACM collections.

In the subsurface, fossils of an undesignated nature belonging to the Timms Point Silt have been found in wells at a depth of approximately 335 meters along the western edge of Wilmington (Poland, et al., 1956). Timms Point faunas have also been identified by M. L. Natland from wells to the northeast of Signal Hill at depths between 214 and 244 meters (Poland, et al., 1956).

Environment and Fauna. At the type locality of the Timms Point Silt in San Pedro, A. Clark (1930, 1931) divided the formation

into three stratigraphic units. The uppermost (bed 1) is interpreted to represent depths between 137 and 183 meters, and indicates temperatures cooler than those of today at the same depths. The fauna from this bed contains species representative of several of Valentine's faunal communities, including a large number of northern extra-limital Oregonian species. The molluscan fauna of bed 2 is similar to that of bed 1, but probably represents shallower water, perhaps between 92 and 137 meters. Bed 3 at Timms Point is considered representative of the shallow, outer sublittoral Thyasira gouldi -Neptunea tabulata community at depths between 46 and 92 meters and temperatures lower than at these depths at this latitude today. Valentine and Meade (1961) have suggested the limiting range of sea surface temperatures to be between 11° and 14°C (6°C at 92 meters) for the Timms Point Silt. Isotopic paleotemperatures of 13.8°C for a littoral species and 5.7°, 5.7°, and 7.6°C for outer sublittoral species have been recorded by these authors.

On Deadmans Island, the mollusks of the Timms Point Silt all represent habitats at depths greater than 92 meters, and suggest cool water (Valentine (1961)). In downtown San Pedro on Second Street the fauna of the Timms Point is a Cyclocardia barbarensis-Antiplanes perversa association representing the deep, outer sublittoral, 92 to 183+ meters, chiefly on mud bottom. Temperature tolerances of 19 species of Holocene ostracods found at the same locality indicate minimum and maximum sea surface temperatures of 13° to 18°C for the Timms Point Silt (P.C. Valentine, 1973).

The fauna of the Timms Point Silt is more varied than that of the other Pleistocene formations in the area and contains sizable numbers of organisms other than mollusks. The foraminifera have been described by Bagg (1912) and by Cushman and Gray (1946a,b); the bryozoans by Canu and Bassler (1923), A. Clark (1931), and Soule and Duff (1957); and the ostracods by P.C. Valentine (1973; listed herein, page 34). Studies citing 20 or more species of fossil mollusks from the Timms Point Silt (or "Arnolds' Pliocene") are: Arnold (1903, 1906), Ashley (1895), B.L. Burch (1947), A. Clark (1931), Crickmay (1929b), DeLong (1941), Grant and Gale (1931), Natland (1957), J. W. Valentine (1961), and Woodring, Bramlette, and Kew (1946). The vertebrates are discussed by Fitch (1968) and Langenwalter (herein).

Lomita Marl

Historical Aspects. Sediments now assigned to the lower Pleistocene Lomita Marl do not crop out along the San Pedro waterfront, and consequently were not recognized by Arnold and Arnold (1902) or Arnold (1903). Woodring (1930) noted the presence of "so-called Pliocene deposits" in several localities in and around San Pedro, and commented on the warm water aspect. Gale (Grant and Gale, 1931) correlated the thick sequence which underlay the Timms Point Silt, and contained a warm water

Pleistocene fauna, with the Las Posas zone of Ventura County. He noted the best exposures were at Lomitas Quarry, and at Hilltop Quarry, now built over. The term Lomita formation had come into local usage and had been mentioned casually in other printed reports before Woodring, Bramlette and Kew (1946) formalized the name "Lomita Marl" with the type locality being near Lomita Quarry, in the western part of the Gaffey Syncline. Lomita Marl is the currently accepted name for these deposits.

Exposures. Surface exposures of the Lomita Marl occur only in San Pedro and on the northern border of the Palos Verdes Hills. As mapped by Woodring, et al., (1946) outcrops in San Pedro occurred in the vicinity of Mesa Street between Sixth and Ninth Streets, all now destroyed; on Second Street between Pacific Avenue and Mesa Street; near the old Hilltop Quarry in vicinity of present Park Western and Coralmount Drives; in unincorporated Los Angeles County between Western Avenue and Miraleste Canyon; in Rolling Hills Estates and the southeasternmost part of Torrance in an area containing Lomita Quarry and the type locality for the Lomita Marl; and, outside of the area, along the NW-SE trending southern boundary of Walteria (Torrance).

In the subsurface, Lomita Marl fossils have been recognized at a depth of 366 meters at the western edge of Wilmington, and in wells on the northeast flank of Signal Hill at depth of 286 to 331 meters (Poland, et al., 1956). In neither case were the fossil identities given.

Environment and Fauna. Stratigraphically controlled collections of mollusks from the Lomita Marl have not been reported on in the literature and the paleoecologic interpretations of Woodring, et al., and of J. W. Valentine (1961) are somewhat generalized.

The Lomita Marl exposed in Lomita Quarry is characterized by deep, outer sublittoral assemblages, presumably the Cyclocardia barbarensis-Antiplanes perversa community of Valentine, representing depth ranges of from 92 to 183 meters. The lithology is mostly calcareous sand and marl, with some glauconite. A list of mollusks by I.S. Oldroyd (In Jordan and Hannibal, 1923) suggests the presence of a moderately deep water fauna in the lower beds and a shallow water fauna above. In areas to the east of Lomita Quarry, probably upsection from those at Lomita Quarry, sands and gravel contain an inner sublittoral association. At Hilltop Quarry, Woodring, et al., (1946) recognized three beds; a lower one of calcareous algae 1.8 meters thick, an overlying marl bed 4.3+ meters thick, and on top a calcareous sand and gravel unit 3 meters thick. They suggested that the algal bed represented deposition at a depth of 46 to 92 meters. Shoaling is thought to have occurred during deposition of the Lomita Marl, and shallow-water fossil associations overlie the deeper-water faunas. The Lomita Marl contains both cool water, northern extra-limital, and warm water, southern extra-limital molluscan species. However the cool water forms are mostly exposed shore or outer

sublittoral in habitat, while the warm water forms represent quiet, inner sublittoral habitats (Valentine and Meade, 1961).

Grant (1936) postulated a paleotemperature of 16.6°C for the Lomita Marl. Oxygen isotope ratios for three species of mollusks have given paleotemperatures of 13.2°, 15.7° and 19.0° C (Valentine and Meade, 1961). They have also suggested limiting range of sea surface temperatures for the Lomita fauna to be 11° and 21°C (7°C at 92 meters). P. C. Valentine (1973) using the temperature tolerances of 55 species of Holocene ostracods which occur in the Lomita Marl, has inferred the paleotemperature to have ranged between 13° and 18° C. Emiliani and Epstein (1953) give oxygen isotope temperatures of 12° to 30° for forminifera.

The fauna of the Lomita Marl is dominated by mollusks, but contains minor numbers of many phyla. More important papers on non-molluscan elements are: Galloway and Wissler (1927a) on foraminifera, and P.C. Valentine (1973, listed herein) on ostracods. Paper citing more than 20 species of mollusks include: A. Clark (1931); Grant and Gale (1931); Jordan and Hannibal (1923); Natland (1957); Schenck (1945); Valentine and Meade (1961); and Woodring, Bramlette, and Kew (1946). A discussion of the vertebrates from the Lomita Marl are included by Langenwalter, herein.

UPPER PLIOCENE

Fernando (?) Formation

Historical Aspects. The term Fernando Formation was first used in a publication by Eldridge, (Eldridge and Arnold, 1907) for exposures skirting the sides of the San Fernando Valley in Los Angeles County. The name was attributed to Homer Hamlin who used the term on unpublished maps of the area. In recent years the Fernando Formation has been raised in rank to group status. According to Durham and Yerkes (1959), the Fernando now comprises the Repetto Formation below, and unnamed conglomerates and siltstones above, probably the Pico Formation of various authors.

Exposures. The Fernando Formation has not previously been recognized in surface outcrops in the Palos Verdes Hills or in the Wilmington, Long Beach and Signal Hill areas. The only known exposure was discovered and collected in 1963, in road cuts for Interstate 405 near Cherry Avenue in Long Beach. The exposure was soon obliterated by construction of the freeway, but was reported on by Fitch and Reimer (1967). Other known exposures of the Fernando, all outside of the area, include building excavation sites in downtwon Los Angeles (LACM collections) and in the Upper Newport Bay region in Orange County (Zinsmeister, 1970(1971)).

Subsurface presence of the Fernando Formation has not previously been reported, except that upper Pliocene sediments

do underlie the entire Long Beach plain, including Signal Hill, although these have in the past been referred to as the Pico Formation. Also, if the Fernando is assigned groups status, then it would encompass the Repetto Formation which does occur in the subsurface, and would then be considered to be in the area at depth.

Environment and Fauna. Fitch and Reimer (1967) recorded the presence of 32 species of elasmobranch and teleost fish which, "with but two exceptions, was typical of a shallow-water, coastal fauna similar to what one would fine at the same latitude today" (see list herein, p. 89-90). The invertebrates include mollusks, barnacles, decapod crustaceans, sand dollars, and bryozoans (listed herein, page 67). The mollusks are chiefly inner sublittoral, sandy bottom forms with some rock dwellers, typical of the present southern California coastal fauna.

LOWER PLIOCENE

"Repetto" Formation

Historical Aspects. The Repetto Formation was named by Reed (1932) for exposures along the northeastern margin of the Los Angeles Basin. The type locality is the Repetto Hills, along the west side of Atlantic Boulevard in Los Angeles. The geology and paleontology of the Repetto Formation have been discussed at length by Woodring (1938). Woodring, et al., (1946), on the basis of exposures in the Palos Verdes Hills, referred to this formation as the "Repetto siltstone." The Repetto Formation is now considered by many workers to be the lower member of the Fernando Group. The United States Geological Survey has abandoned the term "Repetto" (Keroher, et al., 1966). Because of the ill defined status of the Formation at present, I have used the name in quotation marks.

Exposures. The only surface exposures of the "Repetto" Formation in the area occur in a small, 1.5 square mile area extending across Narbonne Avenue immediately north of Palos Verdes Drive North, in Rolling Hills Estates (Woodring, et al., 1946). The "Repetto" Formation is about 46 meters thick in the Palos Verdes Hills. The formation also occurs in the subsurface below the Wilmington and Long Beach areas. In the Wilmington oil field it is about 315 meters thick and consists of marine siltstone, shale, and sandstone (Poland, et al., 1956). In the Signal Hill area it ranges from 670 to 800 meters thick (op. cit.; Yerkes, et al., 1965).

Environment and Fauna. The foraminifera of the "Repetto" formation in the Palos Verdes Hills are the same as those in the subsurface in other parts of the Los Angeles Basin and are similar to those found today living at depths of 2000 to 2500 meters off the California coast (Woodring, et al., 1946). The only mollusks from the "Repetto" in the study area are deep water mud-pectens, and one species of Acila from Wilmington. Lima hamlini, not

found in the Palos Verdes Hills, but widespread in the "Repetto" Formation in the Los Angeles Basin, suggests depths of 550 to 1100 meters (Woodring, 1938).

Although the only abundant fossils from the "Repetto" are foraminifera (Woodring, et al., 1946), there appears to be no published list of the fauna from the study area.

MIOCENE

Monterey Formation

Outcrops of siliceous, light colored shales which are similar in age and lithologies to those from the type region of the Monterey Shale, near Monterey, California, occur in the coast ranges along the entire central California coastline. According to Woodring, et al., (1946), the Miocene strata in the Palos Verdes Hills had generally been assigned to the Modelo Formation, and the corresponding Miocene subsurface section in the adjoining Los Angeles Basin to the Puente Formation. Woodring, Bramlette, and Kleinpell (1936) called the shale Monterey, but chose to subdivide the formation into three formal, named members; the Malaga Mudstone, the Valmonte Diatomite, and the Altamira Shale. It is not within the scope of the present report to discuss whether these refined stratigraphic terms should be given full formational status or ranked as members of the Monterey Formation. I have chosen to use the refined terms without any indications as to their heirarchy.

UPPER MIOCENE

Malaga Mudstone

Historical Aspects. Previous to 1936, the Miocene sediments in the Palos Verdes Hills had been variously assigned to several different formations by different authors. The topmost section of radiolarian mudstone, has been described by Woodring, Bramlette, and Kleinpell (1936) and named the "Malage mudstone member" of the Monterey Shale. The type locality is at Malaga Cove, on the northwest border of the Palos Verdes Hills, in the city of Torrance.

Exposures. The Malaga Mudstone consists chiefly of light chocolate-brown or olive-gray, massive radiolarian mudstone or fine-grained siltstone. It occurs only on the northern and eastern flanks of the Palos Verdes Hills (Woodring, Bramlette, and Kew, 1946) where it is 92 to 183 (?) meters thick, respectively. The formations has not yet been reported from other areas, although similar sections are present outside of the study area, in Newport Beach and at the east end of the Laguna Hills in Orange County (Woodring, Bramlette, and Kleinpell, 1936). In San Pedro the Malaga Mudstone overlies the Valmonte Diatomite and is overlain by lower Pleistocene sediments. Other outcrops, overlain by the lower Pliocene "Repetto" Formation and by lower Pleistocene sediments, are present on Western Avenue just south of Palos

Verdes Drive North; around Narbonne Avenue just north of Palos Verdes Drive North; and near Crenshaw Boulevard on the Torrance-Rolling Hills Estates boundary.

Environment and Fauna. According to Woodring, Bramlette, and Kleinpell (1936) the abundance of the foraminifers Bathysiphon, Bulimina inflata, Cassidulina delicata, Eponides healdi, and Gyroidina soldanii rotundimargo suggests a deposition depth of greater than 915 meters. Campbell and Clark (1944) came to essentially the same conclusion on the basis of the radiolarian faunas, but added that the deposits were probably laid down under conditions not dissimilar to those presently found in the Catalina Channel under open sea conditions.

Fossils in the Malaga Mudstone are almost entirely limited to micro-fossil groups, although sponge spicules are not uncommon. Diatoms are quite common in some beds of diatomite in the unit. The radiolarians have been treated by Campbell and Clark (1944) and by Casey, Price, and Swift (1972). Lists of foraminifera have appeared in Woodring, Bramlette, and Kleinpell (1936), Kleinpell (1938), and by Woodring, Bramlette, and Kew (1946).

Valmonte Diatomite

Historical Aspects. The "Valmonte diatomite member" of the Monterey Formation was described and named by Woodring, Bramlette, and Kleinpell (1936) for the diatomite and diatomaceous silt or clay underlying the Malaga Mudstone. They described the type region as being east of the Valmonte district, a residential area, where the upper part of the member is well exposed in the quarries of the Dicalite Company. This is along the lower course of Agua Negra Canyon, according to Woodring, Bramlette, and Kew (1946), and is now mostly in Rolling Hills Estates and unincorporated land surrounded by it. Two small extensions to north enter Torrance and Palos Verdes Estates.

Exposures. The Valmonte Diatomite, mostly interbedded pure diatomite and diatomaceous mudstone or shale, occurs in a narrow bank from south-central San Pedro northward, past the old Hilltop Quarry area, and then northwestward on the northern border of the Palos Verdes Hills. At the type locality it is estimated to be 230 meters thick. In the San Pedro area, where not obscured by terrace cover, it underlies the Malaga Mudstone, and in turn overlies the Altamira Shale, although the contact between the latter is hard to define because of the diatomite in the upper parts of the Altamira (Woodring, et al., 1946). Two other major outcrops exist in the Palos Verdes Hills, but both are outside of the study area. The formation has not been recognized elsewhere, although its microfossil fauna has been.

Environment and Fauna. Foraminifera assemblages collected from the eastern part of the Palos Verdes Hills in the Valmonte Diatomite are all of the "medium-depth type and point to deposition in the bathyal rather than the neritic zone" (Woodring, Bramlette,

and Kleinpell, 1936). Campbell and Clark (1944), using radiolarians, felt that in general, the deposits including the Valmonte Diatomite were laid down under conditions not greatly dissimilar to those which now are found in the adjacent Catalina Channel under open sea conditions.

Other than foraminifera listed by Woodring, Bramlette and Kleinpell (1938) and Woodring, Bramlette and Kew (1946), and radiolarians described and figured by Campbell and Clark (1944), little has been published on the fauna or flora of the Valmonte Diatomite. Despite its diatomaceous nature, only a few short papers discuss the diatoms, usually from localities outside of the area. The only mollusks from these beds are deep water mud-pectens referrable to Hyalopecten and (?) Delecto-pecten.

Vertebrates described from the Valmonte include birds, fish and several marine mammals (L.H. Miller, 1935, Lyon, 1941, L.H. Miller and DeMay, 1942; Howard, 1958; Applegate, 1964; Wilson, 1973). Additional vertebrate material, in the LACM collections is discussed by Langenwalter, herein.

MIDDLE AND UPPER MIOCENE

Altamira Shale

Historical Aspects. The "Altamira shale member of the Monterey shale" was described and named by Woodring, Bramlette, and Kleinpell (1936) for exposures on the south slope of the Palos Verdes Hills along and adjoining Altamira Canyon. Included within were two new tuff beds, named the Portuguese tuff bed and Miraleste tuff bed. The Altamira was subdivided into three informal units, the upper being principally phosphatic and bituminous shale, the middle being principally porcelaneous and cherty shale, and the lower principally silty shale. Subsequent paleontologic workers in the Palos Verdes Hills have retained the term Altamira Shale.

Exposures. Outcrops of the Altamira Shale include the greater part of the Palos Verdes Hills. The formations occurs at Point Firmin and vicinity and west of the contact with the Valmonte Diatomite, which runs approximately north by northwesterly through San Pedro, before curving around in a west by northwesterly direction on the northern border of the Palos Verdes Hills. The Altamira Shale has not been recognized in other regions of the study area. Correlative subsurface sediments underlying the Long Beach oil field are unnamed.

Environment and Fauna. The Altamira Shale has been subdivided into three parts. The foraminifera from each indicate slightly different depositional environments, and the following conclusions are taken from Woodring, Bramlette, and Kleinpell (1936). Foraminiferal assemblages from the upper part suggest depositions in comparatively shallow water, probably at or near the edge of the littoral zone, and (at other localities) in deeper parts of

the neritic zone. Benthic foraminifera from the lower two-thirds of the middle part of the Altamira are mostly medium-depth species, and, with one or two exceptions, indicate a site of deposition near the 180 meter line. Other localities have faunas more peculiar to a 550-915 meter depth, and some are similar to faunas which now inhabit sea weed forests in the modern oceans. The lower part of the formation contains faunas which are of a shallow to medium-depth type, suggesting deposition in the neritic zone.

Fossil fish discussed by David (1943) suggest warmer regional oceanic temperatures for this section of the coast during the middle Miocene. The presence of warmer water is supported by a tropical molluscan fauna, many of the species being allied to those now living in the Gulf of California and vicinity (Woodring, Bramlette, and Kleinpell, 1936).

Foraminifera from the Altamira Shale have been listed by Woodring, Bramlette, and Kleinpell (1936), Kleinpell (1938), and Woodring, Bramlette, and Kew (1946). The 55 species of mollusks listed and discussed by Woodring, Bramlette, and Kew (1946) represent an essentially new fauna for the California coast ranges, being one with a warmer water aspect than typical for the middle Miocene of California.

Although vertebrate records for the Altamira are poor, David (1943) has described six species of fish, two of which were new, from this formation. Additional vertebrates are listed by Langenwalter, herein.

THE PALEONTOLOGICAL RECORD

The area around San Pedro contains the richest described sequence of lower and upper Pleistocene marine invertebrate faunas on the entire west coast of North America. These faunas, first reported and discussed by geologists of the Pacific Railroad Investigations in the 1850's (Blake, 1856, Conrad, 1855c), have been intensively studied in the last 70 years. Because of the vast amount of literature presently available on the fossil mollusks of the area, it does not seem necessary to duplicate those faunal lists here; except for some taxonomic revision, the fauna is documented. Other groups however, mostly minor elements in the local faunas, still need much work before they are fully documented and understood. Except for a few papers on Signal Hill, and foraminiferal studies on subsurface deposits, the fossil record of the Wilmington and Long Beach areas is minor in relation to that of San Pedro and the Palos Verdes Hills. Consequently the treatment of fossil groups in the subsequent sections is biased towards those occurrences in the San Pedro area.

Pterophytes

Fossil land plants are rare in the Miocene, Pliocene, and Pleistocene formations in the San Pedro and Long Beach areas.

This is probably due to the nature of the underlying sediments in the area, which are mostly marine. Many land plant groups, based on pollen studies, are cited by Martin and Gray (1962) from Mio-Pliocene sediments from a core in the Wilmington area. Plant material has been recovered from Plio-Pleistocene sediments by Bartosh (1938), who reported a redwood log deposit at depth in the Wilmington oil field; by Mason (1932), who described a closed-cone pine from the Long Beach area; and by Axelrod (1967b), who speculated on the composition of the vegetation of the coastal strip during Plio-Pleistocene times. Axelrod (1967a) has also discussed the fossil closed-cone pines (? Pleistocene in age) collected near Bixby Slough, now Harbor Lake.

No additional plant material was seen in the museum collections examined, although paleo-botantical collections were not specifically sought out for examination.

Algae

Fossil algae are probably more common in certain stratigraphic units than are reported on. I have undoubtedly missed a number of references to these aquatic plants, because of the casual way they are usually mentioned. David (1943: 81) has reported "sea weeds" from the Altamira Shale in association with Miocene fish. I know of no records of marine algae from the local Pliocene sediments. In the Pleistocene deposits, especially certain beds in the Lomita Marl, calcareous algae are very common. Howe (1934) referred these to the genus Mesophyllum (?) although they have also been referred to as Lithothamnion by Woodring (1930). Emery (1958) used fossil algae to date a submerged terrace off of the Palos Verdes Peninsula.

Outside of the algal beds exposed in Lomita Quarry and the old Hilltop Quarry, (Lomita Marl), I have not seen calcareous algae in other formations in the area.

Diatoms

Most of the papers which refer to diatoms, or to commercial deposits of diatomite, in the Palos Verdes Hills concern areas outside of the present study area. Many also refer to the deposits at Malaga Cove, on the northwest border of the Peninsula. Oddly enough, there have never been any monographic studies on the flora of the Valmonte Diatomite, or any of the diatomaceous deposits in the Palos Verdes Hills. Wornardt (1967) does mention however that the diatom flora of the Malaga Mudstone here is very comparable to that of the upper type Monterey Formation near Monterey, California. Most references to diatoms are only casual remarks on their presence, and few name more than one or two genera, if any. Bagg (1912) reported diatoms from the Pleistocene deposits of San Pedro, but this report was later doubted by Hanna (1927).

Many papers which mention diatomite deposits are reports of

a commercial nature (for example, Cleveland, 1966; Gay and Hoffman, 1954; Oakeshott, 1957) and usually give little more than a history of Dicalite Division's production at the quarry and plant in Walteria and Rolling Hills Estates.

Coccolithophorids

Serious paleontologic work on coccoliths from this coast has come into its own only within the last ten years, since the advent of the scanning electron microscope. The only published record of coccoliths from the San Pedro-Long Beach area is by Jankins (1964), who found one specimen of Discoaster sp. in the Lomita Marl, from Lomita Quarry.

Undoubtedly quantities of unpublished data exist in oil company research centers, where coccoliths are being used with increasingly greater frequency for correlation and biostratigraphy. Unfortunately this data remains in unpublished and inaccessable form.

Ebridians

The only mention I found of ebridians from the study area is the description of a single species, Ebria antiqua rectangularis Schulz, 1928, "von S. Pedro" (Loeblich, et al., 1968).

Silicoflagellates

Little work has been done on the silicoflagellates of the Miocene sediments of the Palos Verdes Hills. Although Wornardt (1972: fig. 18) has indicated the presence of silicoflagellates throughout the Bolivina hughesi and B. obliqua foraminiferal zones of the Altamira Shale, Valmonte Diatomite, and Malaga Mudstone, only one species has been described to date from this area. It is Dictyocha mutabilis Deflandre, 1950, from "Diatomite miocene (moyen) de San Pedro, Californie." (Loeblich,et al., 1968).

Radiolarians

Casual mention of radiolarians in local Miocene sediments has been made by several authors; for example, Woodring, Bramlette and Kew (1946), characterized the Malaga Mudstone as a radiolarian mudstone and noted (p. 37) that "Relatively large globular Radiolaria ... are visible in field examination." The only monographic treatment of this group has been by Campbell and Clark (1944). They described 76 species and varieties (all new) from the Valmonte Diatomite and Malaga Mudstone from various localities in the Palos Verdes Hills in the San Pedro region, in addition to another 20 species from outside of the area. Casey, Price, and Swift (1972) recently listed and figured many radiolarian species from Malaga Cove from the Malaga Mudstone. In the Long Beach area, Casey (1972) used ratios of spongodiscids (generally cold) to other spumellarid

radiolarians (generally warm) to determine possible paleotemperatures for subsurface Mio-Pliocene sediments. However, no species were listed.

Foraminifera

The foraminifera of several of the formations in the Palos Verdes Hills and San Pedro areas are relatively well known. Those from the subsurface in the Wilmington and Long Beach (Signal Hill) oil fields have also been extensively studied and used for correlating and defining the producing zones of these fields. However I am not aware of published reports citing these faunas. Longer lists of foraminifera are not available for the "Repetto" and Fernando(?) Formations, the San Pedro Sand, or the Palos Verdes Sand. Miocene foraminifera from the Altamira Shale, Valmonte Diatomite, and Malaga Mudstone have been cited by Woodring, Bramlette, and Kleinpell (1936), Kleinpall (1938), and Woodring, Bramlette, and Kew (1946). Numerous papers have cited occurrences of selected taxa from the local Pleistocene formations. Major papers on the faunas of the Timms Point Silt have been published by Bagg (1912), and Cushman and Gray (1946a,b), and of the Lomita Marl by Galloway and Wissler (1927a).

Numerous recent papers have mentioned foraminifera in regard to the definition of the Plio-Pleistocene boundary, and especially to left or right coiling forms of the planktonic series Globigerina pachyderma in the Lomita Marl.

Sponges

The only mention of sponges in the Miocene, Pliocene, and Pleistocene formations of the San Pedro area have all been casual notes on the occurrence of sponge spicules, which have not been further identified. Borings in molluscan remains in museum collections of Pleistocene mollusks may be attributable to clionid-like sponges.

Corals

No work on fossil corals from the San Pedro-Long Beach area has been done since the turn of the century, when Vaughan (1900) described Caryophyllia arnoldi, n. sp., from the Pleistocene of San Pedro Hill, and three years later (in Arnold, 1903) described four species, three of which were new, from the San Pedro Pleistocene. Recent papers on the coral fauna of this coast (Durham, 1947; Durham and Barnard, 1952) add no new fossil records from this area.

Corals are rare in museum collections of Pleistocene material from the San Pedro area.

