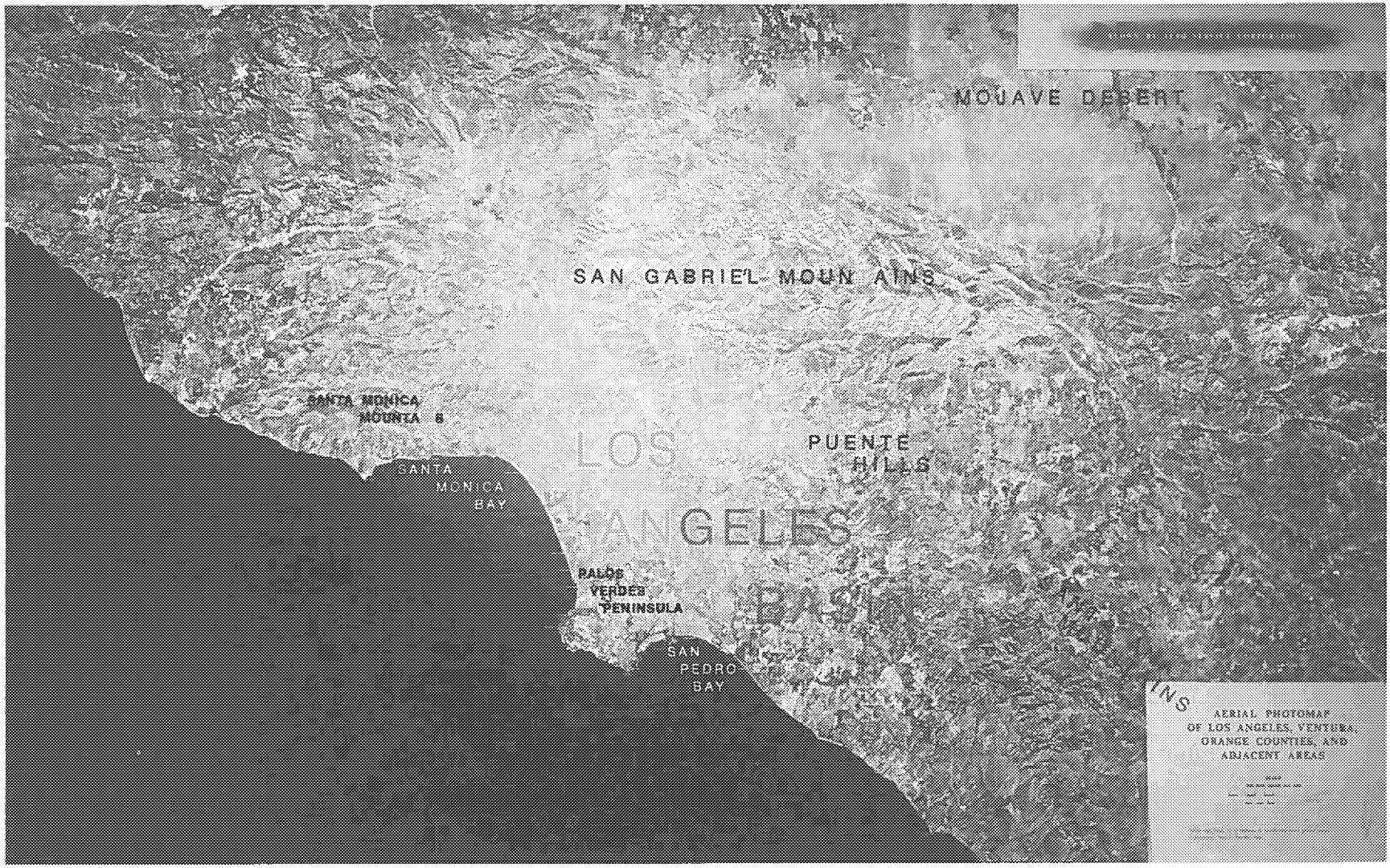
PLEISTOCENE VERTEBRATES OF THE LOS ANGELES BASIN AND VICINITY (EXCLUSIVE OF RANCHO LA BREA)



Aerial Photomap of a portion of Southwestern California including the Los Angeles Basin and Vicinity. Line on Photomap represents 10 miles.

PLEISTOCENE VERTEBRATES OF THE LOS ANGELES BASIN AND VICINITY (EXCLUSIVE OF RANCHO LA BREA)

By WADE E. MILLER

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PROFESSIONAL PUBLICATIONS OF THE LOS ANGELES COUNTY MUSEUM

The professional publications of the Los Angeles County Museum of Natural History include two series, *Contributions* and *Bulletins*. In the past, articles, monographs and catalogs in the fields of history and science have appeared under various headings--*Contributions*, *Science Series*, *History Leaflet Series* and unnumbered catalogs of exhibitions and collections. To simplify and to standardize matters, all professional publications of the History and Science Division of the Museum will now be issued at irregular intervals either as *Contributions*, or as *Bulletins*. The former will contain short, technical papers which may be occasionally gathered in volumes, octavo in size. The latter will contain longer, separate monographs and catalogs, usually quarto in size, although this will depend on the needs of the presentation. Papers in each series are to be numbered consecutively.