Bryozoans

Although fossil bryozoans from western North America are still only poorly known, two important papers have been based on Pleistocene material at least in part from the San Pedro area. Nineteen species were described by Canu and Bassler (1923) from Deadman Island, and San Pedro, and numerous primary records, based on San Pedro area localities, have been cited by Soule and Duff (1957). In addition, 13 and 6 species (respectively) are recorded by A. Clark (1931) from the Timms Point Silt of Timms Point, and from Deadman Island. Scattered primary records of Pleistocene material can be found in Osburn's (1950, 1952, 1953) monograph on the living bryozoans of this coast. Additional records of fossil bryozoans are present in some of the longer lists of fossils (usually mollusks) from this area.

Bryozoans are not uncommon in various museum Pleistocene collections from the San Pedro, Wilmington, Long Beach and Signal Hill areas, but are rarely identified.

Brachiopods

Brachiopod remains are rare in the Pleistocene deposits in the San Pedro and Long Beach areas. The only monograph on west American fossil bachiopods (Hertlein and Grant, 1944) described seven species, none new, from various Pleistocene and "Pliocene" localities in the San Pedro and Long Beach areas. In addition, brachiopods are occasionally cited in larger lists of Pleistocene mollusks from this region. No brachiopods are known from the Miocene or Pliocene sediments in the area.

Echinoderms

There have been no recent monographs on the fossil echinoderms of western North America, although that by Grant and Hertlein (1938) is still the accepted authority on the subject. That paper includes descriptions of six species and subspecies, one new, from the San Pedro and Long Beach areas. Other papers which mention the occurrence of echinoid species in this region are Arnold (1903) who recorded three species, Kew (1920) who listed the same three species, all from San Pedro, and Clark and Twitchell (1915) who reported two species of sea urchin from the San Pedro Sand. Additional Pleistocene occurrences are often appended to longer lists of mollusks from the area.

The only Pliocene echinoid known is Dendraster sp., from the Fernando(?) Formation, from near Signal Hill. The only Miocene record is one by Woodford (1925), of an echinoid spine from the Point Firmin area of San Pedro.

Echinoid remains, usually fragmental, are not uncommon in museum collections of Pleistocene material from San Pedro, Wilmington, Signal Hill and Long Beach. Spines and disarticulated

plates of Strongylocentrotus are usually found in rocky shore assemblages, and worn or complete specimens of Dendraster in sandy and shelly facies. Asteroid arm plates, possibly belonging to the genus Astropecten, are very rare but have been found in the Lomita Marl of San Pedro.

Annelids

Various groups of worms are very important in the benthos of modern sediments, but are virtually unknown in the fossil record. Even the few groups which secrete calcareous tubes have a poor fossil record, a mass of worm tubes was described by Howell and Mason(1937), as "Serpula" saxistructoris n. sp., from the Pleistocene of Deadman Island, but was later doubted in a paper by Packard (1942).

Calcareous worm (?) tubes are rare in present museum collections of Pleistocene material from San Pedro. Specimens of Spirorbis and burrows of spionid worms can also be found in the same collections, but are not identified even to family. The supposed spionid ichnofossil Helicotaphrichus commensalis is not uncommon in various museum collections of Pliocene and Pleistocene mollusks.

Mollusks (marine)

Fossil mollusks are probably the most thoroughly documented of all fossil groups in the study area. Pliocene and Miocene occurrences are rare. The mollusks from the middle Miocene Altamira Shale in the Palos Verdes Hills are listed and figured by Woodring, et al., (1946:27, pl. 28). Lower Pliocene mollusks from the "Repetto" Formation are unusual and less than half a dozen species total are known from surface or subsurface occurrences in the Palos Verdes Hills or in the Wilmington and Long Beach areas. Fossil mollusks from the upper Pliocene Fernando(?) Formation, from a locality in the Signal Hill area are listed below (Table I).

Both lower and upper Pleistocene mollusks from the San Pedro and Long Beach areas are usually very abundant when found, and have been the source of many papers on the local faunas as well as on selected taxa. Mollusks have been used for most of the paleoecologic interpretations of the Pleistocene formations, perhaps because they are the dominant fossils. Papers which cite more than 20 species are: Arnold (1903, 1906); Ashley (1895); Berry (1922); B. L. Burch (1947); J. Q. Burch and T. W. Burch (1947); Chace (1966); Chace and Chace (1919); A. Clark (1931); E. D. Clark (1943); Cook and Clark (1943); Crickmay (1929b); DeLong (1941); Gabb (1869); Grant and Gale (1931); Jordan and Hannibal (1923); Marincovich (1970); Meals (1973); Mount (1970a,b); Natland (1957); T. S. Oldroyd (1914, 1924, (1925)); Peska (1975); Schenck (1945); J.P. Smith (1912); Valentine (1961, 1962a); Valentine and Meade (1961); Watts (1900 (1901)); Woodring, Bramlette, and Kew (1946); and herein (Table II).

TABLE I

Preliminary list of species from the upper Pliocene, Fernando (?) Formation, from an excavation below Interstate 405, near Cherry Avenue, city of Long Beach, Los Angeles County, California (LACMIP loc. 423).

Mollusca: Bivalvia
- Amiantis callosa (Conrad)
- Chama sp.
- Chione sp. cf. C. californiensis (Broderip)
- C. fluctifraga (Sowerby)
- Clinocardium sp. cf. C. nuttallii (Conrad)
- Corbula luteola Carpenter
- Crassinella branneri (Arnold)
- Cryptomya californica (Conrad)
- Donax californicus (Conrad)
- D. gouldii Dall
- Florimetis obesa (Deshayes)
- Glycymeris sp.
- Leptopecten latiauratus (Conrad)
- Lucina tenuisculpta Carpenter
- Lucinisca nuttalli (Conrad)
- Macoma yoldiformis Carpenter
- M. nasuta (Conrad)
- mactrid
- Modiolus rectus Conrad
- M. sp.
- Mysella sp.
- mytilid
- Nucula exigua Sowerby
- Nuculana taphria (Dall)
- Ostrea lurida Carpenter
- Pandora sp.
- Panopea generosa (Gould)
- Penitella penita (Conrad)
- Periploma planiusculum Sowerby
- Petricola sp.
- Protothaca tenerrima (Carpenter)
- Sanguinolaria sp.
- Siliqua lucida (Conrad)
- Spisula planulata (Conrad)
- Tellina bodegensis Hinds
- T. idae Dall
- T. nuculoides (Reeve)
- Trachycardium quadragenarium? (Conrad)
- Tresus pajaroanus (Conrad)

Mollusca: Gastropoda
- Acanthina spirata (Blainville)
- Acteocina sp.
- Bittium? sp.
- Bursa californica (Hinds)
- Caecum crebricinctum (Carpenter)
- Calliostoma canaliculatum (Lightfoot)

C. gemmulatum Carpenter
C. gloriosum Dall
C. ligatum (Gould)
C. tricolor Gabb
Calyptraea sp.
Cancellaria tritonidea Gabb
Cerithidea californica (Haldeman)
Conus californicus Reeve
Crepidula perforans (Valenciennes)
C. sp. cf. C. onyx Sowerby
C. sp. cf. C. coei Berry
C. sp. or spp.
Epitonium bellastriatum (Carpenter)
E. tinctum (Carpenter)
Fartulum occidentale Bartsch
Forreria wrighti Jordan and Hertlein
"Fusinus"? sp.
Halistylus pupoideus (Carpenter)
Kelletia kelletii (Forbes)
Margarites (s.l.) sp.
Megasurcula carpenteriana (Gabb)
Mitra catalinae Dall
Mitrella carinata (Hinds)
M. c. v. gausapata (Gould)
M. gouldi (Carpenter)
Nassarius delosi (Woodring)
N. fossatus (Gould)
N. mendicus (Gould)
N. m. v. cooperi Forbes
N. perpinguis (Hinds)
N. tegula (Reeve)
Nucella lamellosa (Gmelin)
Ocenebra sp. cf. O. foveolata (Hinds)
Odostomia sp.
Olivella baetica Carpenter
O. biplicata (Sowerby)
Ophiodermella sp.
Polinices reclusianus (Deshayes)(includes P. altus (Pilsbry))
Pteropurpura festiva (Hinds)
Terebra sp.
Turbonilla sp.
Turritella sp.

Mollusca: Scaphopoda
Dentalium neohexagonum Sharp and Pilsbry
D. sp.

Porifera: Demospongea
clionid

Annelida: Polychaeta
Helicotaphrichus commensalis Kern, Grimmer, and Lister

Arthropoda: Cirripedia
unidentified barnacles

Arthropoda: Malacostraca
unidentified appendages

Ectoprocta
  unidentified ectoprocts
Echinodermata: Echinoidea
  Dendraster sp.
Chordata
  See LACM loc. 3245, page 41

TABLE II

Preliminary list of species from the upper Pleistocene Palos Verdes Sand, from the east side of the Pacific Coast Highway, between Seventh and Colorado streets, city of Long Beach, Los Angeles County, California (LACMIP locs. 4568 and 4865).

Mollusca: Bivalvia

- Adula diegensis (Dall)
- Aequipecten aequisulcatus (Carpenter)
- Americardia biangulata (Broderip and Sowerby)
- Amiantis callosa (Conrad)
- Chaceia ovoidea (Gould)
- Chione californiensis (Broderip)
- C. gnidia (Broderip and Sowerby)
- C. undatella (Sowerby)
- Clinocardium sp. cf. C. nuttallii (Conrad)
- Corbula luteola Carpenter
- Crassinella sp.
- Cryptomya californica (Conrad)
- Cyclocardia sp.
- Diplodonta orbella (Gould)
- Donax californicus (Conrad)
- D. gouldii Dall
- Florimetis obesa (Deshayes)
- Glycymeris sp.
- Hiatella arctica (Linnaeus)
- Kellia sp.
- Laevicardium substriatum (Conrad)
- Leptopecten latiauratus (Conrad)
- Lucina tenuisculpta Carpenter
- Lucinisca nuttalli (Conrad)
- Macoma acolasta Dall
- M. indentata Carpenter
- M. nasuta (Conrad)
- M. secta (Conrad)
- Mactra sp.
- Modiolus rectus Conrad
- Nuculana taphria (Dall)
- Ostrea lurida Carpenter
- Pandora punctata Conrad
- Penitella penita (Conrad)
- Periploma planiusculum Sowerby
- Petricola sp.
- Petricolaria parallela (Pilsbry and Lowe)
- Prothothaca laciniata (Carpenter)
- P. staminea (Conrad)
- P. tenerrima (Carpenter)
- Psammotreta viridotincta (Carpenter)
- Sanguinolaria nuttallii (Conrad)
- Semele decisa (Conrad)
- Siliqua lucida (Conrad)
- Solen sp.
- Spisula catilliformis Conrad

S. hemphilli (Dall)
Tagelus californianus (Conrad)
Tellina bodegensis Hinds
T. meropsis Dall
T. modesta (Carpenter)
Tivela stultorum (Mawe)
Trachycardium procerum (Sowerby)
T. quadragenarium (Conrad)
Transennella tantilla (Gould)
Tresus nuttallii (Conrad)
Yoldia cooperi Gabb
Zirfaea pilsbryi Lowe

Mollusca: Gastropoda
Acanthina spirata (Blainville)
Acteocina spp.
Bittium?sp.
Bulla gouldiana Pilsbry
Calliostoma canaliculatum (Lightfoot)
C. gemmulatum Carpenter
C. ligatum (Gould)
C. tricolor Gabb
Cancellaria tritonidea Gabb
Ceratostoma nuttalli (Conrad)
Cerithidea californica (Haldeman)
Colliselia sp. cf. C. conus (Test)
Conus californicus Reeve
Crepidula sp. cf. C. coei Berry
C. onyx Sowerby
C. perforans (Valenciennes)
Crucibulum spinosum (Sowerby)
Epitonium minuticosta (deBoury)
E. sp. cf. E. indianorum (Carpenter)
E. sp.
eulimid
Forreria belcheri (Hinds)
Fusitriton oregonensis (Redfield)
Kelletia kelletii (Forbes)
Lirularia sp.
Megasurcula carpenteriana (Gabb)
Melampus olivaceus Carpenter
Mitrella carinata (Hinds)
M. tuberosa (Carpenter)
M. sp.
Nassarius cerritensis (Arnold)
N. delosi (Woodring)
N. fossatus (Gould)
N. mendicus v. cooperi Forbes
N. m. v. indisputalis Oldroyd
N. perpinguis (Hinds)
N. tegula (Reeve)
Notoacmea insessa (Hinds)
Ocenebra foveolata (Hinds)
Olivella baetica Carpenter
O. biplicata (Sowerby)

Ophiodermella sp.
Polinices reclusianus (Deshayes) (includes P. altus (Pilsbry))
Pteropurpura festiva (Hinds)
P. leeana (Dall)
Roperia poulsoni (Carpenter)
Tegula aureotincta (Forbes)
T. eiseni Jordan
T. funebralis (Adams)
T. montereyi (Keiner)
Terebra sp. or spp.
Turbonilla sp. or spp.
Turritella sp.
Mollusca: Scaphopoda
Dentalium neohexagonum Sharp and Pilsbry
D. sp.

Porifera: Demospongea
Clionid
Coelenterata: Anthozoa
Astrangia sp.
Annelida: Polychaeta
Heliotaphrichus commensalis Kern, Grimmer, and Lister
Spionid
Arthropoda: Cirripedia
Balanus sp.
Arthropoda: Malacostraca
unidentified appendages
Ectoprocta
unidentified ectoprocts
Echinodermata: Echinoidea
Dendraster excentricus (Eschscholtz)
Chordata
See LACM loc. 3757, page 53

Additional references to papers citing fewer than 20 species are listed in the bibliography.

Mollusks (non-marine)

Non-marine molluscan fossils are rare in the Pleistocene formations of the San Pedro area and unknown from the Wilmington and Long Beach regions. None are known from the Miocene or subsurface Pliocene sediments in the same region. New species described from the San Pedro area are Paludestrina curta and P. stokesi by Arnold (1903) and Alabina io by Bartsch (1911). According to Woodring, Bramlette and Kew (1946), A. io was described as from San Diego, but was actually from San Pedro. Additional records of non-marine mollusks are given by Arnold (1903), Hannibal (1912), Oldroyd (1924(1925)), Woodring, Bramlette and Kew (1946), Burch (1947), and Taylor (1966). Taylor (1966) has assigned the known species from this area to the following taxa: "Hydrobia" imitator (Pilsbry), Tryonia stokesi (Arnold), Gyraulus parvus (Say), Planorbella tenuis californiensis (Baker), Physa virgata Gould, Discus cronkhitei (Newcomb), and Zonitoides arboreus (Say). In addition, Helix (Epiphragmophora) sp. indet. of Arnold presumably belongs to one of the local living genera of Helminthoglyptidae, Helminthoglypta or Micrarionta (Taylor, 1966).

Barnacles

There have been no monographic accounts of fossil barnacles from western North America. However, an unpublished thesis by Zullo (1960) on fossil barnacles from this coast is on file in the Library of the University of California at Berkeley. Barnacles are not uncommon in the Pleistocene deposits of the San Pedro and Long Beach areas, but references to them are usually found with lists of molluscan fossils. Specimens cited are generally not identified to species, and the fossil cirriped fauna from this region remains relatively unknown.

Barnacles are unknown in the Miocene sediments of the San Pedro and Long Beach areas. The only Pliocene record, probably Balanus sp., is from the Fernando (?) Formation, from near Signall Hill.

Malacostracans

Remains of decapod crustaceans (crabs, shrimp, lobsters, etc.) are not uncommon in the Pleistocene Palos Verdes Sand, San Pedro Sand, and Lomita Marl of the San Pedro and Long Beach regions. In the literature they are most often unidentified. This can be traced to the fact that few specialists are capable of identifying decapod remains from isolated and worn appendages. Rathbun (1926) monographed the fossil stalk-eyed crustaceans of the Pacific slope and describes 25 species, six of which were new, from the Pleistocene of San Pedro and 12 species, 3 of them new, from Signal Hill material. Menzies (1951) has described and

figured five species of Cancer from the San Pedro Pleistocene. Nations (1975) also described and figured 10 species of Cancer from the area included in this report. Large amounts of material used by Nations (1969) from the Pleistocene deposits of the San Pedro and Long Beach areas are in the LACM collections but identified only to the family level.

Ostracods

Except for the casual mention of ostracods in the Pleistocene formations in the San Pedro area, usually the Lomita Marl, only three published papers have dealt with this group of organisms as fossils. Twenty-one species and varieties, 20 of which were new, were described and figured by LeRoy (1943) from the Lomita Marl, Timms Point Silt, and the San Pedro Sand. Five new species were described by Triebel (1957) from the Lomita Marl and Timms Point Silt of San Pedro, and one new genus and two new species were described by Hazel (1962) from the Lomita Marl of San Pedro. A dissertation by P.C. Valentine (1973; in press) is the only monographic study of west American fossil and recent ostracods. I am grateful for permission to include the following data from his work.

Of 87 species found in six localities in San Pedro from exposures of the Lomita Marl, Timms Point Silt, and the Palos Verdes Sand, 56 are new, but not limited to fossil occurrences. These species and the local formations in which they occur are listed in Table III. Temperature tolerances for 55 Holocene ostracod species which occur in the Lomita Marl indicate minimum and maximum paleotemperatures (to the nearest $1^{\circ}C$) to be 13°-$18^{\circ}C$; for 19 Holocene species in the Timms Point Silt to be 13°-$18^{\circ}C$; and for 31 Holocene species in the Palos Verdes Sand to be 13°-$18^{\circ}C$.

Locality data for the samples cited in the following list can be found in Valentine (1973). These correspond to the following localities plotted on the map of fossil localities herein: Palos Verdes Sand, loc. 78 (?); Timms Point Silt, loc. 71; Lomita Marl, locs. 71 and 103.

Other Arthropods

The literature on other arthropod groups is varied and scattered, and undoubtedly I have missed some references to them. The only papers that I am aware of which deal with fossil material from the project area are two by Pierce, one on a new Miocene whiptail scorpion, Thelyphonus hadleyi, from Cabrillo Beach (1945), and the other on two new orthopterids, Protosegestes lloydi and Exacretoptera fosteri, from the Valmonte Diatomite of San Pedro (1944).

TABLE III

List of 87 ostracod species found in the Pleistocene Lomita Marl (LM), Timms Point Silt (TPS), and Palos Verdes Sand (PVS), of San Pedro, Los Angeles County, California. Unpublished data provided by P.C. Valentine, U.S. Geological Survey, Woods Hole.

species	LM	TPS	PVS
Ambostracon californicum (Hazel, 1962)	x	x	x
A. costatum Hazel, 1962	x	x	
A. diegoensis (LeRoy, 1943)	x		
A. glaucum (Skogsberg, 1928)			x
A. microreticulatum (LeRoy, 1943)	x		x
A. sp. F	x		x
A. sp. G	x		x
A. sp. J	x		x
A. sp. L	x	x	
A. sp. M	x		
A. sp. N	x	x	
Aurila lincolnensis (LeRoy, 1943)	x		
A. sp. A	x		
A. sp. B	x		
A. sp. C	x		x
A. sp. D	x		x
"Aurila" driveri (LeRoy, 1943)	x	x	x
"A." sp. C	x		x
"A." sp. D	x	x	x
Basslerites delreyensis LeRoy, 1943	x		
"Bradleya" pennata (LeRoy, 1943)	x	x	
"B." simiensis (LeRoy, 1943)	x	x	x
Buntonia sp. B	x		
B. sp. C		x	
Cativella semitranslucens (Crouch, 1949)	x		
Caudites fragilis LeRoy, 1943	x		x
C. sp. A	x		x
C. sp. B			x
Coquimba schencki (LeRoy, 1943)		x	x
C. sp. A	x	x	x
C. sp. B	x		
Cythere maia (Benson, 1959)	x		
Cytherelloidea californica LeRoy, 1943	x		x
"Cytheretta" corrugata (LeRoy, 1943)	x		x
"C." sp B		x	
Cytheromorpha sp. B	x	x	
Cytheropteron sp. B	x		
"Hemicythere" californiensis LeRoy, 1943	x	x	x
"H." hispida LeRoy, 1943	x		
"H." sp. A	x	x	x
"H." sp. B	x		x
"H." sp. D	x		x
"H." sp. G	x	x	

	LM	TPS	PVS
Hemicytherura sp. C	x		
H. sp. H	x		
H. sp. I	x		
H. sp. K	x		
H. sp. L	x		
Hermanites kewi (LeRoy, 1943)	x	x	x
H. sp. B	x		
H. sp. C	x		
H. sp. D	x		x
H. sp. G	x		
H. sp. H	x		
Kangarina sp. C	x		
K. sp. D	x		
K. sp. G	x		
Krithe sp. A	x		
Loxoconcha helenae Crouch, 1949		x	
L. lenticulata LeRoy, 1943	x	x	x
L. sp. B	x		x
Loxocorniculum sp. A			x
Munseyella pedroensis Triebel, 1957	x	x	
M. sp. B	x		
Palaciosa sp. A	x		
P. sp. B	x		
P. sp. D			x
Palmanella californica Triebel, 1957		x	x
Paracytheridea granti LeRoy, 1943	x	x	
P. sp. A	x		
P. sp. B	x		
P. sp. E	x	x	
P. sp. G	x		x
Pectocythere clavata (Triebel, 1957)		x	
Pellucistoma bensoni McKenzie and Swain, 1967	x		
Perissocytheridea pedroensis (LeRoy, 1943)	x	x	x
Pontocythere sp. A		x	
P. sp. B		x	x
Radimella palosensis (LeRoy, 1943)	x		x
"Radimella" aurita (Skogsberg, 1928)	x		x
"R." jollaensis (LeRoy, 1943)	x	x	x
"R." pacifica (Skogsberg, 1928)	x		x
"R." sp. A	x	x	x
"R." sp. B	x		
Sahnia sp. A			x
New genus A sp. A	x		
New genus B sp. A		x	

CHORDATES

The Fossil Vertebrates of the Los Angeles-Long Beach Harbors Region

by

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Introduction

The first record of vertebrate fossils from the Los Angeles-Long Beach Harbors region was that of a mammoth tooth, cited by W.P. Blake in 1855. However, it was not until 1912 that an extensive assemblage of fossil vertebrates (avians) was recorded from San Pedro (L.H. Miller, 1912). During the succeeding decades many localities in the surrounding region were discovered and reported on, providing one of the most extensive bases for understanding the vertebrate fossil record of the southern California coastal plain.

Today most of these classic localities no longer exist. The natural outcrops, which had produced the early faunal records, have long since been destroyed by urban development of the region. However, this same development created equally important new localities, although usually under less than desirable circumstances. Together, the natural and the man-made localities have complimented each other in the data they have provided.

The present discussion is intended as a survey of published and unpublished work. New data on vertebrate taxa from the local Pleistocene deposits are included in Table IV. The discussion is reflective of our present knowledge concerning fossil vertebrates of the area, and cannot be considered entirely complete.

The discussion is geographically limited to that area bounded by the Pacific Ocean on the south, Carson Street on the north, Palos Verdes Drive East on the west, and Lakewood Boulevard and its projection on the east. LACM(CIT) loc. 388 is the single exception. It is located just outside of the western boundary and is included here to provide data for the Valmonte Diatomite. Several references to this material are included in the bibliography. Localities occuring in alluvial deposits and randomly distributed in the area are not included.

In addition to published records, unpublished data based on the collections of the following institutions have been utilized: Natural History Museum of Los Angeles County, Section of Vertebrate Paleontology (LACM); the California Institute of Technology, Pasadena, collection now at the museum (LACM(CIT)); University of California, Berkeley, Museum of Paleontology (UCMP); and California Academy of Sciences, Department of Geology (CAS).

Paleontology

The record of fossil vertebrates in the study area is relatively extensive, only the Newport Bay area in Orange County having produced as much information on Pleistocene coastal vertebrates in western North America. Hay (1927) provides a relatively comprehensive discussion of fossil vertebrate research up to the 1920's.

Vertebrates are known from most of the sedimentary formations exposed in the San Pedro and Long Beach areas. Those of the Miocene and Pliocene formations are scanty and poorly documented. The earliest remains, Barstovian in age, occur in the Altamira Shale, and have been discussed by David (1943:81-88) and Howard (1944: 75-77). The assemblage from the Valmonte Diatomite is discussed by L.H. Miller (1935: 73-80), L. H. Miller and DeMay (1942: 52,73-76); Lyon (1941: 23-41); Howard (1958: 10-11); Applegate (1964, 181-184); and L.C. Wilson (1973). The only substantial work on a Pliocene (Blancan) vertebrate assemblage within the study area is a study of fish remains from the Signal Hill area by Fitch and Reimer (1967). The earliest Pleistocene (Irvingtonian) records are from the Lomita Marl. Extensive fish assemblages from LACM locs. 3758 and 3759 in Miraleste Canyon, San Pedro, have been discussed by Fitch (1969: 75), and several sirenian ribs are also known from the Lomita Sand Pit (LACM loc. 3065).

Pleistocene outcrops of the Timms Point Silt (Irvingtonian), San Pedro Sand (Rancholabrean), and Palos Verdes Sand (Rancholabrean) have yielded specimens of approximately 150 taxa. These have been documented in numerous papers, including those by Brattstrom and Sturn (1959), Fitch (1967, 1968, 1969a, 1969b, 1970), Howard, (1944, 1949), Kanakoff (1956), L. H. Miller (1912, 1914, 1921, 1928, 1930), L. H. Miller and DeMay (1942), and W. E. Miller (1971). These works form the data base for any possible paleoecological discussion of the area.

The fossil fish assemblage has been used by Fitch and Reimer (1967) to characterize the Fernando (?) Formation from the Signal Hill area as "typical of a shallow-water, coastal fauna similar to what one would find at the same latitude today." Later Fitch (1967, 1968) characterized the fish assemblages of the Timms Point Silt and San Pedro Sand in a similar manner.

Too little is known about the fossil amphibians and reptiles of the area to use them for paleoecological interpretation.

A fairly complete knowledge of avian fossils exists only for the Palos Verdes Sand. L. H. Miller and Demay (1942: 58) and Howard (1949: 26-28) conclude that this avian assemblage reflects a lesser marine adaptation than do other southern California coastal fossil avian faunas, and is indicative of both sand dune and brackish lagoon habitats.

The mammalian assemblage from the Palos Verdes Sand of San Pedro compares favorably with that of the Newport Bay assemblage from the Palos Verdes Sand there (W. E. Miller, 1971: 42). The terrestrial assemblage is characterized as originating in grassland and woodland habitats.

A summation of the data suggests an essentially similar marine environment with slightly cooler marine temperatures than found today (Fitch, 1967, 1968). The adjacent land area appears to have had a semi-arid condition similar to that of today (W. E. Miller, 1971: 49), being covered by grasslands and woodlands, with sand dunes and brackish lagoons along the coast.