These papers are original articles and studies based on the collections and work of the Museum, presenting newly acquired information and understanding in the fields of Anthropology, Botany, Geology, History, Mineralogy, Paleontology, Technology and Zoology.

GILES W. MEAD, Director
Los Angeles County Museum of Natural History

VIRGINIA D. MILLER
Editor

All communications concerning science manuscripts, exchange of science publications, and the purchase of science publications should be sent to the Managing Editor, Los Angeles County Museum of Natural History, 900 Exposition Boulevard, Los Angeles, California 90007.

ROBERT J. LAVENBERG
Managing Editor

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

PLEISTOCENE VERTEBRATES OF THE LOS ANGELES BASIN AND VICINITY (EXCLUSIVE OF RANCHO LA BREA)

By WADE E. MILLER[1]

ABSTRACT: No known terrestrial fauna in the Los Angeles basin or vicinity is earlier than Rancholabrean, thus strengthening the belief that the basin was inundated, at least in large part, up to the Late Pleistocene. After retreat of the Pleistocene sea and associated lagoons, the area was probably a grassland interrupted by wooded hills. This interpretation is supported by comparison of the Late Pleistocene terrestrial faunas with the living fauna of the area and by geologic studies. Climatic changes that are recognized within the Late Pleistocene of the region by some workers are not reflected in the presently known vertebrate faunas. The vertebrates comprising these faunas probably lived in a semiarid environment similar to that of the Los Angeles basin just before its habitation by Spanish settlers.

The relatively flat-lying deposits containing terrestrial vertebrates in and adjacent to the Los Angeles basin provide additional evidence for a pre-Late Pleistocene date of the last intense folding of rocks in the area. However, diastrophic movements are still continuing as evinced by the jointing and faulting of the Late Pleistocene sediments at Costeau Pit, recent earthquake activity and geodetic measurements. A study of the fossil mammals from the Laguna Hills area and elsewhere provides corrections for errors in previous dating of beds, further substantiating the importance of terrestrial vertebrates, especially mammals, for precisions in geochronology. The San Pedro and Newport faunas contain mixed marine and nonmarine assemblages which add information regarding their mutual relationships in chronologically restricted deposits. The faunas from Costeau, Newport and San Pedro apparently predate the Rancho La Brea fossil assemblage, whereas the La Mirada fauna seems nearly contemporaneous with Rancho La Brea.

Taxa recorded from Pleistocene deposits in the Los Angeles basin and vicinity for the first time are: *Scapanus latimanus, Antrozous pallidus, Peromyscus* cf. *crinitus, Reithrodontomys* cf. *humulis, Ondatra,* and a small species of equid. The occurrence of fossil muskrat is the first noted in California. *Peromyscus imperfectus* Dice from Rancho La Brea is considered a synonym of *P. maniculatus,* and the *Reithrodontomys* from the McKittrick deposits is identified as *R. megalotis.* The species, *Equus occidentalis,* is considered a *nomen dubium,* and *Bison chaneyi* is synonymized with *B. alleni.*

As reported to date, the Costeau Pit fauna contains the largest collection of *Bison latifrons* from a single deposit, and it marks one of the very rare joint associations of *B. latifrons* and *B. antiquus.*

INTRODUCTION

Rancho La Brea has long directed attention to the Pleistocene vertebrates of southwestern California, but many sites in the general area containing related fossils from the same epoch have been largely overlooked. Other localities from the Los Angeles basin and vicinity are here described and their vertebrate faunas are compared with the Rancho La Brea fauna and with each other. Because it is a good representation of Late Pleistocene continental vertebrates in southwestern California, the Costeau locality and fauna are given special attention.

The Los Angeles basin is a physiographic feature (see Fig. 1). Its northernmost border extends to the Santa Monica Mountains, the Elysian, Repetto and Puente Hills; its east and southeastern borders extend to the Santa Ana Mountains and the San Joaquin Hills. The southern boundary is marked by the Pacific Ocean and the Palos

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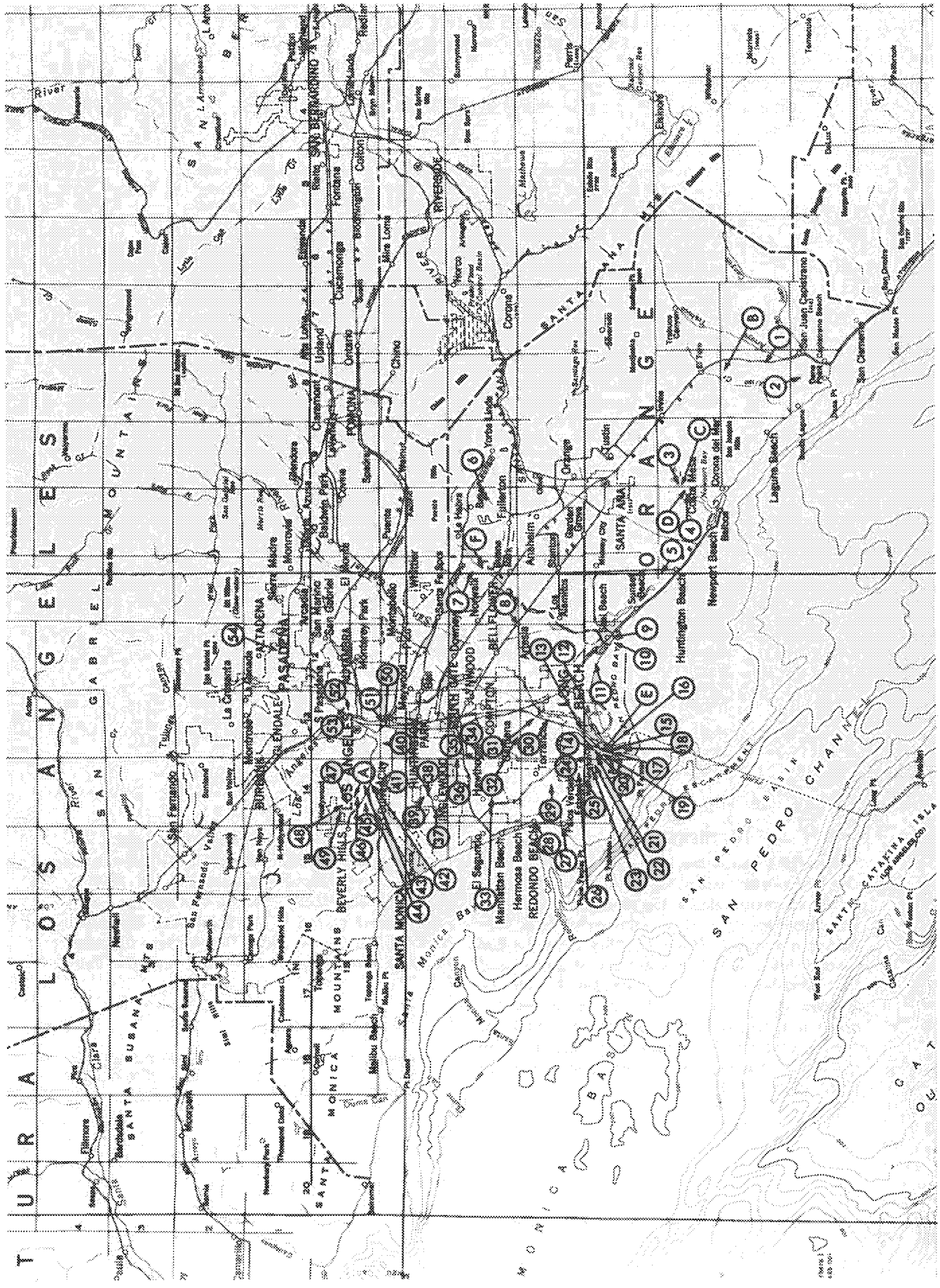

SAN GABRIEL MOUNTAINS
SANTA SUSANA MTS.
SANTA MONICA MOUNTAINS
SAN PEDRO BASIN
SAN PEDRO CHANNEL
SANTA CATALINA ISLAND
SANTA ANA MTS.
SAN BERNARDINO
RIVERSIDE
POMONA
PASADENA
BURBANK
GLENDALE
LOS ANGELES
BEVERLY HILLS
SANTA MONICA
CULVER CITY
INGLEWOOD
COMPTON
LONG BEACH
SANTA ANA
ANAHEIM
ORANGE
FULLERTON
HUNTINGTON BEACH
NEWPORT BEACH
LAGUNA BEACH
SAN JUAN CAPISTRANO
SAN CLEMENTE
REDONDO BEACH
HERMOSA BEACH
MANHATTAN BEACH
SAN FERNANDO
SAN GABRIEL
MONTEREY PARK
WHITTIER
LA HABRA
SANTA MONICA BAY

Verdes Hills and it is bordered at its western terminus by the Pacific Ocean. The Los Angeles basin is also reflected as a structural feature which is greater in areal extent than the topographic one (Yerkes et al., 1965: A1). The physiographic basin concept is used in this paper as the extent of the structural basin is difficult to define.