Chondrichthyes

Sharks, skates, and rays are relatively common in the marine sediments of southern California, although only three of the several dozen localities considered in the present work contain more than a single taxon. In the Miocene, a shark, Carcharias sp. has been recorded by David (1943: 81) from the Altamira Shale, and Applegate recorded the genus Isurus from the Valmonte Diatomite. Fitch and Reimer (1967), in their discussion of the sharks and rays from Signal Hill (LACM loc. 3245), include a treatment of eight taxa recovered from the Fernando (?) Formation. Records of several taxa are known from the Lomita Marl localities LACM loc. 3758 and LACM loc. 3759 at Miraleste Canyon (Fitch, 1969a: 75). Fitch (1968, 1967) treats ten taxa each from the Timms Point Silt and San Pedro Sand.

Osteichthyes

Fossil remains of bony fishes are much more common than those of sharks and rays. David (1943: 81-87) discusses five teleosts from the Altamira Shale near White Point (LACM (CIT) loc. 341), from which she infers warmer, regional, oceanic temperatures during the middle Miocene. Eleven taxa are recorded for the Valmonte Diatomite from LACM (CIT) loc. 388. The Signal Hill area Pliocene locality, Fernando(?) Formation discussed by Fitch and Reimer (1967) contained 22 taxa. Over 80 taxa are recorded for the Lomita Marl at Miraleste Canyon (LACM locs. 3758 and 3759) in San Pedro by Fitch (1969a: 75). Fitch (1968) in his discussion of the Timms Point Silt (LACM loc. 3217) treats 55 taxa. Fitch's (1967) paper on the San Pedro Sand at Miraflores Street in San Pedro (LACM loc. 3175) includes a discussion of 31 taxa.

Fitch (1967 and 1968) has compared the fish faunas of the San Pedro Sand and Timms Point Silt with the modern fauna of this area and found them to be similar. The only exceptions are the occurrence of several northerly forms in the fossil record. He concluded that deposition of the assemblages occurred in shallow water (25 to 100 fathoms) and that the ocean temperatures near this part of the coast were considerably cooler than at present.

Amphibia

This class is the most poorly represented among the vertebrates from the study area. A single specimen, possibly a frog, is known from the San Pedro Sand in San Pedro (Incinerator site, LACM loc. 1602). Three taxa are also known from the Palos Verdes Sand of the Lumberyard locality (LACM(CIT) loc. 187). Included are a toad, a frog, and a salamander.

Reptilia

Brattstrom and Sturn (1959: 68) and W. E. Miller (1971: 44) have presented data on the sparse representation of reptiles in the San Pedro Sand and Palos Verdes Sand. Fossils from the San Pedro Sand included two taxa of turtles from the Incinerator site (LACM loc. 1602). Two turtles and three snakes have been recorded from the Palos Verdes Sand at Pacific Avenue and Oliver Street (LACM(CIT) loc. 186) and at the Lumberyard locality (LACM (CIT) loc. 187) on the San Pedro waterfront.

Aves

Occurrences of fossil birds in the study area are scattered. Most were recovered from the Palos Verdes Sand. The occurrences from the Altamira Shale include a member of the Charadriiformes (LACM loc. 1925), and a member of the Rallidae from Point Firmin (LACM loc. 6456) discussed by Howard (1944: 75-77).

The San Pedro Sand contains two recorded taxa of birds, from Miraflores Street in San Pedro (LACM loc. 3175). Of the numerous localities representing the Palos Verdes Sand, only one, the old Lumberyard locality (LACM(CIT) loc. 187), contains a noteworthy assemblage. The avian remains of this locality were first reported by L. H. Miller (1912). Later discussions by L. H. Miller (1914, 1930) expanded upon his original work and added to the list of taxa. Although this locality no longer exists, it has provided one of the largest known avian assemblages from the Pleistocene of California. L. H. Miller and DeMay (1942: 58) believe the assemblage reflects adjacent sand dune and brackish lagoonal habitats. Their work supports Arnold's (1903) interpretation of the regional geology.

Mammalia

The fossil mammals are the most widely distributed, both geographically and geologically, of any of the vertebrates in the

area. The earliest occurrences are from the Altamira Shale and include fragmental remains of a sea lion from LACM loc. 1714, a cetacean from Miraleste High School (LACM loc. 7140), and cetacean remains from a submerged reef near White Point (LACM (CIT) loc. 341) noted by David (1943: 81). The Dicalite Quarry locality (LACM(CIT) loc. 388) has yielded a cetacean and sea lion from the Valmonte Diatomite (Lyon, 1941: 23-41).

The only remains of fossils mammals known from the Lomita Marl are three specimens of a fossil sirenian from the Lomita Sand Pit (LACM loc. 3065).

Some of the fossil mammals known from the San Pedro Sand are rabbits, rodents, cetaceans, carnivores, proboscideans and ungulates. The presence of the genus Bison indicates a Rancholabrean age for the formation. W. E. Miller (1971: 53) mentions several taxa from the Incinerator site (LACM loc. 1602). Unpublished new data have expanded this list to the size presented herein. W. E. Miller (1971: 1) indicates that all known terrestrial vertebrate localities in the Pleistocene sediments of the Los Angeles Basin are Rancholabrean in age.

The record of fossil mammals from the Palos Verdes Sand is scattered. Excepting the Lumberyard locality (LACM(CIT) loc. 187; =UCMP loc. V-2047), only one or two taxa are known from any single locality. The Lumberyard locality has yielded one of the most extensive mammalian assemblages recovered from the formation (W. E. Miller, 1971: 44-47). Miller interprets the terrestrial environment surrounding the San Pedro region as consisting of both grassland and wooded areas.

TABLE IV

Taxonomic lists of vertebrate assemblages by formation and locality.

MIOCENE

Altamira Shale

Barstovian

LACM loc. 1280
Vertebrata
LACM loc. 1348
Pisces
LACM loc. 1714
Pisces
   Carangidae
   Sparidae
Mammalia
   Allodesmus sp.
LACM(CIT) loc. 341
Pisces
   Carcharias sp.

Peteroplatea lapislutosa David
Opisthonema palosverdensis David
Syngnathus sp.
cf. Eclipes extensus Jordan
Alciola sp.
Mammalia
Cetacea
LACM loc. 1925
Aves
Charadriiformes
LACM loc. 3539
Mammalia
Cetacea
LACM loc. 6456
Aves
Puffinus diatomicus Miller
Rallidae
LACM loc. 7140
Mammalia
Phocoena sp.

Valmonte Diatomite

Clarendonian

LACM(CIT) 388
Pisces
Isurus sp.
cf. Xyne grex Jordan and Gilbert
Ganolytes cameo Jordan
cf. Cyclosthone sp.
Sternopthchidae
Chauliodus eximias (Jordan and Gilbert)
Lampanyctus sp.
Moridae
Eclipes sp. ?
Carangidae
Sparidae
Aves
Diomedea sp.
Puffinus diatomicus Miller
Sula willetti Miller
S. stocktoni Miller
Mammalia
Physeteridae
Odontoceti
Imagotaria downsi? Mitchell

PLIOCENE

Fernando Formation

Blancan

LACM loc. 3245
Pisces

Carcharodon carcharias (Linnaeus)
Triakis semifasciata Girard
Carcharinus spp.
Galeorhinus zyopterus Jordan and Gilbert
Sphyrna spp.
Urolophus halleri Cooper
Myliobatis californicus Gill
Engraulis mordax Girard
Electrona rissoi (Cocco)
Porichthys notatus Girard
P. myriaster Hubbs and Schultz
Microgadus proximus Girard
Merluccius productus (Ayres)
Otophidium scrippsae Hubbs
O. taylori Girard
O. spp.
Atherinopsis californiensis Girard
Sebastes spp.
Artedius notospilotus Girard
Genyonemus lineatus Ayres
Seriphus politus Ayres
Roncador stearnsi (Steindachner)
Cymatogaster aggregata Gibbons
Lepidogobius lepidus (Girard)
Citharichthys sordidus (Girard)
C. stigmaeus Jordan and Gilbert
C. spp.
Paralichthys californicus (Ayres)
Lyopsetta exilis (Jordan and Gilbert)
Parophyrs vetulus Girard

PLEISTOCENE

Lomita Marl

Irvingtonian

LACM loc. 3065
Mammalia
Sirenia
LACM loc. 3758
Pisces
Heterodontus francisci Girard
Notorynchus maculatus Ayres
Carcharodon carcharias (Linnaeus)
Isurus oxyrinchus Rafinesque
Lamna ditropis Hubbs and Follett
Cetorhinus maximus (Gunnerus)
Parmaturus xaniurus (Gilbert)
Triakis semifasciata Girard
Carcharinus spp.
Galeorhinus zyopterus Jordan and Gilbert
Prionace glauca (Linnaeus)
Squalus acathias Linnaeus
Squatina californica Ayres
Raja spp.

Myliobatis californica Gill
Clupea pallasi Valenicennes
Engraulis mordax Girard
Bathylagus wesethi Bolin
Leuroglossus stibius Gilbert
Nansenia sp.
Benthosema suborbitale (Gilbert)
Cerathoscopelus townsendi Eigenmann and Eigenmann
Diaphus theta Eigenmann and Eigenmann
Aotomyctophum cf. crockeri (Bolin)
Stenobrachus leucopsasus (Eigenmann and Eigenmann)
Tarletonbeania crenularis (Jordan and Gilbert)
Poriahthys notatus Girard
Microgadus proximus Girard
Physiculus rastrelliger Gilbert
Merluccius productus (Ayres)
Brosmophycis marginata (Ayres)
Otophidium taylori (Girard)
Coryphaenoides acrolepis (Bean)
Atherinops affinis (Ayres)
Sebastes chlorostictus (Jordan and Gilbert)
S. dalli (Eigenmann and Beeson)
S. diploproa (Gilbert)
S. saxicola (Gilbert)
S. jordani (Gilbert)
S. semicinctus (Gilbert)
Artedius notospilotus Girard
Chitonotus pugetensis Steindachner
Enophrys bison Girard
E. tuarina Gilbert
Gilbertidia sigalutes (Jordan and Starks)
Icelinus burchami Evermann and Goldsbourough
I. filementosus Gilbert
I. fimbriatus Gilbert
I. quadriseriatus (Lockington)
I. tenuis Gilbert
Paricelinus hopliticus Eigenmann and Eigenmann
Radulinus asprellus Gilbert
R. cf. bolcoides Gilbert
Cottidae
Xenesetmus spp.
Trachurus symmetricus (Ayres)
Seriphus politus Ayres
Amphistichus argenteus Agassiz
Cymatogaster aggregata Gibbons
Hyperprosopon anale Agassiz
Hypsurus caryi Agassiz
Phanerodon furcatus Girard
Damalichthys vacca Girard
Embiotocidae
Sphyraena argentea Girard
Oxyjulis californica (Gunther)
Pimelometopon pulchrum (Ayres)
Cebidichthys violaceus (Girard)
Coryphopterus nicholsii (Bean)

Pneumatophorus japonicus (Houttuyn)
Citharichthys sordidus (Girard)
C. stigmaeus Jordan and Gilbert
C. xanthostigma Gilbert
Glyptocephalus zachirus Lockington
Lyoposetta exilis Jordan and Gilbert
Parophays ventulus Girard

LACM loc. 3759

Pisces
Carcharodon carcharias (Linnaeus)
Isurus oxyrinchus Rafinesque
Lamna ditropis Hubbs and Follett
Cetorhinus maximus (Gunnerus)
Cephaloscyllium ventriosum (Garman)
Triakis semifasciata Girard
Carcharhinus spp.
Prionace glauca (Linnaeus)
Squalus acanthias Linnaeus
Raja spp.
Dasyatis cf. dipterura (Jordan and Gilbert)
Clupea pallasi Valenciennes
Engraulis mordax Girard
Leuroglossus stilbius Gilbert
Benthosema suborbitale (Gilbert)
Ceratoscopelus townsendi (Eigenmann and Eigenmann)
Diaphus theta Eigenmann and Eigenmann
Lampadena urophaas Paxton
Lampanyctus regalis Gilbert
Myctophum nitidulum Garman
Notoscopelus resplendens Richardson
Protomyctophum cf. crockeri (Bolin)
Stenobrachus leucopsarus (Eigenmann and Eigenmann)
Symbolophorus californiensis (Eigenmann and Eigenmann)
Tarletonbeania crenularis (Jordan and Gilbert)
Triphoturus mexicanus (Gilbert)
Porichthys notatus Girard
Physiculus rastrelliger Gilbert
Merluccius productus (Ayres)
Brosmophycis marginata (Ayres)
Otophidium taylori (Girard)
Lycodopsis pacifica (Collett)
Lyconema barbatum Gilbert
Coryphaenoides sp.?
Atherinops affinis (Ayres)
Melamphaes lugubris Gilbert
Scopelogadus bispinosus (Gilbert)
Sebastes aurora (Gilbert)
S. chlorostictus (Jordan and Gilbert)
S. crameri (Jordan)
S. diploproa (Gilbert)
S. goodei (Eigenmann and Eigenmann)
S. ensifer Chen
S. polyspinis (Taranetz and Moiseeu)
S. spp.
Seabastolobus sp.

Chitonotus pugetensis (Steindachner)
Enophrys taurina Gilbert
Gilbertidia sigalutes (Jordan and Starks)
Icelinus burchami Evermann and Goldsborough
I. spp.
Malacocottus zonurus Bean
Paricelinus hopliticus (Eigenmann and Eigenmann)
Radulinus asperellus Gilbert
R. cf. boleoides Gilbert
Cottidae
Xeneretmus spp.
Trachurus symmetricus (Ayres)
Seriphus politus Ayres
Cymatogaster aggregata Gibbons
Hyperprosopon anale Agassiz
H. argenteum Gibbons
Phanerodon furcatus Girard
Damalichthys vacca Girard
Embiotocidae
Oxyjulis californica (Gunther)
Pimelometopon pulchrum (Ayres)
Rathbunella hypoplecta (Gilbert)
Poroclinus rachtocki Bean
Lyconectes aleutensis Gilbert
Ammodytes hexapterus Pallas
Coryphopterus nicholsii (Bean)
Pneumatophorus japonicus (Houttuyn)
Citharichthys sordidus (Girard)
C. stigmaeus Jordan and Gilbert
C. xanthostigma Gilbert
Atheresthes stomias (Jordan and Gilbert)
Glyptocephalus zachirus Lockington
Lyopsetta exilis (Jordan and Gilbert)
Parophrys vetulus Girard

PLEISTOCENE

Timms Point Silt

Irvingtonian

LACM loc. 3217
Pisces
Carcharodon carcharias (Linnaeus)
Isurus oxyrinchus Rafinesque
Triakis semifasciata Girard
Galeorhinus zyopterus Jordan and Gilbert
Prionace glauca (Linnaeus)
Squatina californica Ayres
Raja spp.
Heterodontus francisci (Girard)
Squalus acanthias Linnaeus
Clupea pallasi Valenciennes
Engraulis mordax Girard
Ceratoscopelus townsendi (Eigenmann and Eigenmann)
Diaphus theta Eigenmann and Eigenmann

Electrona rissoi (Cocco)
Pampadene urophaos Paxton
Protomyctophum crockeri (Bolin)
Stenobrachius leucopsarus (Eigenmann and Eigenmann)
Tarletonbenia crenularis (Jordan and Gilbert)
Porichthys notatus Girard
Theragra chaleogramma (Pallas)
Microgadus proximus (Girard)
Merluccius productus (Ayres)
Brosmophycis marginata (Ayres)
Otophidium taylori (Girard)
Lycodopsis pacifica (Collett)
Atherinopsis affinis (Ayres)
Melamphaes lugubris Gilbert
Scopelogadus bispinosus (Gilbert)
Sebastes goodei Eigenmann and Eigenmann
S. hopkinsi Cramer
S. rosaceus Jordan and Gilbert
S. spp.
Seabastolobus sp.
Cottidae
Artedius notospilotus Girard
Chitonotus pugetensis (Steindachner)
Enophrys taurina Gilbert
Icelinus burchami Evermann and Golds
I. filamentosus Gilbert
I. fimbriatus Gilbert
I. quadriseriatus (Lockington)
I. tenuis Gilbert
Leptocottus armatus Girard
Malacocottus zonurus Bean
Radulinus asperellus Gilbert
cf. Xeneretmus latifrons (Gilbert)
Trachurus symmetricus (Ayres)
Genyonemus lineatus (Ayres)
Seriphus politus Ayres
Embiotocidae
Cymatogaster aggregata Gibbons
Oxyjulis californica Gunther
Pimelometopon pylchrum (Ayres)
Lyconectes aleutensis Gilbert
Ammodytes hexapterus Pallas
Coryphopterus nicholsii (Bean)
Lethops sp.
Citharichthys sordidus (Girard)
C. stigmaeus Jordan and Gilbert
C. xanthostigma Gilbert
Atheresthes stomias (Jordan and Gilbert)
Glyptocephalus zachirus Lockington
Lyopsetta exilis (Jordan and Gilbert)
Microstomus pacificus (Lockington)
Parophrys vetulus Girard

San Pedro Sand

Rancholabrean

LACM loc. 1012
Pisces
Porichthys notatus Girard
Rhacochilus vacca (Girard)
Aves
Branta sp.
Fulica sp.
Mammalia
Rodentia
LACM loc. 1056
Mammalia
Cetacea
Bison sp.
LACM loc. 1602
Pisces
Galeorhinus zopterus Jordan and Gilbert
Squatina californica Ayres
Raja spp.
Dasyatis dipterus (Jordan and Gilbert)
Myliobatis californicus Gill
Porichthys myriaster Hubbs and Schultz
P. notatus
Genyonemus lineatus (Ayres)
Seriphus politus Ayres
Cymatogaster aggregata Gibbons
Pimelometopon pulchrum (Ayres)
Lepidogobias lepidus (Girard)
Citharichthys stigmaeus (Jordan and Gilbert)
Amphibia
Reptilia
Chelonia sp.
Clemmys marmarota Baird and Girard
Mammalia
Sylvilagus sp.
Thomomys bottae (Eydoux and Gervais)
Peromyscus sp.
Microtus sp.
Cetacea
Canis dirus (Leidy)
Zalophus sp.
Mammuthus sp.
Equus sp.
Odocoileus sp.
Capromeryx sp.
LACM loc. 3175
Pisces
Notorynchus maculatus Ayres
Isurus oxyrinchus Rafinesque
Triakis semifasciata Girard
Carcharhinus spp.

Galeorhinus zyopterus Jordan and Gilbert
Prionace glauca (Linneaus)
Squatina californica Ayres
Raja spp.
Myliobatis californica Gill
Squalus acanthias Linnaeus
Clupea pallasi Valenciennes
Engraulis mordax Girard
Spirinchus starksi (Fisk)
Stenobrachius leucopsarus (Eigenmann and Eigenmann)
Porichthys notatus Girard
Microgadus proximus (Girard)
Brosmophyis marginata (Ayres)
Lycodopsis pacifica (Collett)
Atherinops affinis (Ayres)
Sebastes goodei Eigenmann and Eigenmann
S. carnatus (Jordan and Gilbert)
S. spp.
Cottidae
Chitonotus pugetensis (Steindachner)
Enophrys taurina Gilbert
Icelinus tenuis Gilbert
Leptocottus armatus Girard
Radulinus asprellus Gilbert
Scorpaenichthys marmoratus (Ayres)
Trachurus symmetricus (Ayres)
Genyonemus lineatus (Ayres)
Seriphus politus Ayres
Cymatogaster aggregata Gibbons
Damalichthys vacca Girard
Oxyjulis californica (Gunther)
Coryphopterus nicholsii (Bean)
Icichthys lockingtoni Jordan and Gilbert
Citharichthys sordidus (Girard)
C. stigmaeus Jordan and Gilbert
C. spp.
Glyptocephalus zachirus Lockington
Lyopsetta exilis (Jordan and Gilbert)
Eposetta jordani (Lockington)
Pelecanus cf. P. erythrorhynchus Gmelin
Brachyramphus sp.

LACM loc. 3200
Mammalia
Paramylodon sp.
Bison sp.

LACM loc. 3248
Mammalia
Equus sp.

LACM loc. 3268
Mammalia
Mammuthus sp.

Palos Verdes Sand

Rancholabrean

LACM(CIT) loc. 186
Reptilia
Clemmys marmarota Baird and Girard
Aves
Puffinus gresus (Gmelin)
Mammalia
Canidae
Zalophus sp.
Equus sp.
LACM(CIT) loc. 187 = UCMP loc. V-2047
Pisces
Carcharhinus sp.
Carcharodon sp.
Notorynchus sp.
Selachii
Myliobatinae
Urolophus halleri? Cooper
Gasterosterus aculeatus Linnaeus
Teleostei
Osteoichthyes
Actinopterygia
Amphibia
Bufo sp.
cf. *Rana* sp.
Taricha sp.
Anura
Reptilia
Cheloniidae
Clemmys sp.
Pituophis melanoleucus (Daudin)
Lampropeltis getulus Linnaeus
Crotalus viridis (Rafinesque)
Serpentes
Aves
Gavia immer (Brunnich)
G. arctica (Linnaeus)
Colymbus auritus? Linnaeus
C. nigricollis (Hermann)
Aechmophorus occidentalis (Lawrence)
Diomedia nigripes Audebon
D. albatrus Pallas
D. sp.
Puffinus opisthomelas Coues
P. gresus (Gmelin)
Fulmarus glacialis (Linnaeus)
Phalacrocorax auritus (Lesson)
P. penicillatus (Brandt)
Branta canadensis (Linnaeus)
B. nigricans? (Lawrence)
Ansen albifrons (Scopoli)
Anas platyrhynchos (Linnaeus)

A. carolinense (Gmelin)
Mareca americana (Gmelin)
Anatidae
Histrionicus histrionicus? (Linnaeus)
Bucephala albeola (Linnaeus)
Spatula clypeata (Linnaeus)
Melanitta deglandi (Bonaparte)
M. perspicillata (Linnaeus)
Chendytes lawi Miller
Fulica americana Gmelin
Limosa fedoa? (Linnaeus)
Totanus sp.?
Larus glaucescens Naumann
Synthliboramphus antiquus (Gmelin)
Ptychoramphus aleuticus (Pallas)
Cathartes aura (Linnaeus)
Coragyps sp.?
Haliaetus leucocephalus (Linnaeus)
Falco sparverius Linnaeus
Lophortyx californica (Shaw)
Sturnella negecta Audobon
Mammalia
Nothroptheriops cf. N. shastense Sinclair
Megalonyx sp.
Lepus sp.
Sylvilagus cf. bachmani (Waterhouse)
Leporidae
Citellus beecheyi (Richardson)
Thomomys bottae (Eydoux and Gervais
Microtus cf. M. californicus (Peale)
Neotoma cf. N. fuscipes Baird
Rodentia
Felis cf. F. atrox (Leidy)
F. cf. F. concolur Linnaeus
Smilodon cf. S. californicus Bovard
Otariidae
Arctocephalinae
Canis dirus? (Leidy)
Enhydra cf. E. lutris (Linnaeus)
Carnivora
Delphinidae
Cetacea
Mysticeti
Mammuthus sp.
Equus sp.
Camelops sp.
Odocoileus cf. O. hemioneus (Caton)
Capromeryx sp.
Bison cf. B. latifrons (Harlan)
B. sp.
LACM(CIT) loc. 484
Mammalia
Eumetopias sp.
Mirounga sp.

LACM loc. 1055
Aves
Chendytes lawi Miller
LACM loc. 1087
Pisces
Teleostei
Aves
Gavia sp.
Aechmophorus occidentalis (Lawrence)
Chendytes lawi Miller
Mammalia
Magalonyx sp.
Cetacea
Mammut americanus (Kerr)
Mammuthus sp.
Equus sp.
Camelops sp.
LACM loc. 1158
Mammalia
Equus sp.
Bison sp.
LACM loc. 1277
Mammalia
Cetacea
LACM loc. 2026
Mammalia
cf. *Paramylodon* sp.
LACM loc. 3085
Mammalia
Delphinidae
LACM loc. 3254
Pisces
Heterodontus francisci Girard
Isurus oxyrinchus Rafinesque
Lamna ditropis Hubbs and Follett
Triakis semifasciata Girard
Carcharhinus spp.
Galeorhinus zyopterus Jordan and Gilbert
Prionace glauca (Linnaeus)
Sphyrna spp.
Squatina californica Ayres
Raja spp.
Urolophus halleri Cooper
Myliobatus californicus Gill
Engraulis mordax Girard
Electrona rissoi (Cocco)
Symbolophorus californiensis Eigenmann and Eigenmann
Porichthys myriaster Hubbs and Schultz
P. notatus Girard
P. spp.
Merluccius productus (Ayres)
Optophidium scrippsi Hubbs
O. taylori (Girard)
O. spp.

Atherinopsis californiensis Girard
Atherinidae
Sebastes spp.
Prionotus ruscarius Gilbert and Starks
P. stephanophrys Lockington
Chitonotus pugetensis (Steindachner)
Leptocottus armatus Girard
Calamus brachysomus (Lockington)
Cynoscion reticulatus (Gunther)
Bairdiella icistia (Jordan and Gilbert)
Genyonemus lineatus (Ayres)
Menticirrhus undulatus (Girard)
Ophioscion sp.
Roncador stearnsi (Steindachner)
Serphius politus Ayres
Umbrina roncador Jordan and Gilbert
Amhistichus roelzi (Hubbs)
Cymatogaster aggregata Gibbons
Demalichthys vacca (Girard)
Lepidogobius lepidus (Girard)
Coelorhynchus scaphopsis (Gilbert)
Citharichthys sordidus Girard
C. stigmaeus Jordan and Gilbert
C. xanthostigma Gilbert
Paralichthys californicus (Ayres)
Symphurus atricauda (Jordan and Gilbert)

Mammalia
Sylvilagus audoboni (Baird)
Thomomys bottae (Aydoux and Gervais)
Neotoma sp.
Bison sp.

LACM loc. 3262

Pisces
Myliobatoidea
Carcharodon sp.
Chondrichthys
Teleostei

Mammalia
Otariidae
Thomomys sp.
Camelops sp.

LACM loc. 3550

Mammalia
Zalophus sp.

LACM loc. 3658

Pisces
Heterodontus francisci Girard
Notorynchus maculatus Ayres
Carcharodon carcharias (Linnaeus)
Cetorhinus maximus (Gunnerus)
Triakis semifasciata Girard
Carcharhinus spp.
Galeorhinus zyopterus Jordan and Gilbert
Sphyrna spp.