ACKNOWLEDGMENTS

I am very grateful to Dr. Theodore Downs, Chief Curator of Earth Sciences at the Los Angeles County Museum of Natural History and to Dr. Donald E. Savage, Director of the Museum of Paleontology, University of California, under whose direction this research was done, for making available necessary money and equipment. Also, their many helpful suggestions and criticisms of this work have been greatly appreciated. Dr. J. R. Macdonald, formerly Senior Curator of Vertebrate Paleontology at the Los Angeles County Museum of Natural History, provided access to comparative materials and kindly gave other assistance.

Gratitude is expressed to Dr. Leslie Marcus, Department of Biology, Queens College, for much aid in computerizing data on *Bison* and *Paramylodon* from Rancho La Brea and Costeau Pit while working under National Science Foundation grant GB 5119. The University of California at Los Angeles, through its Medical Computer Center, kindly made necessary computer equipment available for use.

I am indebted to Mr. Glen Brengle, Vice President of the Macco Corporation, for permission to collect at Costeau Pit. Advice and assistance in machine excavations at the above site were generously provided by Mr. Al Howland of Orange County. Mr. Murray Patton, Geological Engineer for the Boyle Engineering Company, Santa Ana, and Mr. John Douglas, Building Inspector for Orange County, gave helpful information concerning regional geology around Costeau Pit.

Mr. W. Earl Calhoun of Fullerton donated many specimens collected at Costeau Pit. Michael Cady of Laguna Hills gave valuable assistance in collecting at Costeau Pit and also aided in preparation of specimens. Paul Langenwalter, Darryl Bosse, Douglas Asper and Michael Neel, all of La Mirada, kindly donated and loaned specimens from Costeau Pit and La Mirada. The former two were responsible for the initial discovery of fossils at Costeau. Numerous other people made contributions in collecting at this locality.

Primary identification of the birds was made by Dr. Hildegarde Howard, Research Associate at the Los Angeles County Museum of Natural History, who also gave helpful advice. Dr. Janet Warter of California State College at Long Beach made the preliminary pollen studies at Costeau Pit. The mole from Newport Bay Mesa was identified by Mr. Howard Hutchison, University of California at Berkeley, and Mr. Dennis Bramble, of the same University, assisted in the identification of the testudinids from Costeau Pit.

Drawings in the present paper are by Mr. Owen Poe and Mrs. Patricia Lufkin, Staff Artists of the Museum of Paleontology, University of California, Mr. Frank Paul of Los Angeles and Miss Caryl

FIGURE 1. Map of the Los Angeles basin and vicinity showing Pleistocene vertebrate localities. Los Angeles County Museum sites represented by number only. Map extracted from the U.S. Geological Survey State of California base map, 1955 ed. Scale of extract, 1:325,000.

A — Rancho La Brea
B — Costeau Pit, 65129
C — Newport Bay Mesa, 1067
D — Newport Bay Mesa, 1066
E — San Pedro, UCMP V 2047
F — La Mirada, 6689

1 — 1215
2 — 1115
3 — 1068
4 — 1100
5 — 65113
6 — 6472
7 — 1052
8 — 1285
9 — 1409
10 — 1121
11 — 2031
12 — 1144
13 — 1163
14 — 6705
15 — CIT 187
16 — 1057
17 — UCLA 1063.12
18 — 1005
19 — CIT 186
20 — 1602
21 — 1056
22 — CIT 484
23 — 1228
24 — 1158
25 — 65107
26 — 1087
27 — 1876
28 — 1254
29 — 1839
30 — 1165
31 — 1919
32 — 1643
33 — 2035
34 — 1344
35 — 1295
36 — 1225
37 — 1180
38 — 1170
39 — 1266
40 — 1893
41 — 1272
42 — 1276
43 — 1783
44 — 1198
45 — 1238
46 — 1604
47 — 1268
48 — 2034
49 — 2033
50 — 1157
51 — 2029
52 — 2032
53 — 1023
54 — 2027

Maloof, Staff Artist of the Los Angeles County Museum of Natural History.

Much appreciation is extended to my wife, Patricia, whose kind patience and understanding made this work possible.