Squatina californica Ayres
Raja spp.
Urolophus halleri Cooper
Dasyatis dipterurus (Jordan and Gilbert)
Myliobatis californicus Gill
Engraulis mordax Girard
Porichthys myriaster Hubbs and Schultz
P. notatus Girard
Theragra cholcogramma (Pallas)
Otophidium scrippsi Hubbs
O. taylori (Girard)
Lepophidium negropinna Hildebrand and Barton
Atherinops affinis (Ayres)
Icelinus tenuis Gilbert
Cynoscion nobilis (Ayres)
Genyonemus lineatus (Ayres)
Micropogon ectenes Jordan and Gilbert
Seriphus politus Ayres
Amhistichus rhodoterus (Agassiz)
Cymatogaster aggregata Gibbons
Embiotoca cf. E. jacksoni Agassiz
Pimelometopon pulchrum (Ayres)
Lepidogobius lepidus (Girard)
Citharichthys sordidus Girard
C. stigmaeus Jordan and Gilbert
Paralichthys californicus (Ayres)

LACM loc. 3757
Pisces
Carcharodon carcharias (Linnaeus)
Carcharinidae
Prionace glauca (Linnaeus)
Squatina cf. californica Ayres
Myliobatus californicus Gill
Urolophus halleri? Cooper
Merluccius productus (Ayres)
Genyonemus lineatus (Ayres)
Damalichthys vacca Girard
Citharichthys sp.
Reptilia
cf. Clemmys sp.
Squamata
Aves
Gavia
Chendytes lawi Miller
Mammalia
Thomomys sp.
Cetacea
Canis cf. latrans Say
Enhydra sp.
Equus sp.
Hemiauchenia sp.

LACM loc. 3760
Mammalia

UCLA loc. 1063.12
Mammalia
Megalonyx milleri Lyon
UCMP loc. V-7004
Mammalia
Phoca cf. *P. vitulina* (DeKay)
CAS loc. 92
Pisces
Pemelometopon cf. *P. pulchrum* (Ayres)

RECOMMENDATIONS

Two categories of recommendations have been developed from this study. The first deals with the preservation of important paleontologic sites in the San Pedro area, including the type localities of the Timms Point Silt and the Lomita Marl. The second set proposes methods for evaluation, salvage collection, and preservation of invertebrate and vertebrate fossil remains discovered during grading or excavation, and considered scientifically valuable.

Recommendation One:

Preservation of Timms Point

The Timms Point Silt was described and based on exposures at Timms Point in San Pedro, California. At the time the formation was named, Harbor Boulevard ended at Seventh Street in San Pedro. A large part of the type exposure has since been obliterated by the southward extension of Harbor Boulevard past Timms Point. The remaining exposures are present between Harbor Boulevard and the railroad tracks along the west side of Sampson Way. Signal Street bounds the area on the south. The only structures on this triangle of land are a youth baseball field (Bloch Field) and the Harbor Diesel and Equipment Company building. The exposures to be saved are the bluffs below the above buildings, and immediately west of the railroad tracks (Map 2).

As the type locality of the Timms Point Silt, this exposure must be preserved for science at all costs. The entire concept of this lithologic unit, as well as its fauna, ultimately lies with this single exposure. Numerous species have been described from this locality, and it is these types which define the fossil organisms. To allow Timms Point to be destroyed would deny students, educators, and scientists access to this classical occurrence of one of paleontology's unique sites.

Recommendation Two:

Preservation of Lomita Quarry and vicinity

The Lomita Marl was described and based on occurrences near Lomita Quarry and the western reaches of the Gaffey Syncline, now contained in the southern tip of the city of Torrance and the easternmost part of the city of Rolling Hills Estates, California. At present, access is not available to the general public and a geologic reconnaissance was not made. The Torrance side is bordered by closely spaced residential homes.

In addition to being the type locality for the Lomita Marl, it is also the type locality for numerous fossil organisms, and most importantly, is considered to be the basis for defining the lower boundary of the Pleistocene as presently defined in west coast invertebrate geochronology. This classical locality is

one of the unique paleontological sites and must be preserved for future generations (Map 3).

Recommendation Three:

Preservation of a geological contact

Although it is scientifically untenable to consider the destruction of the type areas of San Pedro's paleontological heritage, one other outcrop exists in the community of San Pedro which also warrants preservation. This exposure is the only area known in which the contact between the locally unique Timms Point Silt and the Lomita Marl can be observed and studied. The exposure is on Second Street between Pacific Avenue and Mesa Street in San Pedro (see geologic map in Woodring, Bramlette and Kew, 1946: pl. 14). It is becoming increasingly crucial to save this area, because many square blocks immediately adjacent to it have already been razed and leveled to grade for urban renewal.

The following three recommendations concern the preservation and salvage of important paleontological material which might otherwise be destroyed in the process of urban improvements.

Recommendation Four:

Paleontologist on call

It is strongly recommended that a professional paleontologist either be on call or located at any site, whenever trenching, road grading, or building excavations are taking place within the project area. This procedure is deemed especially important in areas of downtown San Pedro, and in areas which have a poorly documented fossil record.

Recommendation Five:

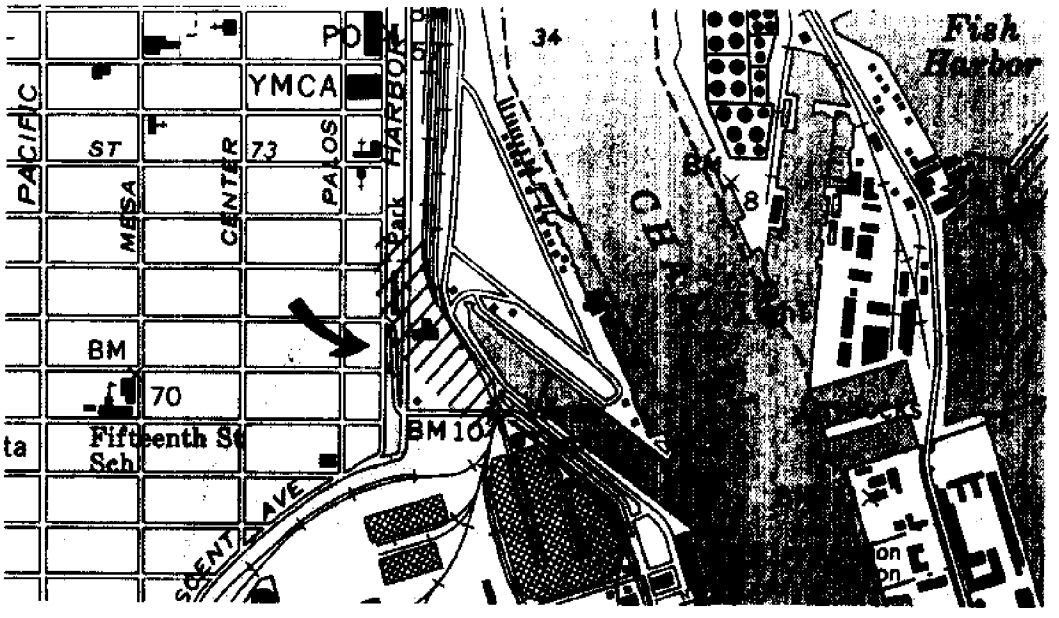
Evaluation of fossil remains

A professional paleontologist, if not already on the site, should be called in to make a scientific evaluation of any fossil remains, either vertebrate or invertebrate, which may have been discovered in the process of earth removal. Such an evaluation would determine the necessity of making a scientific collection of the exposure. This should be done in a manner that would least disturb the activities of the project.

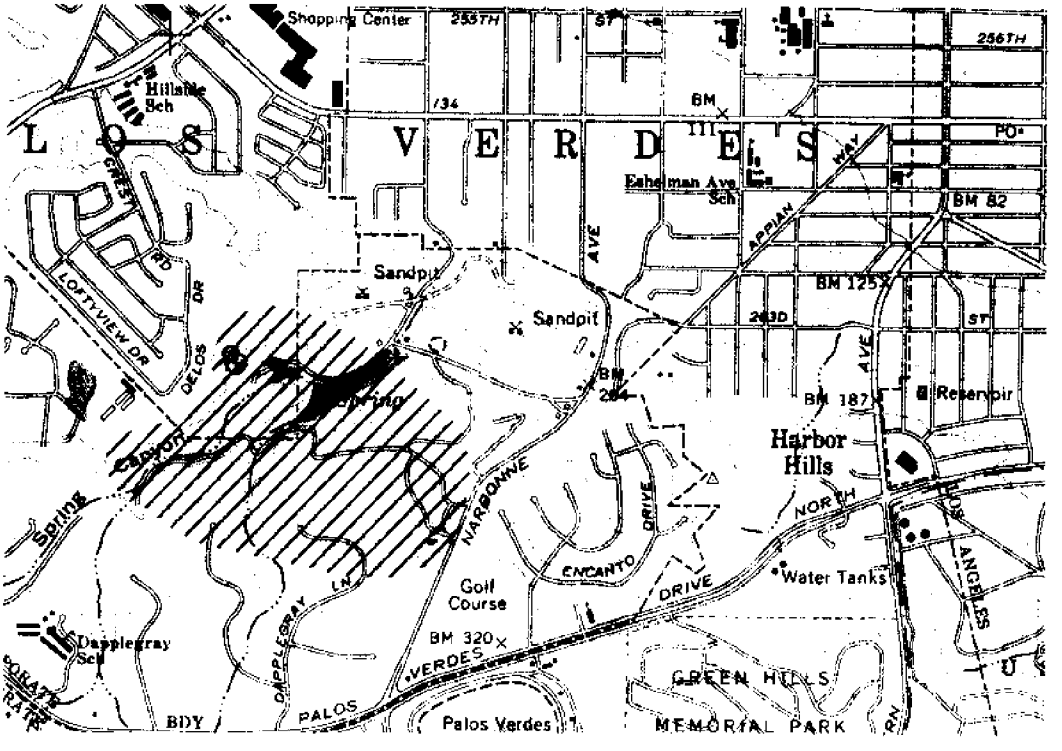
Recommendation Six:

Salvage collection

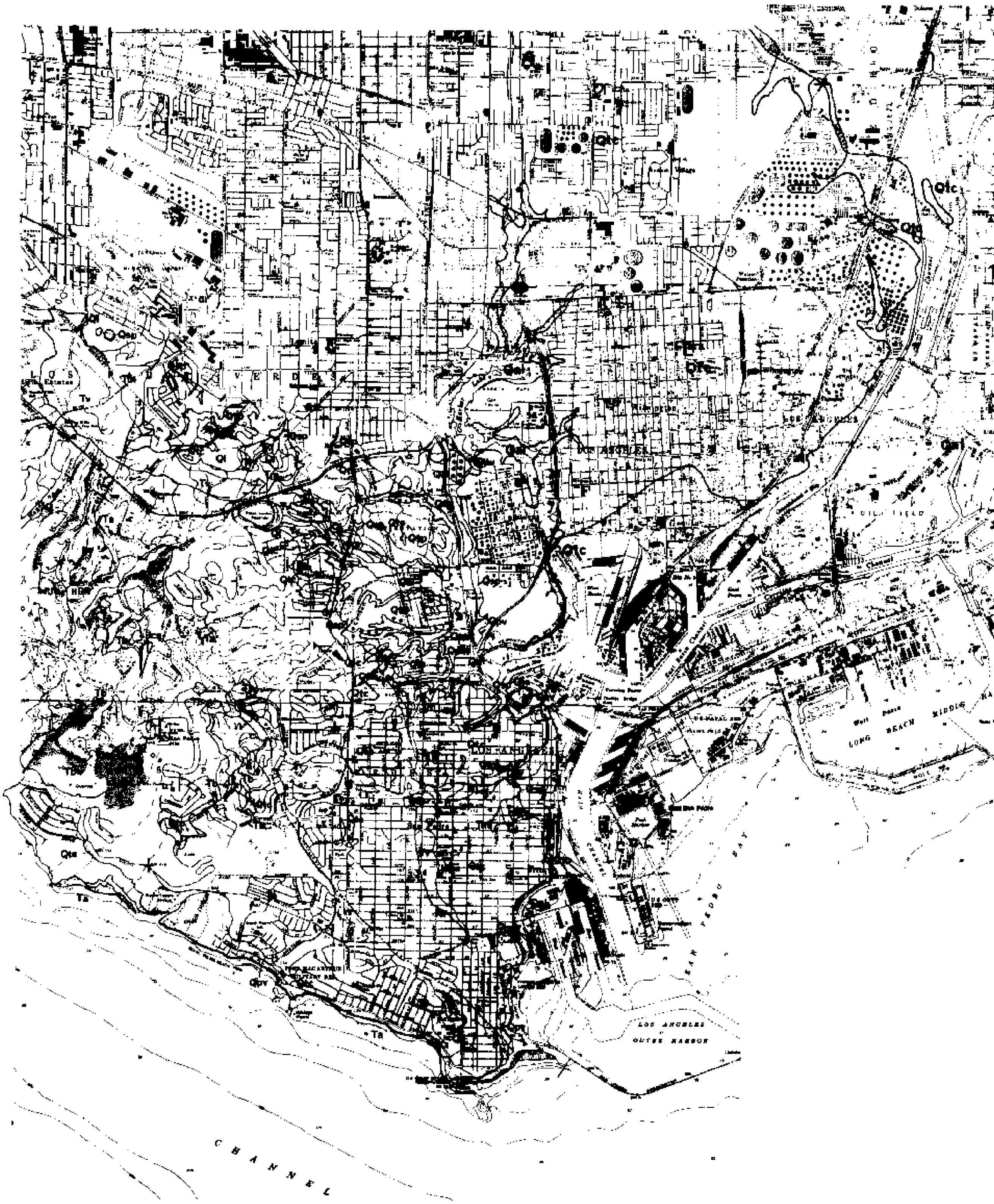
Professional paleontologists should make such salvage collections as deemed necessary by them for the preservation of paleontological remains in areas of earth removal. If at all possible, such work should be done with a minimum of disturbance to the project under way.

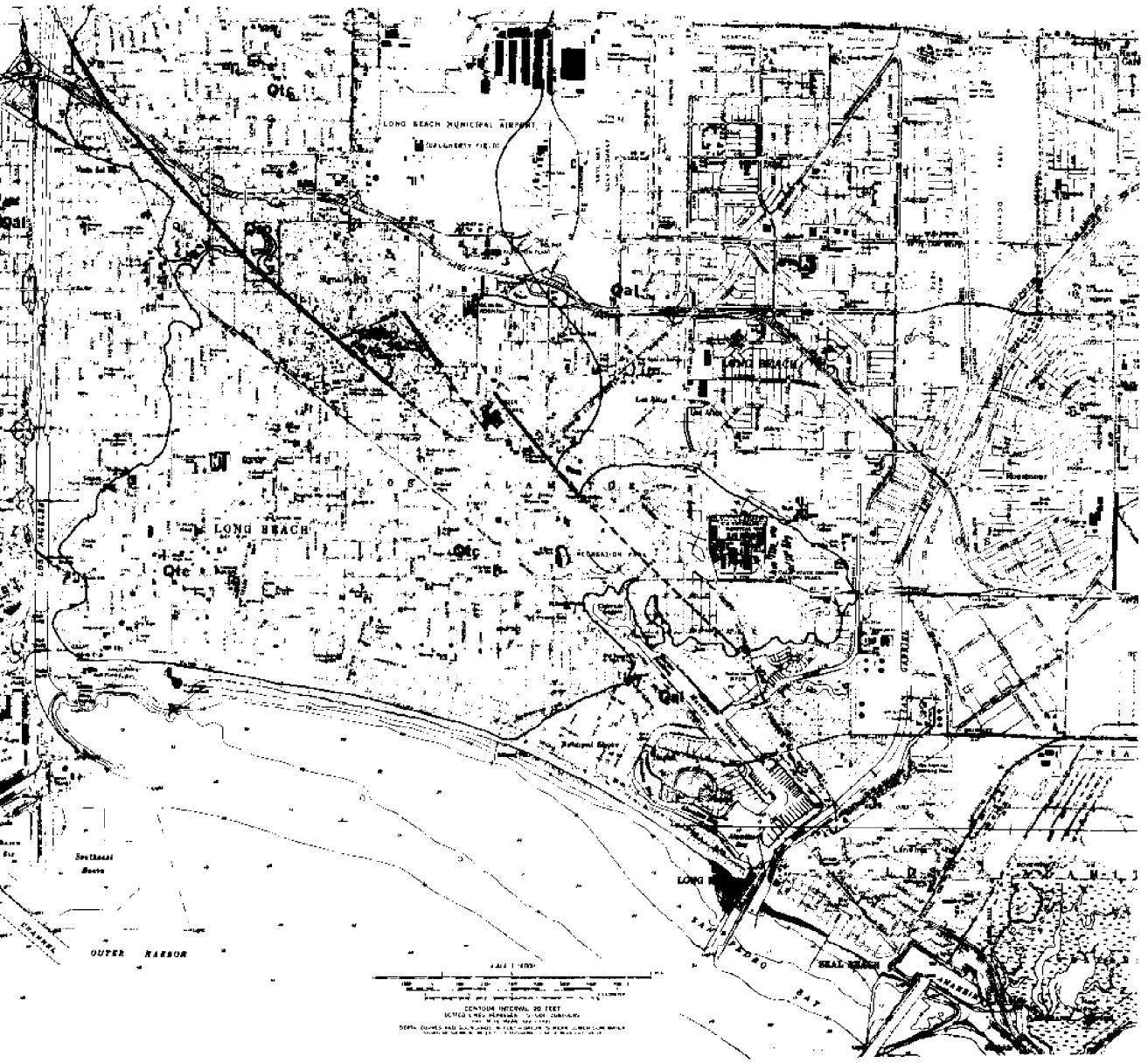


Map 2. Type locality of the Timms Point Silt (lower Pleistocene), at Timms Point, community of San Pedro, City of Los Angeles, Los Angeles County, California. Scale 1:15,160. Base map is U.S. Geological Survey, San Pedro, Calif. quadrangle (1964), 7½ minute series, scale 1:24,000.



Map 3. Type locality of the Lomita Marl (lower Pleistocene), at Lomita Quarry (•) and the western reaches of the Gaffey Syncline, cities of Torrance and Rolling Hills Estates, Los Angeles County, California. Scale 1:24,000. Base map is U.S. Geological Survey, Torrance, Calif. quadrangle (1964), 7½ minute series, scale 1:24,000

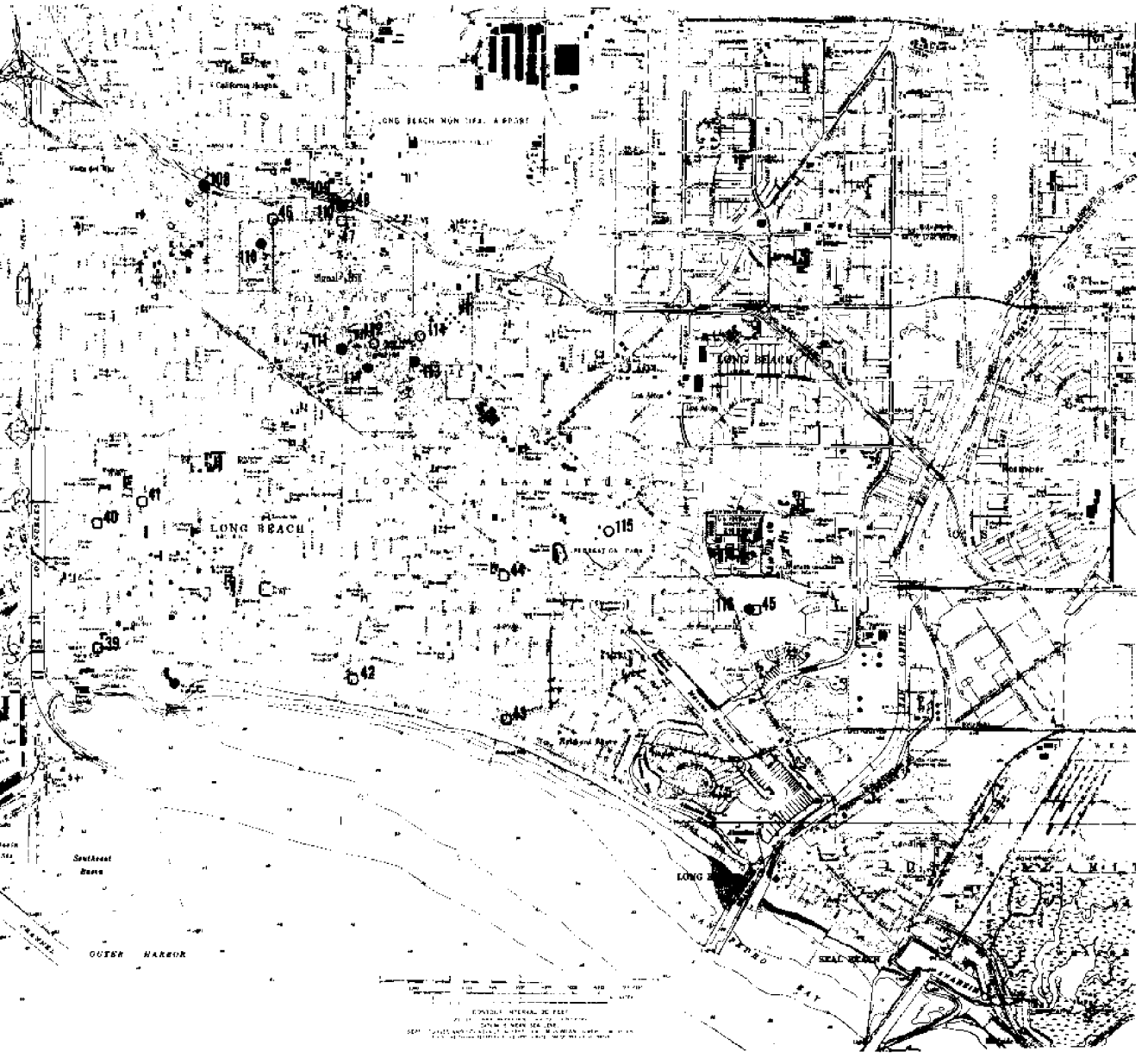

LOS ANGELES
OUTER HARBOR
LONG BEACH
SAN PEDRO BAY
C H A N N E L
OIL FIELD
Qtc
Ts



Map 4. Simplified geologic map of the San Pedro and Long Beach areas adapted from Woodring, et al.(1946) and Poland, et al.(1956).

Symbols: Qal, Quaternary alluvium; Qtc, Quaternary terrace cover (includes Palos Verdes Sand in Wilmington, Long Beach and Signal Hill areas); Qpv, Quaternary Palos Verdes Sand; Qsp, Quaternary San Pedro Sand; Qtp, Quaternary Timms Point Silt; Ql, Quaternary Lomita Marl; Tr, Tertiary (Pliocene) Repetto Formation; Tm, Tertiary (Miocene) Malaga Mudstone; Tv, Tertiary (Miocene) Valmonte Diatomite; Ta, Tertiary (Miocene) Altamira Shale; Tb, Tertiary (Miocene) basalt; Jcs, Jurassic(?) Catalina Schist.


LONG BEACH
LOS ANGELES
OUTER HARBOR
SAN PEDRO BAY
SAN PEDRO CHANNEL



Map 5. Fossil localities in the San Pedro and Long Beach area represented by collections in seven west coast museums and universities.

Vertebrate localities, □ are numbered 1-49 and 120-129.

Invertebrate localities, numbered 50-119, are indicated three ways; collections of more than 20 species present, ● ; collections of less than 20 species, ⊙ ; and localities which can not be accurately located, ○ .

Except as noted in the Index of Localities, all localities represent Pleistocene deposits. Map is based on a composite of the following U.S. Geological Survey, 7.5minute series, 1:24000 scale topographic quadrangles: Torrance, Calif.(1964), San Pedro, Calif. (1964), Long Beach, Calif.(1964), Los Alamitos, Calif.(1964), and Seal Beach, Calif.(1965).

Index of Vertebrate Fossil Localities
Nos. 1-49, 120-129

1. SSW of San Pedro Hill, unincorporated Palos Verdes Hills, LACM loc. 1898.

2. SW of Marymount School, unincorporated Palos Verdes Hills, LACM loc. 1927.

3. Near ocean end of Anchovy Street, San Pedro, LACM loc. 1194.

4. Miocene. Submerged reef one half mile west of White Point, LACM(CIT) loc. 341.

5. Miocene. Near Paseo Del Mar, San Pedro, LACM loc. 1348.

6. Miocene. Near Paseo Del Mar, San Pedro, LACM loc. 1280.

7. Miocene. Cabrillo Beach, San Pedro, LACM loc. 1925 (= loc. 1935).

8. Miocene. Cabrillo Beach, San Pedro, LACM loc. 6456.

9. Timms Point, San Pedro, LACM locs. 3217 and 3259.

10. Corner of Gaffey Street and 10th Street, San Pedro, LACM loc. 2026 (=1727).

11. SE corner of 4th and Mesa Streets, San Pedro, LACM loc. 7138.

12. Pacific Avenue between 2nd and 3rd Streets, San Pedro, LACM loc. 3251.

13. First Street and Harbor Boulevard, San Pedro, LACM loc. 3248.

14. Lumberyard site, San Pedro, LACM(CIT) loc. 187 (=UCMP loc. V-2047).

15. NE corner of Oliver Street and Pacific Avenue, San Pedro, LACM (CIT) loc. 186.

16. Near corner of Bonita Street and Pacific Avenue, San Pedro, LACM loc. 3254.

17. Near corner of Pacific Avenue and approach to Vincent Thomas Bridge, San Pedro, LACM loc. 3658.

18. North of Channel Street between Gaffey Street and the Harbor Freeway, San Pedro, LACM loc. 3175.

19. Corner of Gatun and Cabrillo Streets, San Pedro, LACM loc. 1056.

20. Incinerator site, now near Los Angeles Police station, San Pedro, LACM loc. 1602.

21. South of Union Oil Co. refinery, San Pedro, UCMP loc. V-7004.

22. Bluff immediately south of Union Oil Co. refinery, LACM loc. 3262, UCMP loc. V-7027.

23. Near Miraleste High School on west side of Palos Verdes Drive East, unincorporated Palos Verdes Hills, LACM loc. 7146.

24. Miocene. Miraleste School, unincorporated Palos Verdes Hills, LACM loc. 7140.

25. Miocene. Miraleste Canyon near east end of Canada Drive, unincorporated Palos Verdes Hills, LACM loc. 1714.

26. Near corner of Western Avenue and Westmount Drive, unincorporated Palos Verdes Hills, LACM(CIT) loc. 484.

27. South side of Green Hills Memorial Park, unincorporated Palos Verdes Hills, LACM loc. 3200.

28. NW corner of Green Hills Memorial Park, unincorporated Palos Verdes Hills, LACM loc. 1228.

29. SE of intersection of Gaffey Street and Agajanian Drive, Harbor City-San Pedro area, LACM loc. 3268.

30. Corner of Gaffey and Anaheim Streets, Harbor City, LACM loc. 1809.

31. NW corner of Anaheim Street and Normandie (Vermont) Avenue, Harbor City, LACM loc. 1158.

32. Chandler sand pit, Rolling Hills Estates, LACM loc. 1087.

33. Pennsylvania Avenue between Chandler and Sidebotham sand pits, Rolling Hills Estates, LACM loc. 1277.

34. Sidebotham sand pit, Rolling Hills Estates, LACM loc. 1053.

35. Corner of Petroleum Avenue and 253rd Street, Harbor City, LACM (CIT) loc. 263.

36. Corner of Lomita Boulevard and Main Street (Wilmington Boulevard), Carson-Wilmington boundary, LACM loc. 3085.

37. Watson, corner of Alameda Street and Sepulveda Boulevard, Carson, LACM loc. 1165.

38. NW corner of Anaheim Street and Henry Ford Avenue, Wilmington, LACM loc. 1163.

39. Corner of Magnolia Avenue and Ocean Boulevard, Long Beach, LACM loc. 6896.

40. Corner of Magnolia Avenue and 11th Street, Long Beach, LACM loc. 1144.

41. Corner of Pine Avenue and 12th Street, Long Beach, LACM loc. 3550.

42. Bixby Park near Junipero Avenue and Ocean Boulevard, Long Beach, LACM loc. 1005.

43. Livingston Avenue between Grand and Miramar Avenues, Long Beach, LACM loc. 2033.

44. Corner of Miramar Avenue and 7th Street, Long Beach, LACM loc. 6746.

45. East of Pacific Coast Highway (1), south of U. S. Veterans Hospital, Long Beach, LACM loc. 3757.

46. Corner of Orange Avenue and Spring Street, Long Beach-Signal Hill boundary, LACM loc. 1022.

47. Corner of Cherry Avenue and Spring Street, Long Beach-Signal Hill boundary, LACM loc. 1021.

48. Pliocene. Interstate 405 near Cherry Avenue, Long Beach, LACM loc. 3245.

49. Near intersection of Second and Beacon Streets, San Pedro, UCLA loc. 1063.12.

120. Miocene. South of Cabrillo Beach, San Pedro, LACM loc. 3539.

121. Corner of Third and Mesa Streets, San Pedro, LACM loc. 3760.

122. Below Park Western Drive, San Pedro, LACM locs. 3758 and 3759.

123. Wilmington and San Pedro Road, San Pedro, LACM loc. 1012.

124. Deadman Island, San Pedro, CAS loc. 92.

The following localities are off the margin of the map or are general localities and have not been plotted.

125. Bixby Road between Atlantic and Orange Avenues, Long Beach, LACM loc. 6802.

126. Near intersection of Pixie Avenue and Cover Street, Lakewood, LACM loc. 3660.

127. Dicalite diatomite quarry near Hawthorne Boulevard and Pacific Coast Highway, Walteria, LACM loc. 6455, LACM(CIT) loc. 388, UCMP loc. V-36118.

128. Bixby Slough (now Harbor Lake), Harbor City, LACM loc. 1055.

129. Lomita Pits, Lomita, LACM loc. 3065 (general area locality).

Index of Invertebrate Fossil Localities

Nos. 50-119

50. East side of Crest Road near San Pedro Hill, unincorporated Palos Verdes Hills, LACMIP* loc. 1304.

51. East side of Crest Road near San Pedro Hill, unincorporated Palos Verdes Hills, LACMIP loc. 1305.

52. Near BM 725, boundary area of unincorporated Palos Verdes Hills and San Pedro, LACMIP locs. 1307, 1308.

53. White Point, San Pedro, SDSNH loc. 2421.

54. "Chiton Bed" near Point Firmin, San Pedro, CAS loc. 54052, LACMIP locs. 345, 2673, SDSNH loc. 0625.

55. Gaffey Street just north of 38th Street, San Pedro, UCLA loc. 4243.

56. Cabrillo Beach 220 yards east of breakwater, San Pedro, CAS loc. 1849.

57. San Pedro High School excavation at 15th and Leland Streets, San Pedro, LACMIP loc. 2687, SDSNH loc. 2138.

58. "Crawfish George's", bluffs at foot of 22nd Street, San Pedro, CAS locs. 97, 34635, LACMIP locs. 224, 2628, 2697-2700, SDSNH locs. 0502, (no #), UCLA (no #), UCMP loc. A-1493.

59. Deadman Island (now oblitered), San Pedro, CAS locs. 92-94, 96, 495, 744, 746, 1473-1479,12087, 12135, 13188, 13189, 13191, 28137, 34636, 36495, 36889, 36917, 40765, 45132, 53994, 53997, 54944, CIT locs. 31, 35, 36, 124-131, 270, 271, 275, LACMIP locs. 2, 8, 17, 1206, 2616, 2619, 4655, SDSNH loc. 1884, UCLA (no #) UCMP locs. 2113, 4030, 7102, A-1489, A-2542.

60. Timms Point, San Pedro, CAS locs. 95, 28391, 29844, 34162, 34222, 38861, 45126, 53984, 54010, LACMIP locs. 62, 130-7, 1203 (nearby), 1378, 2684, CIT locs. 1,3,10,24,77,78,136, 264, 274, 320-322, 329, 330, 409, 410, 990, SDSNH loc. 1943, UCLA locs. 2404, 2382 (both on south side), (Tieje coll, no #), UCMP locs. B-1754, D-5435.

61. Center Street, between 8th and 9th Streets, San Pedro, UCLA locs. 3441, 3442.

62. Corner of 8th and Palos Verdes Streets, San Pedro, CAS locs. 45128, 54032, LACMIP loc. 226, SDSNH (no #)
Palos Verdes Street between 8th and 9th Streets, San Pedro, UCLA loc. 3440.

63. Corner of 7th and Palos Verdes Streets, San Pedro, CAS loc. 98

* LACM Invertebrate Paleontology locality.

64. Corner of 3rd and Mesa Streets, San Pedro, CAS loc. 31619, LACMIP loc. 98, SDSNH loc. 2660, UCLA loc. 2314, UCMP (no #).

65. SE corner of 3rd and Mesa Streets, San Pedro, LACMIP loc. 99. Corner of 4th and Mesa Streets, San Pedro, UCLA loc. 2310.

66. Nob Hill (now leveled to grade), San Pedro. This hill existed between 1st and 3rd Streets between Palos Verdes Street and Harbor Boulevard. Oldroyd's (1924(1925)) locality was on the south side of 3rd Street between Beacon Street and Harbor Boulevard (where dot on map is plotted). (See also locs. 68 and 69). SDSNH loc. 1885, UCMP loc. A-1503.

    Nob Hill, San Pedro, CAS locs. 45130, 53987, 54034, LACMIP loc. 228, UCLA (Tieje coll., no #).

67. Corner of 4th Street and Harbor Boulevard, San Pedro, UCLA locs. 233, 273.
    Corner of 4th and Front Streets, San Pedro, LACMIP loc. 2604.
68. Corner of 2nd and Beacon Streets, San Pedro, UCLA locs. 1049, 1053-1055, 1823, 1824, UCMP loc. D-1627.

    Cut through Nob Hill, San Pedro, CAS loc. 1198.

69. Corner of 2nd and Palos Verdes Streets, San Pedro, SDSNH (no#).

70. First Street east of Mesa Street, San Pedro, LACMIP loc. 4752, UCMP (no #).

71. Second Street between Pacific and Mesa Streets, San Pedro, CAS locs. 34484, 34488, 34489, LACMIP locs. 2701, 4557, UCMP locs. A-6730, A-6733.

72. Area near Pacific Avenue and 2nd Street, San Pedro, CAS loc. 34616, UCMP loc. A-9913.

73. Northeast corner of 1st Street and Harbor Boulevard, San Pedro, UCMP loc. A-219.

74. San Pedro bluffs; north end of San Pedro bluffs; San Pedro shoreline; one quarter mile north of S. P. railroad depot; old lumberyard below Nob Hill; etc., San Pedro, CAS locs. 91, 99, 742, 45129, LACMIP loc. 300, UCLA loc. 232, UCMP loc. A-1484.

75. Corner of Beacon and O'Farrell Streets, San Pedro, UCLA loc. 1825.

76. Corner of Pacific Avenue and O'Farrell Street, San Pedro, SDSNH (no #).

77. SE (?) corner of Pacific Avenue and Oliver Street, San Pedro, USGS-M loc. 2017.

78. West side of Pacific Avenue between Oliver and Bonita Streets, San Pedro, CAS locs. 33069, 54041, LACMIP locs. 131, 4665, UCLA locs. 231, 2381, 2445.

79. Near intersection of Gaffey Street and General Avenue, San Pedro, LACMIP loc. 227.

    Gaffey Street Bridge (some may actually be loc. 80), San Pedro, CAS locs. 53972, 54030, 54031, LACMIP loc. 4666.

80. Gaffey Street and Elberon Street overpass, San Pedri, UCMP locs. A-6734, (no #).

81. "Old lumberyard" or "Arnold's lumberyard" exposure (now destroyed), now between Harbor Boulevard and west end of Slip no. 93, San Pedro, CAS locs. 34634, 36917, and (all?) 42177, 42178, 45131, 53989, LACMIP locs. 37, 76, 2624, 2631, and (both?) 2610, 2612, UCLA locs. (all?) 187, 234A, (Tieje coll.), USGS-M loc. 1728.

82. Knoll Drive west of Front Street, San Pedro, UCLA locs. 3682, 3683.

83. Front Street cut, San Pedro, LACMIP locs. 2605, 2625.

    N. Front Street, San Pedro, LACMIP locs. 2606, 2607, SDSNH (no #).

84. Corner of Pacific Avenue and Hards Street, San Pedro, LACMIP loc. 440.

85. South side of Harbor Boulevard near old intersection with Miraflores Street, San Pedro, CAS loc. 54840, LACMIP loc. 4565.

86. 600 block of Miraflores Street (now covered by freeway), San Pedro, LACMIP loc. 332.

87. Hilltop Quarry (now built over), San Pedro, CAS locs. 28390, 31305, 34476, 34477, 38858, 45063, 45125, 45622, 53985, LACMIP loc. 64, UCLA locs. 166A, 166B, 279, 335, 336, UCMP locs. 4029(?), B-1756.

88. Below Park Western Drive near old Hilltop Quarry, San Pedro, LACMIP loc. 435, UCLA loc. 166.

89. Below Park Western Drive, near old Hilltop Quarry, San Pedro, SDSNH loc. 2669.

90. Hill behind Harbor Police Station, San Pedro, SDSNH (no #).

    "Avenue B" behind Police Station, San Pedro, LACMIP loc. 4678.

91. Opposite Sun Lumber Co. on Wilmington and San Pedro Road, San Pedro, UCMP loc. B-469.

92. New lumberyard; Sun Lumber Co.,; opposite Sun Lumber Co.,; one fourth mile north of new lumber yard; Wilmington and San Pedro Road; etc., San Pedro, CAS loc. 38860, LACMIP locs. 165, 299, 430, 2689, 4683, SDSNH locs. 1960, 1967(?), 1977(?), UCLA locs. 234, 235, 337, 4612, UCMP locs. A-210, A-211, (no #), USGS-M loc. 1723.

93. Gully on Wilmington and San Pedro Road, San Pedro, UCLA loc. 3600.

94. Western Avenue, unincorporated Palos Verdes Hills, UCLA locs. 3601, 3602.

95. Hills on both sides of Gaffey Street south of Harbor Lake, Harbor City, UCMP loc. 4033.

96. Bluff on south side of Union Oil Co. refinery and tank farm, San Pedro, LACMIP loc. 1210, UCLA loc. 5917, UCMP loc. B-6411.

97. South of Union Oil Co. refinery; on the hill of the Union Oil Co. refinery; one fourth mile south of the tank farm; etc., San Pedro, CAS loc. 28136, LACMIP loc. 427, SDSNH loc. 1977 (?), UCMP locs. A-210, A-211, A-213, A-214, A-215.

98. SE corner of Gaffey Street and Anaheim Street, Harbor City, LACMIP locs. 229, 2601.

99. Bixby Slough (now Harbor Lake), Harbor City, CAS loc. 45136, LACMIP locs. 2683, 4734.

100. NW corner of Vermont (Normandie) Avenue and Anaheim Street, LACMIP loc. 166.

101. Sidebotham sand pit, Rolling Hills Estates, UCLA loc. A-216.

102. Sidebotham sand pit, Rolling Hills Estates, UCLA loc. 3775.

103. Lomita Quarry, Torrance, SDSNH (no #), UCMP loc. A-217.

104. Near Crenshaw Boulevard and SSW of Hillside School, Torrance, UCLA loc. 3460.

105. NW corner of Sepulveda Boulevard and Vermont Avenue, unincorporated Los Angeles Co. west of Carson, LACMIP loc. 147.

106. Vermont Avenue one block south of Sepulveda Boulevard, unincorporated Los Angeles County west of Carson, CAS locs. 38859, 45131A, LACMIP loc. 1186.

107. Corner of Lomita Boulevard and Main Street (Wilmington Boulevard), Wilmington-Carson boundary area, CAS loc. 41877, LACMIP loc. 77.

108. Near intersection of Interstate 405 and Atlantic Avenue, Long Beach-Signal Hill boundary, LACMIP loc. 424.

109. Interstate 405 west of Cherry Avenue, Long Beach, LACMIP loc. 2668.

110. Pliocene. Approximate intersection of Interstate 405 and Cherry Avenue, Long Beach, LACMIP loc. 423.

111. Cherry Avenue at top of Signal Hill, Signal Hill, CIT locs. 817, 1349, UCLA (Tieje coll.), USGS-M loc. 2011.
West side of Signal Hill, Signal Hill, UCLA loc. 274.
112. "Signal Hill" or "Cerritos", etc., CAS loc. 45133, LACMIP locs. 4, 2629, 2685, UCLA locs. 275, 1191, UCMP locs. 2116, A-1483, A-3421

On south side of Signal Hill, Signal Hill, UCLA loc. 214.

113. NE corner of Hill Street and Temple Avenue, Signal Hill, CIT loc. 1350, UCLA loc. 2353.

114. On east side of Signal Hill, Signal Hill, CIT loc. 333, UCLA loc. 222, UCMP loc. A-223.

115. Recreation Park, Long Beach, LACMIP loc. 2686.

116. East side of Pacific Coast Highway (1) south of U. S. Veterans Hospital, Long Beach, LACMIP locs. 4568, 4865.

117. Southeast corner of projected intersection of Raymond Avenue and Hill Street, Signal Hill, CIT loc. 1348.

118. Southwest corner of projected intersection of 29th Street and Cerritos Avenue, Signal Hill, CIT loc. 1351.

119. San Pedro Hill and vicinity, unincorporated Palos Verdes Hills, LACMIP loc. 428, UCMP loc. D-5440.

Bibliography and Literature Cited

Most of the published papers which refer, even slightly, to fossils in the San Pedro and Long Beach areas are listed in the bibliography. A few important references to Miocene fossils at Malaga Cove, outside of the project area, have also been included. Several important theses and dissertations are cited if they have not since appeared in published form. No attempt has been made to include purely geological papers, except where portions of these are thought to be relevant to this study.

Citations from a series of informal sources, such as various bulletins of amateur shell and fossil clubs, have also been included. They are: Lorquinia, bulletin of the Lorquin Natural History Club, Los Angeles (printed, 1916-1919); Minutes of the Conchological Club of Southern California, Los Angeles (mimeographed, 1941-1960); The Fossileer, bulletin of the Southwest Fossileers, La Mesa (spirit duplicated, 1966-present); The Tabulata, bulletin of the Santa Barbara Malacological Society, Santa Barbara (photo offset, 1967-present); and Bulletin of the Southern California Paleontological Society, Los Angeles (spirit duplicated and photo offset, numbered from 1969-present).

Only a few of the following papers have not been seen by me (indicated by "not seen"). Annotations followed by "WBK" were taken from the bibliography in Woodring, Bramlette, and Kew (1946:-3-8); those followed by "PEL" were written by Langenwalter. Annotations are meant only as a reference to local fossil occurrences, and thus may actually ignore more important aspects of a particular paper.

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Addicott, W. O. 1965. Some western American Cenozoic gastropods of the genus Nassarius. U.S. Geol. Surv., Prof. Paper 503-B: 24p., 1 fig., 3 pls.
Five species of Nassarius from the Pleistocene Palos Verdes Sand of San Pedro are figured.

American Ornithologists' Union, A Committee of. 1957. Checklist of North American Birds, Fifth edition. American Ornithologists' Union, Baltimore. 691 p.
Systematic list of birds, includes records of extant species of birds reported from the Pleistocene of the San Pedro area.

Anon. 1885. Catalogue of the State Museum of California, vol. 2, being the collections made by the State Mining Bureau, from April 16, 1881, to May 15, 1884. California State Min. Bur., Sacramento. 220 p.
Includes 18 species of "Post Pliocene Tertiary Fossil," from San Pedro, and one "Miocene Tertiary Fossil" from Deadman's Island, Bay of San Pedro; all are Pleistocene mollusks.

Anon. 1955. A microfossil locality. Gems and Minerals, no. 210:22, 1 fig. Reprinted in Bull. So. California Paleont. Soc., 2(7):5-6, 1 fig. (1970).
Locality map of the type locality of the Timms Point Silt at Timms Point, San Pedro.

Anon. 1971. 50,000-year-old remains of whale found by youth. Bull. So. California Paleont. Soc., 3(2):8-9. Reprinted from Long Beach Independent Press Telegram, 17 January 1971.
Report of whale remains found in the Palos Verdes Sand in San Pedro.

Applegate, S. P. 1964. A shark tail from the Miocene of Palos Verdes Hills, California. Bull. So. California Acad. Sci., 63(4):181-184, fig. 1-2.
Discusses fossil shark remains from the Valmonte Diatomite from the diatomite on the northern border of the Palos Verdes Hills. (PEL)

Applegate, S. P., and A. E. Daugherty. 1966. The mystical fascination of the shark. Mus. Alliance Quart., 5(2):4-10, 8 figs.
Figure of shark tail from the Valmonte Diatomite in the Palos Verdes Peninsula. See also Applegate, 1964.

Arnold, Delos. 1896. An interrogation regarding the fossil shells of San Pedro Bay. Nautilus, 10(3): 33-34.
Short note on cool water molluscan fossils from the San Pedro region, including a short list of species.

_____. 1897. Fossils of Dead Man's Island. Nautilus,10(12): 140-142.
Short note on Deadman Island and its Pleistocene molluscan fossils.

Arnold, Delos, and Ralph Arnold. 1902. The marine Pleistocene and Pleistocene stratigraphy of the coast of southern California. Jour. Geol., 10(2): 117-138, fig. 1-7, pl. 1-5.
Pleistocene strata of San Pedro are described and the "upper San Pedro", now the Palos Verdes Sand, and "lower San Pedro", now the San Pedro Sand, formally proposed with the type section at Deadman Island.

Arnold, Ralph. 1903. The paleontology and stratigraphy of the marine Pliocene and Pleistocene of San Pedro, California. Mem. California Acad. Sci., 3:420 p., 37 pls. Reprinted as Contrib. Biol., Hopkins Seaside Lab., Leland Stanford Jr. Univ., no. 31.
Monographic treatment of the paleontology and stratigraphy of the San Pedro area Pliocene (=Pleistocene Timms Point Silt) and Pleistocene deposits. Includes faunal lists from Los Cerritos (=Signal Hill) and Long Beach. One vertebrate and 407 invertebrate species are described and many are figured.

_____. 1906. The Tertiary and Quaternary pectens of California. U. S. Geol. Surv., Prof. Paper 47:264 p., 2 figs., 53 pls.
Twenty species and varieties, four new, of pectens are described (and figured) from the Pleistocene and "Pliocene" (=Pleistocene) deposits of the San Pedro area. Includes faunal lists of the San Pedro area Pleistocene.

_____. 1962. Eighty years experience as a conchologist. Leafl. Malacol., 1(20):123-129.
Autobiographical sketch of the author includes references to his early years of fossil collecting in San Pedro and southern Califonria.

Ashley, G. H. 1895a. The Neocene stratigraphy of the Santa Cruz Mountains. I-Stratigraphy. Proc. California Acad. Sci., ser. 2, 5(1):273-367, pl. 22-25. Reprinted as Leland Stanford Jr. Univ. Publ., Geol. and Paleont., no. 1.
Pleistocene deposits in San Pedro assigned to the Pliocene. Lists 103 molluscan species from the "Pliocene" and 13 from the "Quaternary" (probably the Palos Verdes Sand).

_____. 1895b. Studies in the Neocene of California. Jour. Geol., 3(4):434-454, pl. 8-10.
"Pliocene" (Pleistocene) and Pleistocene strata of San Pedro area mentioned (p. 451-452). (WBK)

Axelrod, D. I. 1967a. Evolution of the Californian closed-cone pine forest, p. 93-149, fig. 1-2, pl. 1-8. In R. N. Philbrick, ed., Proceeding of the Symposium on the Biology of the California Islands. Santa Barbara Botanic Garden.

Axelrod, cont.
Three species of closed-cone pine discussed and figured from material collected near Bixby Slough (now Harbor Lake) and Signal Hill.

_____. 1967b. Geologic history of the California flora, p. 267-315, fig. 1-7. In R. N. Philbrick, ed., Proceedings of the Symposium on the Biology of the California Islands. Santa Barbara Botanic Garden, Santa Barbara.
Based on pollen and pine cone data from the Wilmington area (from several sources), it is concluded the coastal plain was dominated in the Plio-Pleistocene by a closed-cone pine forest with cypress, juniper, and some oak woodland and chaparral vegetation typical of the "Madro-Tertiary Geoflora."

Bagg, R. M., Jr. 1912. Pliocene and Pleistocene foraminifera from southern California. U. S. Geol. Surv., Bull. 513:1-153, fig. 1-3, pl. 1-28.
Describes 105 species and varieties of foraminifera from the "Pliocene" (=Pleistocene Timms Point Silt) of Timms' Point in San Pedro, 39 of which are figured from San Pedro material. (WBK) Five fish otoliths are also figured, from "San Pedro sands."

Bandy, O. L. 1960. The geologic significance of coiling ratios in the foraminifer Globigerina pachyderma (Ehrenberg). Jour. Paleontol., 34(4):671-681, fig. 1-7, table 1.
Samples from the Timms Point Silt and Lomita Marl from the Palos Verdes Hills are dominantly sinistral coiled (indicating cooler water).

_____. 1967. Foraminiferal definition of the boundaries of the Pleistocene in southern California, U.S.A., p. 27-49. In Mary Sears, ed., Progress in Oceanography, volume 4. Pregamon Press, Oxford and New York. (not seen)
The Lomita Marl has dominantly sinistral coiled populations of the foraminifer Globigerina pachyderma in most sections dated by Obradovich in the Lomita Quarry. (Bandy and Ingle, 1970)

_____. 1972. Late Paleogene-Neocene planktonic biostratigraphy and some geologic implications, California, p. 37-51, fig. 1-3. In E.H. Stinemeyer and C.C. Church, eds., The Proceedings of ... the Pacific Coast Miocene Biostratigraphic Symposium. Pacific Section, Soc. Econ. Paleontol. Mineral., Bakersfield.
The base of the Pleistocene Lomita Marl is correlated with planktonic events near or just below the 700,000 year level in a paleomagnetic scale.

Bandy, O. L., and K. O. Emery. 1954. Geologic guide for the southwestern part of the Los Angeles basin, southern California, p. 1-14, fig. 1-13. In R.H. Jahns, ed., Geology of Southern California. Geologic guide no. 4. State Calif. Dept. Nat. Resources, Div. Mines, Bull. 170. Reprinted 1949.

Bandy, cont.
Field trip guide, includes sections on the Palos Verdes Hills, San Pedro, and Wilmington areas, with notes on several fossil localities.

Bandy, O. L., and J. C. Ingle, Jr. 1970. Neogene planktonic events and radiometric scale, California, p. 131-172, fig. 1-7, pl. 1. In O. L. Bandy, ed., Radiometric Dating and Paleontologic Zonation. Geol. Soc. Amer., Spec. Paper 124.
Short discussion of the Pliocene-Pleistocene boundary. The Lomita Marl has dominantly sinistral populations of the foraminifer Globigerina pachyderma, indicating cooler water.

Bandy, O. L., and J. A. Wilcoxen. 1970. The Pliocene-Pleistocene boundary, Italy and California. Geol. Soc. Amer., Bull. 81(10):2939-2948.
The authors put the Plio-Pleistocene boundary at the base of the Lomita Marl, but believe this event to be younger than the 3 million year date of Obradovich.

Bartosh, E. J. 1938. Wilmington oil field, Los Angeles County, California. Bull. Amer. Assoc. Petrol. Geol., 22(8): 1048-1079, fig. 1-7.
"In some wells on the north flank of the field large fossil deposits are found in the upper 200 feet of the Pleistocene and in one well on the Domingue : Harbor track a charred redwood log deposit was noted at a depth of 287-293 feet. Similar deposits have been reported in other near-by areas at approximately the same depth" (p. 1053).

Bartsch, Paul. 1907. The west American mollusks of the genus Triphoris. Proc. U. S. Natl. Mus., 33(1569):249-262, pl. 16.
Triphoris pedroanus, n. sp., occurs in the Pleistocene Palos Verdes Sand of Arnold's lumberyard locality in San Pedro.

_____. 1911a. The Recent and fossil mollusks of the genus Alabina from the west coast of America. Proc. U.S. Natl. Mus., 39(1790):409-418, pl. 61-62.
Alabina californica reported from the lower San Pedro (=San Pedro Sand) at Deadman Island in San Pedro.

_____. 1911b. The Recent and fossil mollusks of the genus Cerithiopsis from the west coast of America. Proc. U.S. Natl. Mus., 40(1823):327-367, pl. 36-41.
Four species of Cerithiopsis, three new, occur in the Pleistocene deposits of the San Pedro area.

_____. 1911c. The Recent and fossil mollusks of the genus Bittium from the west coast of America. Proc. U.S. Natl. Mus., 40(1826):383-414, pl. 51-58.
Includes Pleistocene species from the San Pedro area.

_____. 1911d. The Recent and fossil mollusks of the genus Alvania from the west coast of America. Proc. U.S. Natl. Mus., 41(1863):333-362, pl. 29-32.
Alvania pedroana and A. fossilis, both new, are described from the Pleistocene of the San Pedro area.

_____. 1917. A monograph of west American melanellid mollusks. Proc. U. S. Natl. Mus., 53(2207):295-356, pl. 34-49.
Includes records from the Pleistocene deposits of the San Pedro and Long Beach areas.

_____. 1918. A new fossil pyramilellid mollusk from the west coast of America. Proc. Biol. Soc. Washington, 31:81.
The gastropod Turbonilla (Pyrgolampros) amava n. sp., is described from the "lower San Pedro series" of Deadman Island.

Berry, S. S. 1922. Fossil chitons of western North America. Proc. California Acad. Sci., ser. 4, 11(18):399-525, fig. 1-11, pl. 1-16.
Includes numerous records of chitons from the Pleistocene deposits of San Pedro and Signal Hill areas.