PROCEDURE AND ABBREVIATIONS USED

When a taxon is first listed in the text, it is usually discussed at length; subsequent listings of the same taxon receive only superficial discussion. The habitat is given only with the initial citing of each animal. Unless otherwise indicated, information regarding habitats given in this paper are from the following sources: Burt and Grossenheider (1964), Hall (1951), Hall and Kelson (1959), Hibbard and Taylor (1960), Ingles (1965), Peterson (1961), Scheffer (1958), Stebbins (1966), Stock (1963) and Walker (1964). In general the mammalian classification is after Simpson (1945), the amphibian and reptile classification is after Romer (1966) and the bird classification follows Brodkorb (1963, 1964 and 1967). It is assumed that past habitats of living mammalian species listed in this paper were essentially similar to those they currently occupy.

The scatter diagrams in this paper are photographs of a computer controlled (I.B.M. 2840 control unit) video screen (I.B.M. 2250 display scope, model 2). Measurements of *Bison* and *Paramylodon* elements, appearing in Tables 2-19, were key punched on I.B.M. cards, as were symbols, tolerances and other necessary information; the cards were then programmed. All possible indices resulting from measurements on the cards then appeared on the video screen in graph form. These were each photographed.

Each bibliographic entry is followed by a number which also appears in Table 20. All mammalian genera discussed in the literature references have the bibliographic number listed opposite the name of the taxon in Table 20.

A *fauna* as used in this report is an assemblage of animal fossils from one locality which lies in a restricted stratigraphic interval. The fossil assemblage at Rancho La Brea is treated as one fauna (more detailed study of this assemblage may warrant a faunal division or divisions, however; see Marcus, 1960 and Howard, 1962).

Abbreviations and symbols used:

CIT—California Institute of Technology, Pasadena.

LACM—Los Angeles County Museum of Natural History.

UCLA—University of California at Los Angeles.

UCMP—University of California, Museum of Paleontology, Berkeley.

+—An extinct genus.

*—An extinct species.

cf.—Compares with (appears before a taxon when identification was based on limited material).

B.P.—Before present (used in association with radiometric dates).

( )—approximate measurement.

DESCRIPTION OF LOCALITIES AND FAUNAS

Costeau Pit

Location, Setting and Discovery

Costeau Pit is located in the San Joaquin (locally Laguna) Hills, approximately two miles south of the town of El Toro, seven miles north-northwest of San Juan Capistrano and about six and one-half miles northeast of the closest point of the Pacific Ocean. Its elevation is about 320 feet above mean sea level. The Santa Ana Mountains lie nine to ten miles to the northeast with Santiago Peak, a very prominent landmark, about three miles farther back.

The area immediately surrounding the site is hummocky. The hills are grass-covered and are used for grazing of livestock; however, in the past few years residential buildings have been usurping more and more of the land. The drainage pattern is dentritic with the flow direction being northeast to southwest (to the ocean from the Santa Ana Mountains). Costeau Pit is situated in one of these drainage channels in which water flows throughout the year, chiefly because the ground-water table has been penetrated. Usually, some water enters as run-off from the nearby residential area. Before the channel reached its present depth and before residential area run-off was initiated, the stream was ephemeral, as indicated by topographic maps and adjacent drainage channels.

Stratigraphy

The underlying basement rock in the area of Costeau Pit is not definitely known. From the recent work of Yerkes et al. (1965: 23), it can be inferred that the Jurassic Bedford Canyon Formation and the unconformably overlying Santiago Peak Volcanics (?Late Jurassic—?Early Creta-

ceous) probably comprise this basement. Both are commonly intruded by rocks of the southern California batholith. These rock types are exposed in the nearby Santa Ana Mountains and all contribute to the rock fragments found in the Pleistocene deposits of Costeau Pit. Almost certainly, rocks of later Cretaceous age unconformably overlie this basement complex. They too are exposed in the Santa Ana Mountains but over a much larger area. According to Yerkes et al. (1965: 27), there is greater than a ninety-five per cent probability that Paleocene, Eocene and Oligocene marine and nonmarine rocks overlie the Cretaceous rocks in the area that includes the Laguna Hills (where Costeau Pit is located). The oldest exposed rocks are marine Late Miocene–Early Pliocene (Capistrano Formation) and marine Pliocene (Niguel Formation). Outcrops of both formations can be seen in the immediate area. This is best illustrated by the geologic map of Vedder et al. (1957, OM-193).

Prior to the discovery of fossil land vertebrates at Costeau, geological consultants had been hired by a construction firm to ascertain whether the land was sufficiently safe to support residential tracts. Among other findings their reports indicated that, aside from Quaternary alluvium in stream channels, the sediments in the area were marine Miocene and Pliocene, thereby agreeing with earlier investigators. Although Leighton (1964, personal communication) mentioned some marsh deposits of unknown age, based largely on fossil reed imprints, just northeast of Costeau Pit, I have found that there is a representation of nonmarine Pleistocene sediments (previously mapped as marine Miocene and Pliocene) in the area of study. It should be pointed out, however, that some of the marine lithology is very similar to the nonmarine and, without fossils, it is difficult to distinguish between them. Also, the presence of terrestrial vertebrates was not known to earlier workers. Whether the nonmarine sediments are extensive enough to warrant formational status will have to await a further, more detailed geologic study.