_____. 1940. New Mollusca from the Pleistocene of San Pedro, California-I. Bull. Amer. Paleontol., 25(94a):1-18, pl. 2.
Seven species, all new, are described from the Pleistocene of the San Pedro area.

_____. 1941. New Mollusca from the Pleistocene of San Pedro, California-II. Bull. Amer. Paleontol, 27(101): 1-18, pl. 1.
Seven species and one subspecies are described from the Lomita Marl of Hilltop Quarry in San Pedro.

_____. 1946. A re-examination of the chiton, Stenoplax magdalenensis (Hinds), with description of a new species. Proc. Malacol. Soc., 26(6):161-166, fig. 1-12.
Reports Stenoplax heathiana, n. sp., as "common in the 'Lower San Pedro' beds of southern California!"

_____. 1947. New Mollusca from the Pleistocene of San Pedro, California-III. Bull. Amer. Paleontol, 31(127): 1-20. pl. 1-2.
Describes seven new species and two new genera from the Pleistocene of the San Pedro area.

_____. 1948. On Opalia montereyensis (Dall). Jour. Entomol. Zool, Pomona College, 40(1):15-19, fig. 1-5.
Reports O. montereyensis from the Lomita Marl of Hilltop Quarry in San Pedro.

_____. 1950. Partial review of some west American species of Crepidula. Leafl. Malacol., 1(8):35-40.
Crepidula coei, n. sp., reported from the Pleistocene of the San Pedro area.

_____. 1954. New Californian Pleistocene Eulimidae. Bull. Amer. Paleontol., 35(151):1-16, pl. 1.
Describes and figures four new species of the gastropod genus Balcis s. l. and records nine species from the Lomita Marl at Hilltop Quarry in San Pedro.

_____. 1967. Some unusual mollusks, mainly Panamic (abstract). Amer. Malacol. Union (Ann. Rept. for 1967), Bull. 34:71-72.
A pathologic specimen of Megasurcula carpenteriana from the Pleistocene San Pedro Sand is mentioned.

Birkeland, P. W. 1972. Late Quaternary eustatic sea-level changes along the Malibu coast, Los Angeles County, California. Jour. Geol., 80(4):432-448, fig. 1-9, table 1.
Discussion of the Palos Verdes Hills terraces in relation to the marine terraces around Malibu, northwestern Los Angeles County.

Birkeland, P. W. D. R. Crandell, and G. M. Richmond. 1971. Status of correlation of Quaternary stratigraphic units in the western conterminous United States. Quat. Res., 1(2): 208-227, charts A-B.
Short discussion on the Pleistocene formations of the San Pedro area, p. 210.

Blake, W. P. 1855. Remains of the mammoth and mastodon in California. Amer. Jour. Sci. Arts, ser. 2, 19(55):133.
Report of a mammoth tooth from San Pedro, probably from the Palos Verdes Sand. (WBK)

_____. 1856. General report upon the geological collections. U. S. 33rd Cong., 2nd sess., Senate Exec. Doc. no. 78 and House Repr. Exec. Doc. no. 91, v. 3(Report of explorations for a railway route, ... from the Mississippi River to the Pacific Ocean, by A. W. Whipple), pt. 4 (Report on the geology of the route), no. 1:i + 1-98, 106-119.
Describes fossil assemblages collected from San Pedro.

_____. 1857. Geological report. U. S. 33rd Cong., 2nd sess., Senate Exec. Doc. no. 78 and House Repr. Exec. Doc. no. 91, v. 5 (Report of explorations in California for railroad routes, ..., by R. S. Williamson), pt. 2: 310 p., 87 figs., 14 pls., 4 maps, 14 cross sections.
Descriptions of the geology and fossils found in and around San Pedro.

Bramlette, M. N. 1946. The Monterey Formation of California and the origin of its siliceous rocks. U. S. Geol. Surv., Prof. Paper 212: 57 p., 18 pls.
Passing reference to Miocene foraminifera and to diatomaceous deposits in the Palos Verdes Hills.

Brattstrom, B. H., and Ann Sturn. 1959. A new species of fossil turtle from the Pliocene of Oregon, with notes on other fossils Clemmys from western North America. Bull. So. California Acad. Sci., 58(2):65-71, pl. 20-23.
Clemmys marmorata reported and figured from several Pleistocene localities in the San Pedro area. Various other vertebrates also listed.

Brodkorb, Pierce. 1963. Catalogue of fossil birds. Part 1 (Archaeopterygiformes through Ardeiformes). Bull. Fla. State Mus., 7(4):179-293.
Includes previously published records of fossil birds from the San Pedro area. (PEL)

_____. 1964. Catalogue of fossil birds: Part 2 (Anseriformes through Galliformes). Bull. Fla. State Mus., 8(3):195-335.
Includes previously published records of fossil birds from the San Pedro area. (PEL).

_____. 1967. Catalogue of fossil birds: Part 3 (Ralliformes, Ichthyornithiformes, Charadriiformes). Bull. Fla. State Mus., 11(3):99-220.
Secondary record of Limosa fedoa? (a sandpiper) from the Pleistocene of the San Pedro area. (PEL)

Burch, B. L. 1947. Comparison of the molluscs of three Pleistocene beds with the Recent fauna of Los Angeles County, California. Min. Conchol. Club So. California, 73:1-18.
Short discussion and extensive list of Pleistocene fossils from the Nob Hill and Timms Point localities in San Pedro.

Burch, B. L., and T. A. Burch. 1943. A survey of western North American marine molluscs - Tellinidae. Min. Conchol. Club So. California, 25:9-25, 26 figs.
Includes Pleistocene occurrences in the San Pedro region for most of species of Tellinidae included.

Burch, J. Q. 1942-1958. Untitled notes. Min. Conchol. Club So. California, 14:2nd p. (VIII:42); 15:3rd p. (IX:42); 24:9(VI:43); 47:42(IV:45); 55:2(XII:45); 60:34(V:46); 102:2(VII:50);141:12(VIII:54);177:7(V:58).
Untitled notes on collectors, localities, and Pleistocene molluscan fossils, in the San Pedro and Long Beach areas.

_____. 1944-1945. Check list. West North American marine Mollusca from San Diego, Calif. to Alaska. Min. Conchol. Club So. California, 33:7-14, 15 figs. (III:44); continued in 34:3-12,17 figs. (IV:44);35:3-14b,25 figs. (V:44);36: 3-16a, 32 figs. (no fossils) (VI:44); 37:3-16, 17 figs. (no fossils) (VII:44); 38:3-18, 34 figs. (VIII-IX:44);39:4-24, 43 figs. (IX:44);40:3-26, 66 figs. (X:44); 41:19-28, 21 figs. (IX:44); 42:3-20, 52 figs. (XII:44); 43:5-34, 74 figs. (I:45); 44:3-38, 108 figs. (II:45). These pages, plus 45: 3-20 were reissued together under the title, "Distributional list of the west American marine mollusks from San Diego, California to the Polar Sea. Part I. Pelecypoda."

Includes many primary records of bivalves found in the Pleistocene deposits of the San Pedro area.

_____. 1945. (Untitled continuations of) Check list. West North American marine Mollusca from San Diego, Calif. to Alaska. Min. Conchol. Club So. California, 46:8-18, back page, pl. 1 (III:45);47:2-26, 29-31, back page, pl. 2 (IV:45); 48:2-27, back page (V:45); 49: 2-35, 47-48, pl. 3 (VI:45); 50:3-29, 35-38 (VII:45); 51:3-64(VIII:45); 52: 3-33, 39-40 (IX:45); 53:3-31, 37-40, 42 (X:45); 54:(1-2?), 3-48 (XI:45). These pages assembled and reissued together as "Distributional list of the west American marine mollusks from San Diego, California to the Polar Sea. Part II. Volume I."

Includes many primary records of scaphopods and gastropods found in the Pleistocene deposits in the San Pedro area. Two fossils are figured.

_____. 1945-1946. (Untitled continuations of) Check list. West North American marine Mollusca from San Diego, Calif. to Alaska. Min. Conchol. Club So. California, 55:7-38 (XII:45); 56:2-35(I:46); 57:1-38(II:46); 58:1-28(III:46); 60:17-29 (V:46); 61:2-47(VII:46); 62:1-52(VIII:46). These pages plus others, and a 110-page index (IX:46) reissued together as "Distributional list of the west American marine mollusks from San Diego, California to the Polar Sea. Part II. Volume II."

Includes many primary records of gastropods found in the Pleistocene deposits of the San Pedro area.

_____. 1949. A few conchological notes. Min. Conchol. Club So. California, 93:12.

Lists three species of mollusks not previously reported (in the Minutes) from the Timms Point Silt at Timms Point in San Pedro.

_____. 1950a. The Society of the Lost Operculum. Min. Conchol. Club So. California, 96:1-2.

Reports record size specimens of two gastropods from Pleistocene deposits in the San Pedro area. See also Draper, 1973.

_____. 1950b. The Society of the Lost Operculum. List # 3. Min. Conchol. Club So. California, 98:7-8.
Record size specimen of the clam Laevicardium elatum reported from the Pleistocene of San Pedro. See also Draper, 1973.

Burch, J. Q., and T. A. Burch. 1943. The Timms Point Pleistocene horizon at San Pedro, California. Min. Conchol. Club So. California, 22:7-9.
The authors interpret the fauna to be equivalent to that of the Puget Sound area. A faunal list includes 225 mollusks and various other invertebrate and vertebrate species.

Burch, T. A. 1943. Report on Scaphopoda. Min. Conchol. Club So. California, 21:5-9, fig. 1-10.
Dentalium pretiosum reported in the Pleistocene of San Pedro.

Campbell, A. S., and B. L. Clark. 1944. Miocene radiolarian faunas from southern California. Geol. Soc. Amer., Spec. Paper 51: 76 p., 7 pls.
Of 91 new species and varieties described, 76 are based on material from the Valmonte Diatomite and Malaga Mudstone from the San Pedro region.

Campbell, J. E. 1898. Quaternary fossil shells, Long Beach, California. Nautilus, 12(1):7-8.
Five species of Pleistocene mollusks are reported from Signal Hill.

Canu, Ferdinand, and R. S. Bassler. 1923. North American later Tertiary and Quaternary Bryozoa. U. S. Natl. Mus., Bull. 125: 302 p., 38 figs., 47 pls.
One new species from San Pedro, and 18 species, 4 new, from Deadman Island in San Pedro are described and figured, probably from the Timms Point Silt.

Carpenter, P. P. 1864. Supplementary report on the present state of our knowledge with regard to the Mollusca of the west coast of North America. Rept. British Assoc. Adv. Sci. for 1863:513-686. Reprinted in Smithson. Misc. Coll., 1872, 10(252):172 p.
Includes fossils from a "Recent formation" (=Palos Verdes Sand) collected by W. P. Blake at San Pedro and described by T. A. Conrad, p. 589; reprint p. 75.

Carson, C. M. 1925a. Some new species from the Pliocene of southern California with a few changes in nomenclature. Bull. So. California Acad. Sci., 24(2):30-35, pl. 1.
Cantharus fortis and C. arnoldi reported from the Pleistocene and "Pliocene", respectively, of the San Pedro area.

_____. 1925b. Pliocene faunal zones in southern California. Pan-Amer. Geol., 43(4):265-270.
On the basis of several invertebrate species, mostly mollusks, the author considers the Timms Point Silt to "represent the coldest part of the Pliocene epoch."

_____. 1926. New molluscan species from the Californian Pliocene. Bull. So. California Acad. Sci., 25(2):49-62, pl. 1-4.
Chrysodomus hawleyi, n. sp., described from the "upper Pliocene" (=Pleistocene) of San Pedro.

Casey, R. E. 1972. Neogene radiolarian biostratigraphy and paleotemperatures: Southern California, the experimental Mohole, Antarctic core 14-8. Palaeogeog., Palaeoclimat., Palaeoecol., 12(1/2):115-130, fig. 1-4, table 1-5.
Radiolarians from a core in Long Beach Mio-Pliocene sediments give paleotemperatures of ca. 10-15°C., based on ratios of spongodiscids (generally cold) to other spumellarids (generally warm), pl.127 and fig. 3.

Casey, R. E., A. B. Price, and C. A. Swift. 1972. Radiolarian definition and paleoecology of the late Miocene to early Pliocene in southern California, p. 226-238, fig. 1-5, pl. 1-3. In E. H. Stinemeyer and C. C. Church, eds., The Proceedings of ... the Pacific Coast Miocene Biostratigraphic Symposium. Pacific Section, Soc. Econ. Paleontol. Mineral., Bakersfield.
Lists and figures radiolarian species from the Miocene Malaga Mudstone from Malaga Cove, outside of study area, on the Palos Verdes Peninsula. Figure 2 is Fig. 3 of Casey, 1972 (q.v.) with Long Beach paleotemperature curve.

Chace, E. M. 1949. Minutes of the organization meeting of the Pacific Division (A. M. U. P.). Amer. Malacol. Union, News Bull. and Ann. Rept. - 1948:21-24.
Includes comments on Hilltop Quarry in San Pedro, "now mostly buried under a housing project but sometimes accessible in a nearby gully."

Chace, E. P. 1916. Fossil chitons. Nautilus, 30(6):71-72.
Three species of chitons not listed by Arnold (1903) are cited from the Pleistocene of Deadman Island in San Pedro.

_____. 1966. Pleistocene Mollusca from the second terrace at San Pedro, California. Trans. San Diego Soc. Nat. Hist., 14(13):169-172.
Lists 183 molluscan species from the Pleistocene of San Pedro High School in San Pedro.

_____. 1972. Pododesmus complex on the west coast. Tabulata, 5(2):3-8, fig. 1-5.

Chace, E. P., cont.
Pododesmus macroschisma reported from several Pleistocene localities in the San Pedro area.

Chace, E. P. and E. M. Chace. 1919. An unreported exposure of the San Pedro Pleistocene. Lorquinia, 2(6):1-3.
Sixty-six species of Pleistocene mollusks, including 10 species of chitons, are reported from the "Chiton Bed" on Point Firmin in San Pedro.

_____, and _____. 1967. Conchological reminiscences-Recollections of Emery P. Chace and Elsie M. Chace with the help of our notebooks. San Diego Soc. Nat. Hist., San Diego. 38 p.
Includes historical notes on fossil collecting by the Chaces in the San Pedro area.

Church, C. C. 1928. A new species of Bolivinita from the lower Pliocene of California. Jour. Paleontol., 1(4):265-268, fig. 1.
Plectofrondicularia californica, a foraminifer, is reported to be found in abundance in the lower Pliocene shales which crop out in the Palos Verdes Hills.

Clark, Alexander. 1930. Pliocene beds at Timms Point, San Pedro, California (abstract). Geol. Soc. Amer. Bull., 41(1):210.
The Timms Point Silt at Timms Point in San Pedro is subdivided into three lithologic units.

_____. 1931. The cool-water Timms Point Pleistocene horizon at San Pedro, California. Trans. San Diego Soc. Nat. Hist., 7(4):25-41, 2 figs.
Study of the paleontology and stratigraphy of the Timms Point Formation (new) at Timms Point in San Pedro. Faunal list includes 137 mollusks, 17 other invertebrates, and one fish tooth.

Clark, E. M. 1943. Turritella terrace. Min. Conchol. Club So. California, 29:3-4.
Discussion of a Pleistocene locality in San Pedro.

_____. 1947a. March meeting - 1947 (minutes). Min. Conchol. Club So. California, 68:23.
Note on a rich Pleistocene locality at Main Street and Lomita Blvd. in "Lomita", probably on Wilmington-Carson boundary.

_____. 1947b. The lower San Pedro Formation. Min. Conchol. Club So. California, 71:19-22.
Discussion of the San Pedro Sand at Deadman Island and other localities in the San Pedro and Long Beach areas.

Clark, W. B., and M. W. Twitchell. 1915. The Mesozoic and Cenozoic Echinodermata of the United States. Monogr. U.S. Geol. Surv., 54:341 p., 108 pls.

Clark, W. B., cont.
The sea urchins Strongylocentrotus franciscanus and S. purpuratus are both known from the San Pedro Sand of the San Pedro area.

Clements, Thomas. 1955. The Pleistocene history of the Channel Island region, southern California, p. 311-323, fig. 1-2. In R. B. von KleinSmid, ed., Essays in the Natural Sciences in Honor of Captain Allan Hancock on the Occasion of his Birthday July 26, 1955. Allan Hancock Foundation, University of Southern California, Los Angeles.
Limited discussion of the Palos Verdes Hills and its Pleistocene fauna in relation to that on the Channel Islands.

Cleveland, G. B. 1966. Diatomite, p. 151-158, fig. 22, table 17. In J. P. Albers and R. M. Stewart, eds., Mineral Resources of California. Calif. Div. Mines Geol., Bull. 191.
Dicalite Co. mined diatomite in the Palos Verdes Hills from 1930 until 1958.

Coan, E. V. 1971. The northwest American Tellinidae. Veliger, 14, suppl.: 63 p., 30 figs., 12 pls.
Pleistocene occurrences from the San Pedro area are included.

_____. 1973a. The northwest American Semelidae. Veliger, 15(4):314-329, fig. 1-19, tables 1-3.
Includes secondary records of six species of this bivalve family in the Pleistocene of the San Pedro area.

_____. 1973b. The northwest American Psammobiidae. Veliger, 16(1): 40-57, fig. 1-27, tables 1-3.
Includes secondary records for 5 species of this bivalve family in the Pleistocene of the San Pedro area.

Cockerell, T. D. A. 1939. Pleistocene shells from San Clemente Island, California. Nautilus, 53(1):22-23.
Pleistocene fossils are reported to have a median of latitudinal midpoint corresponding to that of the "Timms Point Bed" on the mainland.

_____. 1940. The marine invertebrate fauna of the Californian islands. Proc. Sixth Pacif. Sci. Cong., 3: 501-504.
"The San Clemente Pleistocene collection ... corresponds with the fauna of the Timm's Point Bed on the mainland, as described by Alex Clark."

Conrad, T. A. 1855a. Descriptions of eighteen new Cretaceous and Tertiary fossils & c. Proc. Acad. Nat. Sci. Philadelphia, 7:265-268.
The Recent species Cardita occidentalis, n. sp., is "allied to C. _____, of the San Pedro Recent formation"(=upper Pleistocene Palos Verdes Sand).

_____. 1855b. Note on the Miocene and post-Pliocene deposits of California, with descriptions of two new fossil corals. Proc. Acad. Nat. Sci. Philadelphia, 7:441. Reprinted in the U. S. Geol. Surv., Prof. Paper 59:172 (1909).
Five species of post-Pliocene (=Pleistocene) mollusks are listed from "near Santa Barbara and San Pedro." (WBK)

_____. 1855c. Report of Mr. T. A. Conrad on the fossil shells collected in California by Wm. P. Blake, geologist of the expedition under the command of Lieutenant R. S. Williamson, United States Topographical Engineers. U. S. 33rd Cong., 1st sess., House Repr. Exec. Doc. no. 129, append.(for Preliminary geological report, by W. P. Blake), art. 1:5-20. Octavo edition; partially reprinted in U. S. Geol. Surv., Prof. Paper 59:163-171 (1909).
Twelve molluscan species, one new, are described from the Pleistocene "Recent formation" (=Palos Verdes Sand) of San Pedro.

_____. 1856. (Editor's condensation and partial reprint of Conrad, 1855c). Amer. Jour. Sci. Arts, ser. 2, 21(62): 268-270.
Contains comments on the "Recent formation" (=Palos Verdes Sand) at San Pedro with a short list of fossils.

_____. 1857. Descriptions of the fossil shells. U. S. 33rd Cong., 2nd sess., Senate Exec. Doc. no. 78 and House Repr. Exec. Doc. no. 91, v. 5 (Report of explorations in California for railroad routes, ..., by R. S. Williamson), pt. 2 (Geological report, by W. P. Blake), append., art. 2: 317-329, pl. 2-9. Quarto edition of Conrad, 1855c.
Same paper as Conrad, 1855c, except with corrections and illustrations.

Cook, E. T. 1947. (Untitled list of additions to Pleistocene shells). Min. Conchol. Club So. California, 74: 12.
Additional brachiopod and molluscan species from the Pleistocene of Nob Hill and Timms Point, in San Pedro, are listed.

Cook, E. T., and E. M. Clark. 1943. List of Mollusca found in "Anomia Bed," Vermont Avenue approximately one block south of Sepulveda Boulevard. Min. Conchol. Club So. California, 21:17.
Lists 177 species of Pleistocene mollusks and five other vertebrate and invertebrate species from the Palos Verdes Sand of an unincorporated area north of Harbor Lake, city of Los Angeles.

Cooper, J. G. 1888. Catalogue of Californian fossils. California State Min. Bur., Ann. Rept. State Mineralogist for 1887, 7:221-308.
Includes occurrences of Pleistocene fossils in the San Pedro area.

_____. 1894. Catalogue of Californian fossils. Part III. Additions to the catalogue of Californian fossils obtained since 1888. California State Min. Bur., Bull. 4:23-33.
Includes occurrences of Pleistocene fossils from Deadman Island and San Pedro.

Cossman, Maurice. 1903. The Palaeontology of the marine Pliocene and Pleistocene of San Pedro, California, by Ralph Arnold (Review). Rev. Critique de Paleozool., 7th year, no. 4:214-216.
Includes discussion of several genera and species cited by Arnold (1903).

Crickmay, C. J. 1929a. On a new pelecypod, Calyptogena gibbera. Canadian Field Natural., 43( ):93, 1 fig. (not seen)
Calyptogena gibbera described from the Pleistocene of Deadman Island in San Pedro (Timms Point Silt). (WBK)

_____. 1929b. The anomalous stratigraphy of Deadman's Island, California. Jour. Geol., 37(7):617-638, 1 table.
Detailed stratigraphy of Deadman Island in San Pedro, with lists of fossils. Reworking of older deposits is thought to be responsible for mixtures of cold and warm-water fossils in a single horizon.

Cushman, J. A. 1925. Notes on the genus Cassidulina. Contrib. Cushman Lab. Foram. Res., 1(3):51-60, pl. 8-9.
Includes species described from the "Pliocene" (=Pleistocene) and Pleistocene deposits of the San Pedro area.

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Six species and varieties, 4 new, of foraminifera are described from the "Pliocene" (=Pleistocene) deposits of the San Pedro area (Lomita Quarry and Timms Point).

_____. 1929. Pliocene lagenas from California. Contrib. Cushman Lab. Foram. Res., 5(3):67-72, pl. 11.
Lagena angelina, n. sp., and 17 species and varieties of foraminifera described from the Lomita Marl of the Palos Verdes Hills.

Cushman, J. A., and U. S. Grant, IV. 1927. Late Tertiary and Quaternary elphidiums of the west coast of North America. Trans. San Diego Soc. Nat. Hist., 5(6):69-82, pl. 7-8.
The foraminifer Elphidium crispum? is recorded from the "Pliocene" (=Pleistocene) of the San Pedro area.

Cushman, J. A., and H. B. Gray. 1946a. Some new species and varieties of foraminifera from the Pliocene of Timms Point, California. Contrib. Cushman Lab. Foram. Res., 22 ( ):65-69, (illus.). (not seen)
Description of species from the "Pliocene" (=Pleistocene) Timms Point Silt of Timms Point in San Pedro.

_____, and _____. 1946b. A foraminiferal fauna from from the Pliocene of Timms Point, California. Cushman Lab. Foram. Resl., Spec. Publ. no. 19: 46 p., 8 pls.
Systematic list, with figures, of 161 species and varieties of foraminifera from the Timms Point Silt (=Pleistocene) of Timms Point in San Pedro.

Cushman, J. A., and D. D. Hughes. 1925. Some later Tertiary cassidulinas of California. Contrib. Cushman Lab. Foram. Res., 9(9): 11-16, pl. 2.
Includes description of species from Timms Point and Lomita Quarry. (WBK)

Dall, W. H. 1898a. A table of the North American Tertiary horizons, correlated with one another and with those of western Europe, with annotations. 18th Ann. Rept. U. S. Geol. Surv., pt. 2:323-348, 1 chart.
The term "San Pedro beds" used for "Extensive beds of unconsolidated Pleistocene sand replete with molluscan shells in very perfect condition, best exhibited at Har-Hill, at the head of San Pedro Harbor, California."

_____. 1898b. Contributions to the Tertiary fauna of Florida with especial reference to the Silex Beds of Tampa and the Pliocene beds of the Caloosahatchie River ... Part IV. Trans. Wagner Free Inst. Sci. Philadelphia, 3(4): 571-947, pl. 23-35.
Mentions Pleistocene occurrences of fossils, especially pectens, from San Pedro.

_____. 1900. Contributions to the Tertiary fauna of Florida with especial reference to the Silex Beds of Tampa and the Pliocene beds of the Caloosahatchie River ... Part V. Teleodesmacea: Solen to Diplodonta. Trans. Wagner Free Inst. Sci. Phila, 3(5):949-1218, pl. 36-47.
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_____. 1901. Synopsis of the Lucinacea and of the American species. Proc. U. S. Natl. Mus., 23(1237):779-833, pl. 39-42.
The bivalves Thyasira gouldii and T. bisecta are reported from the "Pliocene" (=Pleistocene) of the San Pedro area.

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Secondary record of the bivalve Dosinia ponderosa in Pleistocene deposits as far north as San Pedro.

_____. 1903. Contributions to the Tertiary fauna of Florida with especial reference to the Silex Beds of Tampa and the Pliocene beds of the Caloosahatchie River ... Part VI. Concluding the work. Trans. Wagner Free Inst. Sci. Phila., 3(6):1219-1654, pl. 48-60, tables 1-2.
Includes a few secondary records of Pleistocene mollusks from San Pedro.

_____. 1909. Contributions to the Tertiary paleontology of the Pacific Coast. I. The Miocene of Astoria and Coos Bay, Oregon. U. S. Geol. Surv., Prof. Paper 59: 278 p., 23 pls.
Contains reprints of T. A. Conrad's papers (1855b, 1855c) which mention Pleistocene fossils in the San Pedro area.

_____. 1917. Summary of the molluscs of the family Alectrionidae of the west coast of America. Proc. U. S. Natl. Mus., 51(2166):575-579.
Note that the gastropod Alectrion cerritensis was described from the Pleistocene of Los Cerritos.

_____. 1921. Summary of the marine shellbearing mollusks of the northwest coast of America, from San Diego, Calif., to the Polar Sea, mostly contained in the collection of the United States National Museum, with illustrations of hitherto unfigured species. U. S. Natl. Mus. Bull., 112: 217 p., 22 pls.
Includes scattered records for species from the Pleistocene of San Pedro and Long Beach (Signal Hill) areas.

Dall, W. H., and Paul Bartsch. 1901. A new Californian Bittium. Nautilus, 15(5):58-59.
The gastropod Bittium (Elachista) californicum, n. sp., is described from the Pleistocene of Deadman Island in San Pedro.