The lithology at Costeau Pit is quite varied with a number of facies in evidence (Fig. 2). Observable beds are poorly indurated and lenticular. As shown in times of heavy rains, these sediments are very easily eroded. Through stream erosion and recent

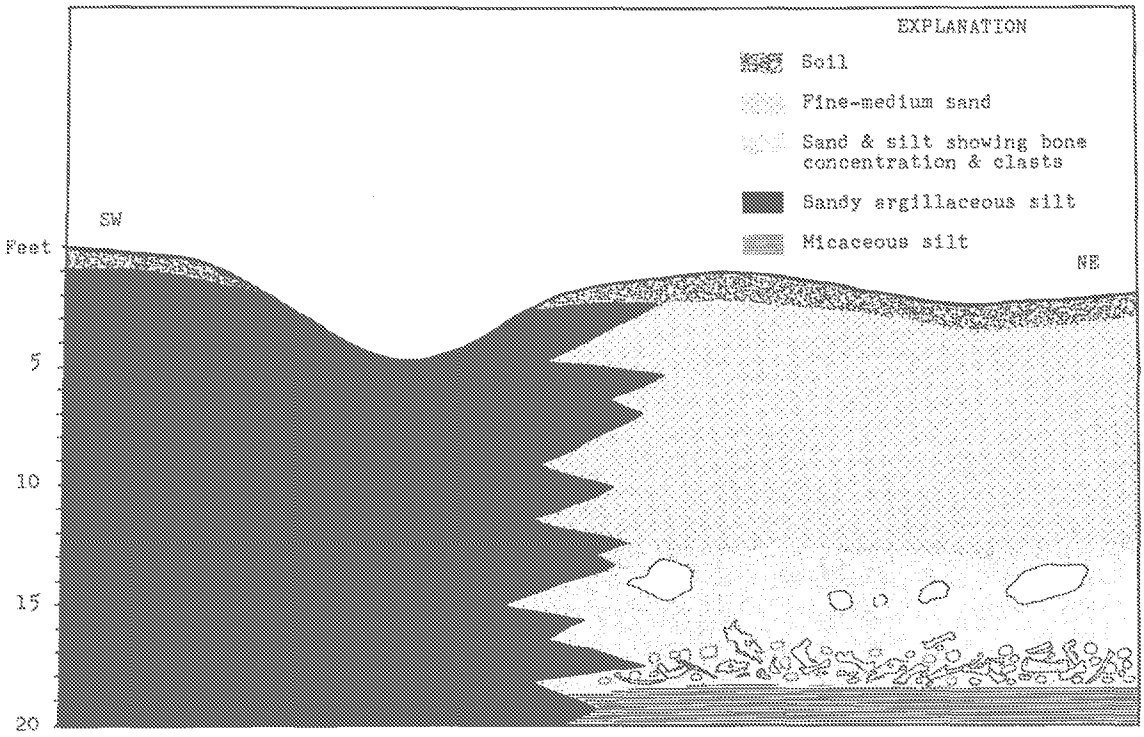


FIGURE 2. Simplified cross section showing relationship of beds at Costeau Pit. Horizontal distance about 150 feet.

machine excavation, the stream channel and adjacent area have been lowered to a depth of approximately twenty feet.

A soil cover, about six inches to one foot in depth, is found throughout most of the area. This grades downward into a moderately-sorted, fine to medium-grained, light grayish brown quartz sand (yellowish brown when weathered) that is ten to twelve feet thick and yields some vertebrate remains. Some streaks of reddish orange and grayish black are found in this sand, as are sandstone clasts reworked from the Niguel Formation. Many small cross-bedded structures indicate its fluviatile origin. Southwestward, this unit grades into a poorly sorted dark brown sandy and argillaceous silt. Numerous irregularly shaped small calcareous bodies, which are light gray to white in color, are found in this silt. Other components are pebbles, cobbles and finely divided plant debris, the latter probably giving rise to the dark coloration of the bed.