_____ , and _____. 1909. A monograph of west American pyramidellid mollusks. U. S. Natl. Mus., Bull. 68: 258 p., 30 pls.
Includes records of Pleistocene occurrences in the San Pedro area.

Dall, W. H., and G. D. Harris. 1892. Correlation papers; Neocene. Bull. U. S. Geol. Surv., 84: 349 p., 43 figs., 3 pls.
Three formations are recognized on Deadman Island, the "uppermost of which is certainly Pleistocene, while the others are Neocene, and the middle layer probably Pliocene."(p.216). (WBK)

David, L. R. 1943. Miocene fishes of southern California. Geol. Soc. Amer., Spec. Paper 43: 193 p., 39 figs., 16 pls.
Six species of Miocene fish, two new, are described from the Altamira Shale one half mile west of White Point on the Palos Verdes Peninsula. "Fossil land plants and sea weeds occur in association with the fish. Remains of whales are also abundant" (p. 81).

_____. 1956. Tertiary anacanthin fishes from California and the Pacific northwest; their paleoecological significance: Jour. Paleontol., 30(3):568-607, fig. 1-27, pl. 69-72, tables 1-3.
Paleobathygadus wilmingtonensis, n. sp., and Progadus miocenicus, n. sp., are described and figured on the basis of fish scales obtained from well cores in the Wilmington oil field.

Deflandre, Georges. 1950. Contribution a l'etude des silicoflagellides actuels et fossiles (Suite et fin). Microscopie 2( ): 191-210, fig. 174-243. (not seen)
The silicoflagellate Dictyocha mutabilis, n. sp., is described and figured from "Diatomite miocene (moyen) de San Pedro, Californie". (See A. R. Loeblich III, et al., 1968: 105, pl. 18, fig. 14.)

DeLong, J. H., Jr. 1941. The paleontology and stratigraphy of the Pleistocene at Signal Hill, Long Beach, California. Trans. San Diego Soc. Nat. Hist., 9(25):229-250, fig. 1-4, 1 chart.
A study of the upper and lower Pleistocene deposits at Signal Hill. Includes lists of molluscan species from Signal Hill and six other localities in the San Pedro area.

Demond, Joan. 1952. The Nassariidae of the west coast of North America between Cape San Lucas, Lower California, and Cape Flattery, Washington. Pacif. Sci., 6(4):300-317, pl. 1-2.
Nassarius cerritensis was described from the Pleistocene of Los Cerritos (now the Signal Hill area).

Downs, Theodore. 1968. Fossil vertebrates of southern California. California Nat. Hist. Guide, No. 23, Univ. California Press, Berkeley and Los Angeles. 61 p. 29 figs., 8 pls.
"The diatomaceous beds of Palos Verdes (Hills) ... are characterized by numerous marine fishes, turtles, and birds." (p. 23).

Draper, B. C. 1973. Lost Operculum Club list of champions (April 1973). Conchol. Club South. California, Los Angeles. 64 p., 4 figs.
Latest of many editions lists the largest known specimens of west American marine mollusks, including many Pleistocene ones from the San Pedro area.

Dunnill, R. M., and E. V. Coan. 1968. A new species of the genus Macoma (Pelecypoda) from west American waters, with comments on Macoma calcarea (Gmelin 1791). Natl. Mus. Canada Nat. Hist. Papers, 43: 19 p., 10 figs.
Macoma elimata, n. sp., occurs in the Timms Point Silt of the San Pedro area.

Durham, J. W. 1937. Gastropods of the family Epitoniidae from Mesozoic and Cenozoic rocks of the west coast of North America, including one new species by F. E. Turner and one by R. A. Bramkamp. Jour. Paleontol., 11(6): 479-512, pl. 56-57.
Previous records of Pleistocene occurrences in the San Pedro area are assigned to six species in the family.

_____. 1947. Corals from the Gulf of California and the north Pacific Coast of America. Geol. Soc. Amer., Mem. 20: 68 p., 2 figs., 14 pls.

Durham, cont.
Secondary references to two corals previously described from the Pleistocene of the San Pedro area.

Durham, J. W., and J. L. Barnard. 1952. Stony corals of the eastern Pacific collected by the Velero III and Velero IV. Allan Hancock Pacif. Exped., 16: 110 p., 16 pls.
Caryophyllia arnoldi mentioned as being described from the Pleistocene of San Pedro Hill.

Durham, J. W., R. H. Jahns, and D. E. Savage. 1954. Marine-nonmarine relationships in the Cenozoic section of California, p. 59-71, fig. 1-4. In R. H. Jahns, ed., Geology of southern California. Chapter III, Historical geology. State California, Dept. Nat. Resources, Div. Mines, Bull. 170. Reprinted 1959.
"One of the youngest marine-nonmarine 'tie-ins' in southern California occurs in the Palos Verdes Sand in San Pedro, at the Lumber Yard locality .... Here a Rancholabrean (later Pleistocene) age is indicated by the presence of Bison and species of smaller mammals that still survive in the area." (p. 69).

DuShane, Helen. 1974. The Panamic-Galapagan Epitoniidae. Veliger, 16, suppl: 1-84, fig. 1-162, 1 map, tables 1-3.
Several occurrences of the gastropod family Epitoniidae are cited from Pleistocene deposits of the San Pedro area.

DuShane, Helen, and B. C. Draper. 1975. The genus Seila in the eastern Pacific (Mollusca: Gastropoda). Veliger, 17(4): 335-345, fig. 1-31.
Secondary record of Seila montereyensis from the San Pedro Sand in San Pedro.

Eaton, J. E. 1928. Divisions and duration of the Pleistocene in southern California. Bull. Amer. Assoc. Petrol. Geol., 12 (2):111-141, fig. 1-6, table 1.
Includes discussion of the Pleistocene deposits in the San Pedro and Signal Hill areas.

Eldridge, G. H., and Ralph Arnold. 1907. The Santa Clara Valley, Puente Hills and Los Angeles oil districts, southern California. U. S. Geol. Surv., Bull. 309: 266 p. 17 figs. 41 pls.
The formational names Puente, Modelo and Fernando are proposed for strata outside of the study area of this report, but have since been recognized in the area by various authors.

Emerson, W. K., and E. P. Chace. 1959. Pleistocene mollusks from Tecolote Creek, San Diego, California. Trans. San Diego Soc. Nat. Hist., 12(21):335-346, fig. 1-3, tables 1-3.
Passing reference to radiometric dates for the lowest exposed terrace of the Palos Verdes Peninsula in San Pedro.

Emery, K. O. 1958. Shallow submerged marine terraces of southern

Emery, cont.
California. Bull. Geol. Soc. Amer., 69(1): 39-59, fig. 1-13, pl. 1.
Five submerged terrace levels are present offshore from the Palos Verdes Hills and in San Pedro Bay, in addition to the 13 levels exposed on land.

_____. 1960. The sea off southern California. John Wiley and Sons, New York. 366 p.
Mentions Pleistocene fossils from terrace 12 of the Palos Verdes Hills, near San Pedro Hill. "Foraminifera in the deposit have been identified ... as typical of warm shallow water and of pre-Wisconsin age" (p. 148).

Emiliani, Cesare, and Samuel Epstein. 1953. Temperature variations in the lower Pleistocene of southern California. Jour. Geol., 61(2):171-181, fig. 1-6, tables 1-4.
Oxygen isotope ratios for foraminifera from the Lomita Marl indicate water temperatures from 12° to 30°C.

Evernden, J. F., and R. K. S. Evernden. 1970. The Cenozoic time scale, p. 71-90, fig. 1-4, table 1. In O. L. Bandy, ed., Radiometric dating and paleontologic zonation. Geol. Soc. Amer., Spec. Paper 124.
Short discussion on the Pliocene-Pleistocene boundary and the Lomita Marl of San Pedro, p. 85.

Fanale, F. P., and O. A. Schaeffer. 1965. Helium-uranium ratios for Pleistocene and Tertiary fossil aragonites. Science, 149(3681):312-317, fig. 1-2, tables 1-2.
Uranium-helium ages for Pleistocene mollusks from the 1200 foot terrace in the Palos Verdes Hills ranged from 330,000 to 420,000 years, and from the 70 foot terrace, 95,000 to 130,000 years. One Lomita Marl sample was dated at 155,000 years.

Fitch, J. E. 1967. The marine fish fauna, based primarily on otoliths, of a lower Pleistocene deposit at San Pedro, California (LACMIP 332, San Pedro Sand). Los Angeles Co. Mus., Contrib. Sci., 128: 23 p., 31 figs.
Discussion of the fossil fish assemblage from Miraflores Street in San Pedro. (PEL).

_____. 1968. Otoliths and other fish remains from the Timms Point Silt (early Pleistocene) at San Pedro, California. Los Angeles Co. Mus., Contrib. Sci., 146: 29 p., 4 figs.
Discussion of the fossil fish assemblage at Timms' Point in San Pedro. (PEL)

_____. 1969a. Fossil records of certain schooling fishes of the California Current system. California Coop. Ocean. Fish. Invest., Rept. 13: 71-80, fig. 1-3, table 1.
Six species of bony schooling fishes are recorded from five "Pliocene" and Pleistocene localities in the San Pedro area. Includes discussion of other fish remains

Fitch, cont.
from the same localities.

_____. 1969b. Fossil lanternfish otoliths of California, with notes on fossil Myctophidae of North America. Los Angeles Co. Mus., Contrib. Sci., 173: 20 p., 4 figs.
Discussion of fossil lanternfish remains from Signal Hill "San Diego Formation", and two localities in San Pedro, Timms Point Silt and San Pedro Sand. (PEL)

_____. 1970. Fish remains, mostly otoliths and teeth, from the Palos Verdes Sand (late Pleistocene) of California. Los Angeles Co. Mus. Nat. Hist., Contrib. Sci., 199: 41 p., 6 figs.
List and figures numerous species from the Palos Verdes Sand from several localities in the San Pedro area.

Fitch, J. E., and L. W. Barker. 1972. The fish family Moridae in the eastern north Pacific with notes on morid otoliths, caudal skeletons, and the fossil record. U. S. Dept. Commerce, Fish. Bull., 70(3): 565-584.
Discusses fossil Moridae (codlings) from San Pedro. (PEL)

Fitch, J. E., and R. J. Lavenberg. 1968. Deep-water teleostean fishes of California. California Nat. Hist. Guide, No. 25, Univ. California Press, Berkeley and Los Angeles. 155 p., 74 figs., 1 map.
Includes section (p. 13-15) on the fossil record of California deep-water fish with reference to Miocene and Pleistocene occurrences around San Pedro.

_____, and _____. 1971. Marine food and game fishes of California. California Nat. Hist. Guide, No. 28, Univ. California Press, Berkeley, Los Angeles and London. 179 p., 60 figs., 8 pls., 1 map.
Includes section on "California's fossil record of food and game fishes" (pp. 13-16) which mentions fossil fish from the Palos Verdes Sand and Lomita Marl of the San Pedro area.

_____, and _____. 1975. Tidepool and nearshore fishes of California. California Nat. Hist. Guide, No. 38, University California Press, Berkeley, Los Angeles and London. In press.
Fossil occurrences of a few nearshore fish are recorded from the San Pedro area.

Fitch, J. E., and R. D. Reimer. 1967. Otoliths and other fish remains from a Long Beach, California, Pliocene deposit. Bull. So. California Acad. Sci., 66(2):77-91, fig. 1-22, table 1.
Discussion of 32 species of teleost and elasmobranch fish from a Pliocene locality in Long Beach (herein assigned to the Fernando(?) Formation). The bivalve Tresus paharoanus (sic) is used as an age indicator for the Pliocene.

Follett, W. I. 1968. Fish remains from two submerged deposits in Tomales Bay, Marin County, California. Occas. Papers California Acad. Sci., 67:1-8, fig. 1-3.
Includes secondary references to fossil fish in the Pliocene and Pleistocene of San Pedro and Long Beach.

Gabb, W. H. 1865. Description of new species of marine shells from the coast of California. Proc. California Acad. Nat. Sci., 3:182-190.
Three new species of Pleistocene mollusks are described from San Pedro.

_____. 1866-1869. Palaeontology of California. Volume II (Cretaceous and Tertiary fossils). Geol. Survey of California, and Sherman and Co., Philadelphia. 299 p., 36 pls.
Six species of mollusks are described from the post-Pliocene of San Pedro in sec. 1, pt. 1. In pt. 2, Pecten pedroanus is assigned to the upper Miocene (p. 60). Sec. 1, pt. 3 includes a list of 86 mollusks and one echinoid from the post-Pliocene (=Pleistocene) of San Pedro.

Galloway, J. J., and S. G. Wissler. 1927a. Pleistocene foraminifera from the Lomita Quarry, Palos Verdes Hills, California. Jour. Paleontol., 1(1):35-87, pl. 7-12, tables 1-2.
Description of one new family, one new genus, and 79 species and varieties, 42 new, of foraminifera from the Lomita Marl at Lomita Quarry.

_____, and _____. 1927b. Correction of names of foraminifera. Jour. Paleontol., 1(3): 193.
New names proposed for homonyms erected by Galloway and Wissler (1927a).

Gay, T. E., Jr., and S. R. Hoffman. 1954. Mines and mineral deposits of Los Angeles County, California. California Jour. Mines Geol., 50(2):467-709, fig. 1-20, pl. 4-8.
Discussion and figure of Dicalite Co.'s diatomite deposits and processing plant one half mile south of Walteria in the Palos Verdes Hills, p. 520-524, fig. 7.

Grant, U. S., IV. 1936. Summary of the marine Pleistocene of California (abstract). Proc. Geol. Sci. Amer., 48:349-350.
Lists a few common(?) species from local formations in the San Pedro area, and postulates possible paleotemperatures at the time of deposition.

Grant, U. S., IV, and H. R. Gale. 1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions. Mem. San Diego Soc. Nat. Hist., 1:1036p., 15 figs., 32 pls. Reprinted 1958.
Part I, by H. R. Gale, includes discussion of stratigraphy and temperature facies of marine Pleistocene formations in the San Pedro region and assignment to glacial and interglacial stages (p. 40-45, 60-76). Part II assembles records of marine mollusks from those formations and in-

Grant, cont.
cludes illustrations of some species based on material from the San Pedro Pleistocene. (WBK)

Grant, U. S., IV, and L. G. Hertlein. 1938. The west American Cenozoic Echinoidea. Publ. Univ. California Los Angeles Math. Phys. Sci., 2: 225 p., 17 figs., 30 pls.
Description of five species of echinoids from the Pleistocene deposits of the San Pedro and Long Beach area, plus Dendraster viscainoensis similaris, n. subsp., from the Palos Verdes Sand of Los Cerritos Station, near Signal Hill, in Long Beach.

Grau, Gilbert. 1959. Pectinidae of the eastern Pacific. Allan Hancock Pacif. Exped., 23: 308 p., 57 pls.
Includes secondary records of species known from the Pleistocene formations of the San Pedro area.

Gregg, W. O. 1938. Pecten pugetensis at Newport Bay, California. Nautilus, 51(4):118-119.
Report of this species, "presumably Pliocene" (=Pleistocene), from Deadman Island in San Pedro.

Hanna, G D. 1923. Results of preliminary examination of seven samples of sediments from near Lomita. Bull. So. California Acad. Sci., 22(2):64.
Analysis of six (of seven) samples of Lomita Marl from Lomita Quarry suggeste deposition in "fairly deep and very quiet water." Fossil groups noted were sponges, bryozoans, foraminifera, mollusks, ostracods, echinoids, and vertebrates.

_____. 1927. The lowest known Tertiary diatoms in California. Jour. Paleontol., 1(2):103-127, pl. 17-21.
Casts doubt on Bagg's (1912:5) record of diatoms in the Pleistocene of San Pedro, believing that they may have been reworked from older formations in the area.

Hanna G D., and C. C. Church. 1927. A collection of Recent foraminifera taken off San Francisco Bay, California. Jour. Paleontol., 1(3): 195-202.
Compares two species with those found in the Pleistocene of San Pedro by Bagg (1912).

Hanna, G D., and L. G. Hertlein. 1941. Characteristic fossils of California, p. 165-182, fig. 60-67. In O. P. Jenkins, ed., Geologic formations and economic development of the oil and gas fields of California. Part two. Geology of California and the occurrence of oil and gas. Chapter VI. Paleontology and stratigraphy. State California, Dept. Nat. Resources, Div. Mines, Bull. 118.
Figures three mollusks (two Pleistocene and one Miocene) and two foraminifera (one Pliocene and one Pleistocene) from the San Pedro area.

Hannibal, Harold. 1912. A synopsis of the Recent and Tertiary freshwater Mollusca of the Californian Province, based upon an ontogenetic classification Proc. Malacol. Soc. London, 10(2 and 3): 112-211, pl. 5-8.
Includes records of several species in the Pleistocene of San Pedro.

Hay, O. P. 1927. The Pleistocene of the western region of North America and its vertebrated animals. Carnegie Inst. Washington, Publ. 322B:346 p., 19 figs., 12 pls., 21 maps.
Assigns the lower San Pedro to the Nebraskan glacial stage and the upper San Pedro to the Aftonian interglacial. Includes list of species from the San Pedro area.

Hazel, J. E. 1962. Two new hemicytherid ostracods from the lower Pleistocene of California. Jour. Paleontol., 36(4): 822-826, fig. 1-3.
Ambostracon costatum, n. g., n. sp., and Urocythereis californica, n. sp., are described from the Lomita Marl of San Pedro.

Hertlein, L. G. 1925. New species of marine fossil Mollusca from western North America. Bull. So. California Acad. Sci., 24(2): 39-46, pl. 3-4.
Pecten (Pseudamusium) vancouverensis fernandoensis, n. subsp., described and figured from the Pliocene Repetto Formation from the Long Beach oil field, northwest of Signal Hill.

_____. 1970. A new species of fossil Kelletia (Mollusca: Gastropoda) from the Lomita Marl, late Cenozoic of San Pedro, California. Los Angeles Co. Mus., Contrib. Sci., 190: 8 p., 3 figs.
Kelletia kanakoffi, n. sp., is described and figured from the Lomita Marl of San Pedro.

Hertlein, L. G., and U. S. Grant IV. 1944. The Cenozoic Brachiopoda of western North America. Publ. Univ. California Los Angeles Math. Phys. Sci., 3: 236 p., 34 figs., 21 pls.
Describes seven species which occur in the Pleistocene (and "Pliocene") deposits around San Pedro and Signal Hill.

Hoskins, C. W. 1957. Paleoecology and correlation of the lowest emergent California marine terrace, from San Clemente to Halfmoon Bay. Unpubl. Ph.D. diss., Dept. Geol., Stanford Univ. 188p., 14 figs., 4 pls.
Documents the Pleistocene molluscan faunas of six localities in the San Pedro, Wilmington, and Long Beach areas.

Howard, A. D. 1952. A puzzle solved by a fossil. Min. Conchol. Club So. California, 119:5.
Recent Adontorhina cyclia identified by comparison with lower Pleistocene material from Hilltop Quarry in San Pedro (type locality).

Howard, Hildegarde. 1936. A new fossil bird locality near Playa del Rey, California, with description of a new species of sulid. Condor, 38(5):211-214, fig. 37.
Mention of several records of Pleistocene avian remains from the San Pedro area.

_____. 1939. Aves, p. 309-322. In O. H. Schindewolf, ed., Fortschritte der Paläontologie. 2. Band, Bericht über die Jahre 1937 und 1938. Gebrüder Borntraeger, Berlin.
Secondary report of a Miocene Puffinus diatomicus from near Point Firmin in San Pedro, and an albatross and a booby from "a diatomite quarry at Lomita."

_____. 1944. Miscellaneous avian fossil records from California. Bull. So. Califonia Acad. Sci., 43(2):74-77, pl. 15.
Includes four Pleistocene and one Miocene occurrence of fossil birds from five localities in the San Pedro and Wilmington areas.

_____. 1945. Fossil birds, with especial reference to the birds of Rancho La Brea. Los Angeles Co. Mus., Sci. Ser. 10, Paleont. 6:39 p., 18 figs., 1 pl.
Refers to Miocene bird records from Lomita (PEL)

_____. 1947. California's flightless birds. Quart. Los Angeles Co. Mus., 6(2):,7-11, 3 figs.
Passing references to Chendytes in Pleistocene deposits at San Pedro.

_____. 1949. Avian fossils from the marine Pleistocene of southern California. Condor, 51(1): 20-28.
Discussion of the fossil birds of San Pedro, including many previously unrecorded taxa. (PEL)

_____. 1955a. Fossil birds, with especial reference to the birds of Rancho La Brea. Revised. Los Angeles Co. Mus., Sci Ser. 17, Paleont. 10: 40 p., 21 figs., 1 pl. "Reprinted" edition (February, 1962) has 44 p., 22 figs., 1 pl., a new Foreward, and "Additions to the record of California's fossil birds 1955-1961".
Refers to Miocene bird remains from Lomita. (PEL)

_____. 1955b. New records and a new species of Chendytes, an extinct genus of diving geese. Condor, 57(3):135-143, fig. 1-3, tables 1-2.
General reference to San Pedro and Palos Verdes specimens of Chendytes. (PEL)

_____. 1958. Miocene sulids of southern California. Los Angeles Co. Mus., Contrib. Sci., 25:15 p., 3 figs.
Discussion of fossil sulids (boobies) from the Valmonte Diatomite of the Dicalite diatomite quarry and comparison with other fossil sulids. (PEL)

Howe, M. A. 1934. Eocene marine algae (Lithothamnieae) from the Sierra Blanca Limestone. Bull. Geol. Soc. Amer., 45(3): 507-518, pl. 52-56.
Mesophyllum(?) recorded from the Lomita Quarry on the north border of the Palos Verdes Hills.

Howell, B. F., and J. F. Mason. 1937. Reef-forming serpulid from the Pleistocene of San Pedro, California. Bull. Wagner Free Inst. Sci., 12(1):1-2, fig. 1-2.
Description of the tube-building worm, "Serpula" saxistructoris, n. sp., from the Pleistocene San Pedro Sand of Deadman Island in San Pedro. This record is disputed by Packard (1942).

Ingram, W. N. 1947. Fossil and Recent Cypraeidae of the western regions of the Ameridas. Bull. Amer. Paleontol., 31(120): 1-82, pl. 1-2.
Secondary references to Cypraea spadicea in the Pleistocene deposits of the San Pedro area.

_____. 1951. The living Cypraeidae of the western hemisphere. Bull. Amer. Paleont., 33(136):125-179, pl. 21-24, tables 1-3.
The cowrie Cypraea spadicea occurs in the upper Pleistocene of San Pedro (secondary records only).

Jenkins, D. G. 1964. Location of the Pliocene-Pleistocene boundary. Contrib. Cushman Found. Foram. Res., 15(1): 25-27, fig. 1.
Three samples from the Lomita Marl of Lomita Quarry cannot be correlated with the Plio-Pleistocene boundary in deep-sea sediments. Nine species of foraminifera are listed, as is the coccolithophorid Discoaster sp. (one specimen found).

Jordan, D. S. 1922. Some sharks; teeth from the Caifornia Pliocene. Amer. Jour. Sci., ser. 5, 3(17):338-342, fig. 1-3.
Description of the teeth of four species of shark from the Pleistocene of the Palos Verdes Hills.

Jordan, D. S., and J. Z. Gilbert. 1919. Fossil fishes of the (Miocene) Monterey formations of southern California, p. 13-60, pl. 3 (fig. 2), 7-21, 23-26, 27 (fig. 1, 3), 28-31. In Fossil fishes of southern California. Leland Stanford Jr. Univ. Publ., Univ. Ser., Stanford University, Stanford.
Description with figures of two new genera and species of Miocene fish, and a Miocene dolphin, all from San Pedro.

Jordan, D. S., and Harold Hannibal. 1923. Fossil sharks and rays of the Pacific slope of North America. Bull. So. California Acad. Sci., 22(2):27-68, pl. 1-6b, 7-14.
Seven species of sharks, and land and marine mammals, are listed from the Lomita Marl of Lomita Quarry. Two Pleistocene occurrences of rays from San Pedro are included, as well as a list of molluscan species from the Lomita Marl prepared by I. S. Oldroyd.

Kanakoff, G. P. 1953. A new fossil shell from the Palos Verdes Sand. Bull. So. California Acad. Sci., 52(2): 67-70, pl. 12-13.
Diodora constantiae, n. sp., is described from the Pleistocene near Wilmington.

_____. 1956. Fish records from the Pleistocene of southern California in the collections of the Los Angeles County Museum. Bull. So. California Acad. Sci., 55(1): 47-49.
Occurrences reported for six species of fish from the San Pedro Sand in San Pedro, one from the Timms Point Silt of Timms Point, and one from Wilmington.

Kanakoff, G. P., and W. K. Emerson. 1959. Late Pleistocene invertebrates of the Newport Bay area, California. Los Angeles Co. Mus., Contrib. Sci., 31: 47 p., 5 figs.
Includes records of Pleistocene mollusks from the San Pedro area in tables 1-3.

Kanakoff, G. P., and J. H. McLean. 1966. Recognition of the cancellariid genus Neadmete Habe, 1961, in the west American fauna, with description of a new species from the Lomita Marl of Los Angeles County, California. Los Angeles Co. Mus., Contrib. Sci., 116: 6 p., 2 figs.
Describes the gastropod Neadmete sutherlandi, n. sp., from the Lomita Marl of San Pedro.

Keen, A. M. 1938. New pelecypod species of the genus Lasaea and Crassinella. Proc. Malacol. Soc. London, 23(1): 18-32, fig. 13-14, pl. 2.
Crassinella occurs "in the Pleistocene at San Pedro."

_____. 1943. A report on the Stanford University conchological collection. Min. Conchol. Club So. California, 24:5-8.
Part of the Ralph Arnold collection, including "much San Pedro Pleistocene material," was donated to Stanford in 1908.

Keen, A. M., and Herdis Bentson. 1944. Check list of California Tertiary marine Mollusca. Geol. Soc. Amer., Spec. Paper 56: 280 p., 4 figs.
Includes discussion of the Plio-Pleistocene boundary (p. 11-15) and remarks on the fauna of the Lomita Marl.

Kellogg, Remington. 1922. Pinnipeds from Miocene and Pleistocene deposits of California. Univ. California Publ., Bull. Dept. Geol. Sci., 13(4): 23-132, fig. 1-19.
Earlier record of "seals" in the San Pedro Sand of San Pedro assigned to Phoca sp. Other vertebrates also mentioned from the same locality.

_____. 1927. Fossil pinnipeds from California. Carnegie Inst. Washington, Publ. 346: 25-37, 8 figs.
Description of a sea lion, Zalophus sp.?, from the lumber yard locality in San Pedro (upper Pleistocene, Palos Verdes Sand).

Kennedy, G. L. 1970a. Field trips - last and next. Fossileer, 5(1): 3.
Planning for a club field trip to a Pleistocene fossil locality in San Pedro.