Conformably underlying the above mentioned sand unit and a part of the dark brown sandy silt is a bed which grades from a silty sand to a sandy silt. Its thickness is four to six feet and it varies in color from bluish gray and grayish green to dark brown. This unit is either lacustrine or palustrine in origin as suggested by the reduced condition of the sediments, the presence of reed imprints, and the occurrence of coot and duck remains. Before the extensive excavations the water table was observed in the upper portion of this bed. The portion of the bed now above the water table has become noticeably indurated through desiccation. It is within this unit that the majority of vertebrates, as well as abundant plant debris (the latter mostly in the dark brown section and evidently contributing to its coloration), have been recovered. Although fossils occur throughout this bed, most are contained in the lower one to two feet. Abundant clasts, granule to boulder size, are present in the entire unit but are also most prevalent in the lower part. Small lenses of coarse sand in this bed are formed from the disintegration and decomposition of sandstone clasts derived from the Niguel Formation. Marine molluscs, a variety of shark teeth and cetacean bones have been recovered from these sand lenses. Also, marine fossils have been found not in association with the sand lenses; all have been observed in the well indurated sandstone fragments. The southwest facies of this highly fossiliferous bed is the dark brown sandy silt that is the lateral equivalent of the overlying sand. This silt is fossiliferous in the lower part but no remains have been noted higher in the unit. Here, the majority of fossils are rodents; no large vertebrates have been seen. Two types of terrestrial snails are fairly common, *Micrarionta* and *Succinea*, the latter preferring fresh-water shorelines. These forms have not been observed in any of the other deposits.

Beneath the fossiliferous deposits conformably lies the lowest exposed unit. It is a light grayish green to brown micaceous (muscovite) silt that is well sorted and contains only a few larger rock fragments. Thus far, the only fossils contained in this silt have come from the uppermost few inches. Most of them have been observed to extend into the fossiliferous unit above. A number of vertical pipe-like structures are present in this bed. The diameters of the holes vary from about one-quarter to a little more than one inch and they extend downward several inches. Immediately encasing the holes is a moderately well indurated oxidized crust and commonly filling them is a fairly well sorted, fine light colored sand. These might be interpreted as root structures except that no woody material has been found in them and they rarely extend far into the overlying conformable bed. Also, very similar structures have been observed about three-quarters of a mile south in marine beds at about the same horizon. These structures may owe their origin to burrowing invertebrates, although no shells have been found in association with the holes. Since these structures are found in marine and nonmarine beds, two types of organisms could be involved.

Most of the included rock fragments in the various lithologic units are derivable from the nearby Santa Ana Mountains. They are well rounded, suggesting several cycles of transport, erosion and deposition. The largest rocks are subangular and are among the few that were not derived from this mountain source. These are composed of sandstone and were apparently brought into the present deposits, largely by mass wasting, from the nearby Niguel Formation. The size of these fragments ranges from small boulders to those with diameters in excess of six feet. Claystone concretions, probably originating *in situ*, are abundant. They range in size from pebbles to small boulders and some contain cetacean bones. The remaining boulders consist of felsite (abundant), quartzite (abundant), andesite (common), granodiorite (common), irregular-shaped ?phosphatic nodules (common), rhyolite (scarce), basalt (scarce), schist (scarce), and gneiss (scarce).

Some small scale deformation has taken place in the Costeau region subsequent to the deposition of the Pleistocene beds. There are two faults, one normal with about seven feet of displacement and a strike of N 65° E, and another, concealed. The

beds generally dip about three degrees to the southwest. This slight dip may in part have been produced by differential compaction. Vertical joints are also in evidence and have been noted by earlier workers in the Miocene and Pliocene rocks of the general region. It can now be said that this jointing, at least in part, is no older than Late Pleistocene and may be Recent.

Preservation and method of fossil recovery

The bones were mostly wet and soft when uncovered, thus necessitating special care in order to remove them intact. Once dry, however, they became hard and resistant. The bones are slightly permineralized and usually reddish brown to brown in color. (It was noted that Recent cow bones when left in reworked sediments subject to wetting attained a brown coloration approaching some of the fossils within a span of two months. The texture and weight of the bone, though, allowed for a distinction between the two.) Those recovered in places where plant debris is abundant are dark brown.

Many of the larger specimens required plaster jacketing in order to insure safe recovery. When a specimen was small to moderate sized and appeared unsafe to remove as found, it proved useful to make a paper jacket using soft tissue saturated in thinned glyptal. Because of the dampness of the specimens, it was necessary to use water soluble glue for major breaks.

Most of the small vertebrates were recovered by screen washing. Enough water was flowing in the stream channel to allow this process to be accomplished at the site.

A majority of the bones and teeth from the fossil deposit show at least some degree of stream abrasion. In a few instances this wear is severe. Very few articulated bones have been recovered and those found in association are rare. All indications, therefore, suggest at least some stream transport for most of the fossil remains.

Systematic discussion of fauna

Class PISCES

Two small vertebrae, LACM 18927, are all that represent this class from Costeau Pit. The type of preservation indicates that they were not reworked from an older deposit. Presumably they represent some type(s) of small fresh-water fish.

Class AMPHIBIA
Order ANURA
Family BUFONIDAE
Bufo

A number of limb elements and a vertebra, LACM 18928, are referable to this genus.