_____. 1970b. San Pedro fieldtrip. Fossileer, 5(4): 6.
Five species of Pleistocene mollusks not previously reported by Mount (1970a) are cited from the Palos Verdes Sand of San Pedro.

_____. West American Cenozoic Pholadidae (Mollusca: Bivalvia). Mem. San Diego Soc. Nat. Hist., 8:127 p., 103 figs., 1 pl.
Numerous primary and secondary records of pholadids (many figured) from the Pleistocene formations of the San Pedro and Long Beach areas are cited.

Kennedy, L. M. 1974. Fossils at Long Beach. Fossileer, 9(1): 6.
Note on Pleistocene fossils from the Palos Verdes Sand collected in Long Beach.

Kern, J. P., J. C. Grimmer, and K. H. Lister. 1974. A new fossil spionid tube, Pliocene and Pleistocene of California and Baja California. Jour. Paleontol., 48(5): 978-982, fig. 1-2, tables 1-2.
The new ichnogenus and species Helicotaphrichnus commensalis, thought to be a spionid worm tube, is reported in five species of mollusks from the Pleistocene deposits of San Pedro.

Keroher, G. C., et al.,1966. Lexicon of geologic names of the United States for 1936-1960. U. S. Geol. Surv., Bull. 1200 (1): 1-1448; (2): 1449-2886; (3): 2887-4341.
Includes pertinent literature on the formations in the San Pedro and Long Beach areas, and their type localities.

Kew, W. S. W. 1920. Cretaceous and Cenozoic Echinoidea of the Pacific coast of North America. Univ. California Publ., Bull. Dept. Geol., 12(2):23-236, fig. 1-5, pl. 3-42.
Includes three species known to occur in the Pleistocene of the San Pedro area.

Kleinpell, R. M. 1938. Miocene stratigraphy of California. Amer. Assoc. Petrol. Geol., Tulsa. 450 p., 14 figs., 22 pls. Reprinted 1955.
Includes correlation of Miocene strata in the Palos Verdes Hills (fig. 14), records of foraminifera from those deposits, and illustrations of 23 species, 13 new, based on material from that area. (WBK)

Kulp, J. L., L. E. Tryon, W. R. Eckelman, and W. A. Snell. 1952. Lamont natural radiocarbon measurements, II. Science, 116 (3016): 409-414, tables 1-4.
Specimen of Schizothaerus(=Tresus) nuttallii from the Palos Verdes Sand of San Pedro dated at "Older than 30,000" years.

LaRocque, Aurele. 1953. Catalogue of the Recent Mollusca of Canada. Natl. Mus. Canada Bull., 129: 406 p.
Isolated species described from the "Pliocene" or Pleistocene of San Pedro listed, although most are cited as "Pleistocene of California".

Lawson, A. C. 1893. The post-Pliocene diastrophism of the coast of southern California. Univ. California, Bull. Dept. Geol., 1(4):115-160, fig. 1, pl. 8-9.
Description of the marine terraces of the Palos Verdes Hills, and assignment of the lower Pleistocene beds to the Pliocene.

LeRoy, L. W. 1943. Pleistocene and Pliocene Ostracoda of the coastal region of southern California. Jour. Paleontol., 17(4): 354-373, fig. 1, a-z, a'-g', pl. 58-62.
Twenty-one species and varieties, 20 new, are described and figured from the Lomita Marl, Timms Point Silt, and San Pedro Sand of the San Pedro area.

Loeblich, A. R., III, L. A. Loeblich, Helen Tappan, and A. R. Loeblich, Jr. 1968. Annotated index of fossil and Recent silicoflagellates and ebridians with descriptions and illustrations of validly proposed taxa. Geol. Soc. Amer., Mem. 106: 319 p., 21 figs., 53 pls.
Includes the original description, with figures, of one species of silicoflagellate and one species of ebridian previously described from the Miocene of the San Pedro area (p. 105, 155).

Lyon, G. M. 1938. Megalonyx milleri, a new Pleistocene ground sloth from southern California. Trans. San Diego Soc. Nat. Hist., 9(6): 15-28, fig. 1-7, tables 1-3.
Description of Megalonyx milleri, n. sp., from the non-marine terrace cover of San Pedro.

_____. 1941. A Miocene sea lion from Lomita, California. Univ. California Publ. Zool., 47(2): 23-41, fig. 1-2, pl. 2-6.
Description of sea lion remains, assigned to Pontolis magnus (=Imagotaria downsi) from (Valmonte) diatomite exposed in a Dicalite Co. quarry "near Lomita". (WBK,PEL)

Mandra, Y. T. 1960. Fossil silicoflagellates from California, U.S.A., p. 77-89, tables A-C. In I. Hessland and G. Erdtman, eds., Pre-Quaternary Micropaleontology. Report of the Twenty-First Session, Norden, 1960. Part VI. Internatl. Geol. Congr., Copenhagen.
Overview of California fossil silicoflagellates, including notes on those from the Miocene (Mohnian) Valmonte Diatomite in San Pedro.

_____. 1968. Silicoflagellates from the Cretaceous, Eocene, and Miocene of California, U.S.A. Proc. California

Mandra, cont.
Acad. Sci., ser. 4, 36(9): 231-277, 83 figs., 7 tables.
Systematic treatment of silicoflagellates includes 15 species, none new, eight of which are figured, from the Valmonte Diatomite from Peck Park in San Pedro.

Marincovich, L. N., Jr. 1970. Pleistocene molluscan faunas from upper terrace deposits of the Palos Verdes Hills, California. Unpubl. M.S. thesis, Dept. Geol., Univ. So. California. 133 p., 5 figs.
A study of the Pleistocene faunas of terraces 5,7,9, and 12 show them to have essentially the same character as the more studied lower terraces, and indicate that the entire terrace sequence should be assigned to the upper Pleistocene, Palos Verdes Sand; 174 species of mollusks are listed.

_____. 1971. Late Pleistocene mollusks from upper terrace deposits of the Palos Verdes Hills, California (abstract). Second Natl. Coastal and Shallow Water Res. Conf., Abst. vol.: 149.
The 174 molluscan species from terraces 5,7,9, and 12 indicate a late Pleistocene age for the entire terrace sequence in the Palos Verdes Hills, and a marine hydroclimate cooler than that found today off the Peninsula.

Martin, Bruce. 1914. Descriptions of new species of fossil Mollusca from the later marine Miocene of California. Univ. California Publ., Bull. Dept. Geol., 8(7): 181-202, pl. 19-22.
Description of Tritonofusus riversi, n. sp., from the Timms Point Silt of Timms Point.

Martin, P. S., and Jane Gray. 1962. Pollen analysis and the Cenozoic. Science, 137(3524): 103-111, fig. 1-5, table 1.
Includes pollen profile (fig 2) of a 960 m core through Miocene and lower Pliocene sediments in the Wilmington area.

Mason, H. L. 1932. A phylogenetic series of the California closed-cone pines suggested by the fossil record. Madrono, 2(6): 49-55.
Pinus linguiformis, n. sp., described from depth of 800 to 900 feet at the Los Alamitos pump station of the Long Beach Water Works, one half mile northeast of Signal Hill, near the Pliocene-Pleistocene boundary.

McLaughlin, R. P., and C. A. Waring. 1914. Petroleum industry of California. California Min. Bur., Bull. 69: 519 p., 78 figs. 18 pls.
Includes list of five Pleistocene mollusks from San Pedro (pl. 1) and a small-scale geologic map of the Palos Verdes Hills (pl. 2). (WBK)

McLean, J. H. 1964. New species of Recent and fossil west American aspidobranch gastropods. Veliger, 7(2): 129-133, fig. 1, pl. 24.

McLean, cont.
Describes and figures Homalopoma berryi, n. sp., from the Timms Point Silt of San Pedro.

_____. 1967. West American Scissurellidae. Veliger, 9(4): 404-410, pl. 56.
Reference to Scissurella lyra described from the Lomita Marl of San Pedro.

_____. 1970. New eastern Pacific subgenera of Turbo Linnaeus, 1758 and Astraea Roding, 1798. Veliger, 13(1): 71-72.
Astraea petrothauma from the lower Pleistocene of San Pedro is placed in synonomy with A. turbanica and placed in the new subgenus Megastraea.

Meals, H. S. 1973. Collecting Pleistocene fossils at my location 164. Bull. So. California Paleontol. Soc., 5(12): 116-117.
Seventy species, mostly mollusks, are listed from an upper Pleistocene (Palos Verdes Sand) locality in Long Beach.

Menzies, R. J. 1951. Pleistocene Brachyura from the Los Angeles area: Cancridae. Jour. Paleontol., 25(2): 165-170, fig. 1-13.
Describes and figures five species of Cancer from three localities in the Pleistocene of San Pedro.

Merriam, C. W. 1941. Fossil turritellas from the Pacific Coast region of North America. Univ. California Publ., Bull. Dept. Geol. Sci., 26(1): 213 p., 19 figs., 41 pls., 1 map.
Includes records of species from the Pleistocene of the San Pedro area.

Miller, L. H. 1912. Contributions to avian palaeontology from the Pacific coast of North America. Univ. California Publ., Bull. Dept. Geol., 7(5): 61-115.
Three species of birds and seven miscellaneous vertebrates are listed from Arnold's lumberyard locality in San Pedro (upper Pleistocene, Palos Verdes Sand).

_____. 1914. Bird remains from the Pleistocene of San Pedro, California. Univ. California Publ., Bull. Dept. Geol., 8(4): 31-38.
Sixteen species of birds are listed from Arnold's lumberyard locality in San Pedro (upper Pleistocene, Palos Verdes Sand).

_____. 1921. A synopsis of California's fossil birds. Condor, 23(4): 129-130.
Reference to avian fossils at Arnold's lumberyard locality in San Pedro. (PEL)

_____. 1923. California's ancient bird life. Univ. California Chron., July: 345-355. (not seen)

Miller, L. H., cont.
Brief mention of avian fossils from San Pedro. (PEL)

_____. 1924. Anomalies in the distribution of fossil gulls. Condor, 26(5): 173-174.
Refers to the absence of gulls from the upper San Pedro (=Palos Verdes Sand) Pleistocene beds. (PEL)

_____. 1928. The antiquity of the migratory instinct in birds. Condor, 30(1): 119-120.
Discussion of migratory species from the San Pedro region. (PEL)

_____. 1929. The fossil birds of California. Faculty Res. Lectures, Univ. California Los Angeles, 1:1-14, 1 table.
Mention that 16 species of birds (based on 25 specimens) had been recognized from Pleistocene deposits in San Pedro up to 1925.

_____. 1930. Further bird remains from the upper San Pedro Pleistocene. Condor, 32(2): 116-118, fig. 45.
Ten species of birds are reported from upper Pleistocene beds at Arnold's lumberyard locality in San Pedro.

_____. 1934. A new horizon for the extinct goose, Chendytes. Science, 80(2067):141-142.
Includes two records of C. lawi from the upper Pleistocene in the San Pedro area.

_____. 1935. New bird horizons in California. Univ. California Los Angeles, Publ. Biol. Sci., 1(5): 73-80, fig. 1-2, tables 1-2.
Description of three sea birds, one new, from Miocene strata in the Palos Verdes Hills (Valmonte Diatomite) and record of a small cetacean. (WBK)

_____. 1960. Notes on the Pleistocene flightless goose, Chendytes. Bull. So. California Acad. Sci., 59(2): 57-61, pl. 19.
Reference made to Howard's (1947) work on Chendytes from San Pedro.

Miller, L. H., and Ida DeMay. 1942. The fossil birds of California: An avifauna and bibliography with annotations. Univ. California Publ. Zool., 47(4):47-142.
Major review of fossil birds, including discussions of the fossil birds from Lomita Quarry and San Pedro breakwater (Altamira Shale), and Arnold's lumberyard locality (Palos Verdes Sand). (PEL)

Miller, W. E. 1971. Pleistocene vertebrates of the Los Angeles basin and vicinity (exclusive of Rancho La Brea). Bull. Los Angeles Co. Mus. Nat. Hist., Sci. 10: 124 p., 155 figs.
Extensive survey of Los Angeles basin Pleistocene vertebrates including discussion of 21 taxa from San Pedro

Miller, W. E., cont.
(UCMP collections, p. 43-47), and the vertebrates from 21 other localities, mostly LACM collections (p. 53-54), in the San Pedro and Long Beach areas.

Mitchell, E. D., Jr. 1966. Northeastern Pacific Pleistocene sea otters. Jour. Fish. Res. Board Canada, 23(12): 1897-1911, fig. 1-6.
Sea otter remains assigned to Enhydra lutris are reported from the Palos Verdes Sand of Arnold's lumberyard locality, and the Timms Point Silt of Timms Point, both in San Pedro. Includes discussion of the paleoecology of the upper Pleistocene of San Pedro.

Mount, J. D. 1970a. Late Pleistocene marine invertebrates from a new locality in San Pedro, California. Bull. So. California Paleontol. Soc., 2(3): 1-5, 1 fig.
List of 154 invertebrate species, mostly mollusks, from the Palos Verdes Sand of a locality in San Pedro.

_____. 1970b. Additions to the late Pleistocene marine invertebrate fauna from San Pedro, California. Bull. So. California Paleontol. Soc.,2(7): 3-4.
List of 25 additional molluscan species not found by Mount (1970a) in the Palos Verdes Sand of San Pedro.

_____. 1974a. Type vertebrates from Lomita, California, in the Municipal Museum, Riverside, California. Jour. Paleontol., 48(1): 198-199.
Types and figured specimens of fossil elasmobranchs and mammals described by Jordan and Hannibal (1923) were found.

_____. 1974b. Notes on Crassatella lomitensis (Oldroyd, 1924) (Mollusca: Bivalvia) from the Plio-Pleistocene of southern California. Echo (Abstracts and Proc. 6th Ann. Meet. West. Soc. Malacol. June 1973), 6:37-44, pl. 1.
Crassatella lomitensis from the Lomita Marl of the San Pedro area is considered a valid species.

_____. 1974c. The Pleistocene Gastropoda of J. J. Rivers (abstract). West. Soc. Malacol., Ann. Rept., 7:20-21.
Taxonomic status of two species of gastropods, described by Rivers from Pleistocene material from San Pedro, is given.

Nations, J. D. 1969. The family Cancridae and its fossil record on the west coast of North America. Unpubl. Ph.D. diss., Dept. Paleontol., Univ. California, Berkeley. 252 p., 18 figs.
Includes numerous occurrences of fossil crabs in the Pleistocene deposits of the San Pedro area.

_____. 1975. The genus Cancer (Crustacea: Brachyura): Systematics, biogeography and fossil record. Nat. Hist. Mus. Los Angeles Co., Sci. Bull. 21: in press.

Nations, cont.
Includes Pleistocene occurrences for 10 species of Cancer from the San Pedro area.

Natland, M. L. 1938. New species of foraminifera from off the west coast of North America and from the later Tertiary of the Los Angeles basin. Bull. Scripps Inst. Oceanogr., Tech. ser., 4(5): 137-163, pl. 3-7.
Virgulina seminuda, n. sp., and Cibicides spiralis, n.sp., are described from the lower Pliocene Repetto Formation at Lomita Quarry.

_____. 1957. Paleoecology of west coast Tertiary sediments, p. 543-571, fig. 1-2, pl. 1-6. In H. S. Ladd, ed., Treatise on Marine Ecology and Paleoecology. Volume 2. Paleoecology. Geol. Soc. Amer., Mem. 67. Reprinted 1963.
Includes chart (pl. 2) of molluscan species from the San Pedro channel, and their occurrences in the Pleistocene deposits of Signal HIll and San Pedro area.

Natland, M. L., and W. T. Rothwell, Jr. 1954. Fossil foraminifera of the Los Angeles and Ventura regions, California, p. 33-42, fig. 1-7. In R. H. Jahns, ed., Geology of southern California. Chapter III, Historical geology. State California, Dept. Nat. Resources, Div. Mines, Bull. 170. Reprinted 1959.
The foraminifera Cassidulina limbata and C. tortuosa are considered characteristic of the Lomita Marl at Lomita Quarry, which also contains many reworked forms. Includes maps of two microfossil localities in the area.

Newberry, J. S. 1861. Geological report. U. S. 36th Cong., 1st sess., Senate Exec. Doc. no. ___ (Report upon the Colorado River of the west, explored in 1857 and 1858 ..., by J. C. Ives), pt. 3:154 p., 27 figs., 6 pls.
Several records of pholadid-bored rocks are noted from the San Pedro area.

Oakeshott, G. B. 1957. Diatomite, p. 183-193, fig. 1-12. In L. A. Wright, ed., Mineral commodites of California - Geologic occurrence, economic development and utilization of the state's mineral resources. State California, Dept. Nat. Resources., Div. Mines, Bull. 176.
Includes discussion of Dicalite Division's diatomite deposits near Walteria in the Palos Verdes Hills.

Obradovich, J. D. 1965. Age of the marine Pleistocene of California (abstract). Bull. Amer. Assoc. Petrol. Geol., 49(7): 1087.
Preliminary results of Obradovich (1968) are given.

_____. 1968. The potential use of glauconite for late Cenozoic geochronology, p. 267-279, fig. 1, tables 1-2. In R. B. Morrison and H. E. Wright, Jr., eds., Means of Correlation of Quaternary Successions. Proc. VII Cong. Internatl.

Obradovich, cont.
Assoc. Quat. Res., vol. 8. Univ. Utah Press, Salt Lake City.
A detailed K-Ar investigation of glauconite from the Lomita Marl from the Lomita Quarry has produced ages of about 3 million years B. P.

Oldroyd, I. S. 1924. Description of a new fossil species of a clam of the genus (Crassatellites). Bull. So. California Acad. Sci., 23(1): 10, pl. C.
Crassatellites lomitensis, n.sp., is described from the lower Pleistocene (Lomita Marl) at Lomita Quarry.

Oldroyd, I. S., and U. S. Grant IV. 1931. A Pleistocene molluscan fauna from near Goleta, Santa Barbara County, California. Nautilus, 44(3): 91-94.
Mentions three molluscan species found in the upper Pleistocene deposits of the San Pedro area.

Oldroyd, T. S. 1914. A remarkably rich pocket of fossil drift from the Pleistocene. Nautilus, 28(7): 80-82.
Lists 105 molluscan species, probably from the Palos Verdes Sand, from the Pleistocene of "Los Cerritos, two miles back from the ocean at Long Beach" (=Signal Hill area).

_____. 1921a. New Pleistocene mollusks from California. Nautilus, 34(4): 114-116, pl. 5, fig. 8-13.
Three new species, Conus californicus fossilis, Vermetus nodosus, and Tornatina tumida, are described from the lower San Pedro series (=San Pedro Sand) of the Nob Hill cut, in San Pedro.

_____. 1921b. Some varieties of western olivellas. Nautilus, 34(4): 117-119, pl. 5, fig. 1-7.
Four new varieties of Olivella are described, three from the Pleistocene and one from the "Pliocene" of San Pedro.

_____. 1924(1925). The fossils of the lower San Pedro fauna of the Nob Hill cut, San Pedro, California. U. S. Natl. Mus. Proc., 65(22):1-39, pl. 1-2.
Paleontology of the Nob Hill cut, now destroyed, in San Pedro, including list of 242 mollusks, 22 new, from the lower San Pedro (=San Pedro Sand).

Orcutt, C. R. 1900. Catalog of fossils in the Orcutt collection. West Amer. Sci., 11(4): 36-38.
Lists Turritella cooperi from San Pedro.

Osburn, R. C. 1950. Bryozoa of the Pacific Coast of America. Part 1, Cheilostomata-Anasca. Allan Hancock Pacif. Exped., 14(1):1-269, pl. 1-29.
Includes scattered primary and secondary records of bryozoans from the Pleistocene of the San Pedro area.

_____. 1952. Bryozoa of the Pacific Coast of America.

Osburn, cont.
Part 2, Cheilostomata-Ascophora. Allan Hancock Pacif. Exped., 14(2):271-611, pl. 30-64.
Includes scattered primary and secondary records of bryozoans from the Pleistocene of the San Pedro area.

_____. 1953. Bryozoa of the Pacific Coast of America. Part 3, Cyclostomata, Ctenostomata, Entroprocta, and addenda. Allan Hancock Pacif. Exped., 14(3): 613-841, pl. 65-82.
Includes scattered primary and secondary records of bryozoans from the Pleistocene of the San Pedro area.

Packard, E. L. 1942. The status of supposed fossil cirratulids from the Pacific Coast. Jour. Paleontol., 16(6): 778.
Suggests Howell and Mason's (1937) "Serpula" saxistructoris from the San Pedro Sand of Deadman's Island is the Recent cirratulid worm Dodecaceria fistulicola and doubts the fossil record.

Parker, Pierre. 1949. Fossil and Recent species of the pelecypod genera Chione and Securella from the Pacific Coast. Jour. Paleontol., 23(6): 577-593, pl. 89-95.
Includes records of four species and varieties of Chione from Pleistocene deposits in the San Pedro area.

Peska, F.J. Jr. 1974a. Progression of a Pleistocene site in Long Beach. Bull. So. California Paleontol. Soc., 6(5): 53.
Note that the Long Beach Pleistocene locality (see Meals, 1973) is slowly being hauled away for fill.

_____. 1974b. An early Pleistocene site for abalone. Bull. So. California Paleontol. Soc., 6(8):86,91, 1 fig.
Twelve molluscan species are reported from the "Lomita Marl" (actually upper Pleistocene deposits on terrace 12 or 13) in the vicinity of San Pedro Hill, west of San Pedro.

Pierce, W. D. 1944. Fossil arthropods of California. 4. Two interesting orthopteroids from diatomaceous deposits. Bull. So. California Acad. Sci., 43(1): 12-17, pl. 4-6.
Protosegestes lloydi, n.sp., and Exaeretoptera fosteri, n.sp., are described from the Valmonte Diatomite of San Pedro.

_____. 1945. Fossil arthropods of California. 7. A fossil whiptail scorpion from Cabrillo Beach. Bull. So. California Acad. Sci., 44(1): 7-8, pl. 5.
Thelyphonus hadleyi, n.sp., is described from middle Miocene Monterey Shale in San Pedro.

Pilsbry, H. A. 1904. Publications received. (Review of) The Paleontology and stratigraphy of the marine Pliocene and Pleistocene of San Pedro, California.-By Ralph Arnold. Nautilus, 17(9): 107-108.
Includes comments on taxonomic "errors" by Arnold.

_____. 1929. Neverita reclusiana (Desh.) and its allies. Nautilus, 42(4): 109-113, pl. 6.
Selection of a neotype for N. r. alta from the "Upper San Pedro at Pacific and Oliver Streets," in San Pedro and record of N. r. imperforata from the same locality.

Poland, J. F., A. M. Piper, and others. 1956. Ground-water geology of the coastal zone, Long Beach-Santa Ana area, California. U. S. Geol. Surv., Water-Supply Paper 1109: 162 p., 2 figs., 8 pls.
Stratigraphy and structure of the Pleistocene and subsurface Pliocene deposits in the Wilmington, Signal Hill, and Long Beach areas. Includes geologic map and cross sections of the area.

Pressler, E. D. 1929. The Fernando Group in the Las Posas-South Mountain district, Ventura County, California. Univ. California Publ., Bull. Dept. Geol. Sci., 18(3): 325-345, fig. 1-4.
Limited comments on the Pleistocene of San Pedro, including two faunal lists with "San Pedro Pliocene, Lower San Pedro, and Upper San Pedro."

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Major work on the Miocene, Pliocene and Pleistocene paleontology and stratigraphy of the Palos Verdes Hills and San Pedro region. Includes list of 55 mollusks from the Miocene Altamira Shale in the San Pedro area, and several lists of Pleistocene fossils from the same area.

Woodring, W. P., M. N. Bramlette, and R. M. Kleinpell. 1936. Miocene stratigraphy and paleontology of Palos Verdes Hills, California. Bull. Amer. Assoc. Petrol. Geol., 20(2): 125-149, fig. 1-3.
Stratigraphic study of the Miocene formations in the Palos Verdes Hills, including lists of microfossils from three new formations; Altamira Shale, Valmonte Diatomite, and Malaga Mudstone.

Wornardt, W. W., Jr. 1967. Miocene and Pliocene marine diatoms from California. Occas. Paper, California Acad. Sci., 63:108 p., 217 figs.
Similar diatom assemblages appear in many of the Miocene rocks in California, including those in the Palos Verdes Hills (p. 7). Those of the Malaga Mudstone are very comparable to those of the upper type Monterey Formation near Monterey (p. 12).

_____. 1972. Late Miocene and early Pliocene correlations in the California Province, p. 284-333, fig. 1-25, pl. 1. In E. H. Stinemeyer and C. C. Church, eds., The Proceedings of ... the Pacific Coast Miocene Biostratigraphic Symposium. Pacif. Sec., Soc. Econ. Paleontol. Mineral., Bakersfield.
The Miocene sediments of the Palos Verdes Hills contain a sequence of foraminiferal zones which range in age from the Relizian Siphogenerina branneri zone through the early Delmontian Bolivina obliqua zone. Fig. 18 gives stratigraphic ranges for 49 foraminiferal species, plus "diatoms" and "silicoflagellates."

Yates, L. G. 1886. Catalogue of fossils in Lorenzo G. Yates' collection, Santa Barbara, Cal. Privately published, Santa Barbara. 37 p.
Lists four species of "Post-Tertiary" fossil mollusks from San Pedro.

Yerkes, R. F., T. H. McCulloh, J. E. Schoellhamer, and J. G. Vedder. 1965. Geology of the Los Angeles Basin, California--an introduction. U. S. Geol. Surv., Prof. Paper 420-A:57p., 14 figs., 4 pls.
General geology of the Los Angeles Basin, including index maps of different age sediments. Plate 1 is a correlation chart of sediments in the Palos Verdes Hills, Wilmington oil field, and Long Beach oil field (southwest flank of Signal Hill).

Zinsmeister, W. J. 1970(1971). A late Pliocene macrofossil fauna of Newport Beach, Orange County, California. Bull. So. California Acad. Sci., 69(3 and 4): 121-125, table 1.
Correlates the upper Pliocene deposits at Newport Beach with the Lomita Marl in the Palos Verdes Hills and considers the molluscan and fish faunas to be evidence for a late Pliocene age for the latter.

Zullo, V. A. 1960. Cenozoic Balanomorpha of the Pacific coast of North America. Unpubl. M. A. thesis, Dept. Paleontol., Univ. California, Berkeley. 147 p., 9 pl.
Includes records of Pleistocene barnacles from the San Pedro area.

Zullo, V. A., and L. G. Hertlein. 1972. Catalog of specimens in the type collection of the Department of Geology, California Academy of Sciences. Echinodermata. Occas. Paper, California Acad. Sci., 91:26 p.
Plastoholotype of Dendraster viscainoensis similaris listed; the original is from Los Cerritos Station, near Signal Hill and Long Beach.