Family RANIDAE
Rana

A few limb elements, LACM 18929, apparently belong to this genus of frog. Its remains are not nearly as numerous as those of the toad, *Bufo*.

Order URODELA
Family SALAMANDRIDAE
cf. *Taricha*

One jaw fragment, LACM 18930, of a large salamander has been recovered. The teeth are broken at the same height, a little above the alveolar border, evidently at the calcified zone.

Class REPTILIA
Order CHELONIA
Family TESTUDINIDAE
cf. *Clemmys*

Two carapace fragments represent the only material assignable to the pond turtle.

cf. *Gopherus*

Four carapace fragments, LACM 18931, one belonging to a juvenile, represent a large tortoise. Although there is a slight possibility that this material could belong to a small *Geochelone*, the configurations seem most similar to *Gopherus*, the desert tortoise.

Order SQUAMATA

A number of specimens, mostly vertebrae, represent this order, most of them being referable to the suborder Ophidia. Even though many specimens are still unidentified, at least four families within the order are present. One of them, Colubridae, is recognized by three vertebrae which cannot be placed in any genus with certainty.

Family IGUANIDAE
Sceloporus

One jaw fragment, LACM 18932, containing four teeth, is the sole occurrence of the spiny lizard. The habitat of this genus, which is still present in the area, is extremely variable.

Family TEIIDAE
Cnemidophorus

The whiptail lizard is represented by a nearly complete jaw with dentition, LACM 18933. Although the teeth are quite worn, assignment to this

genus is made with reasonable certainty. Even though the habitat for this genus varies with the species, a majority thrive in semiarid regions.

Family VIPERIDAE

Crotalus

Two fangs and a vertebra, LACM 18934, have been identified as a rattlesnake. The size of all three specimens indicates a large form, larger than the south Pacific rattlesnake, the most common type in the area today. *Crotalus ruber*, the red diamond rattlesnake, which also occurs in the area, may have individuals which equal the fossil specimens in size, but none were seen. A possibility exists that the fossils belong to the largest western rattlesnake, *Crotalus atrox*, although the present geographic range of this species does not extend as far west as the area of investigation.

Class AVES

Order ANSERIFORMES

Family ANATIDAE

Anas

A complete carpometacarpus, LACM 18935, represents a duck at Costeau. Another specimen, LACM 18936, a proximal carpometacarpus fragment, is evidently an anatid but its preservation indicates it was reworked from an earlier deposit.

Order FALCONIFORMES

Family ACCIPITRIDAE

Buteogallus

Presence of *Buteogallus* is noted by a complete coracoid, LACM 18937. Currently this genus is not found in California; its range extends from southern Arizona and Texas (possibly New Mexico) south to northern South America. However, a minimum of 83 individuals have been collected from the deposits at Rancho La Brea. Evidently the territorial range of this hawk was farther to the west, and probably north, of its present limits.

Order GALLIFORMES

Family PHASIANIDAE

Lophortyx

The quail is the most abundant avian representative from Costeau Pit, having been identified by twenty postcranial elements, LACM 18938.

Order RALLIFORMES

Family RALLIDAE

Fulica cf. *americana*

The American coot's presence in the fossil deposit is noted by three limb elements, LACM 18939. This genus is well-represented in western North America and currently is found in nearby lakes and ponds.

Order STRIGIFORMES

Family STRIGIDAE

Two owls have been recognized; however, the generic identity of the larger form is unknown. It is represented by a proximal tarsometatarsus, LACM 18940, which is about the size of a similar element of a horned owl.

Speotyto

The burrowing owl, identified on the basis of two incomplete tibiotarsi, LACM 18941, is a good indicator of a grassland environment. It presently inhabits the general area, utilizing numerous ground squirrel burrows.

Order PASSERIFORMES

Several passerine elements, LACM 18942, have been recovered that probably represent three or four genera.

Class MAMMALIA

Order INSECTIVORA

Family SORICIDAE

Notiosorex crawfordi (Coues)

Abundance: Five individuals, based on right jaws. Twelve specimens, including two incomplete palates, nine jaws and an anterior half of a skull, LACM 18943-18946.

Habitat: The desert shrew is presently found in semiarid and arid regions of the southwestern United States and northern Mexico. It has been recorded by Hoffmeister and Goodpaster (1954) in a desert grassland environment around the base of the Huachuca Mountains of southeastern Arizona.

Discussion: Two species of shrew are presently assigned to the genus *Notiosorex*, *N. crawfordi* and *N. jacksoni*. Hibbard (1950: 127-128) removed the species '*gigas*' from the genus *Notiosorex* and placed it in a new one, *Megasorex*. Hall and Kelson (1959: 64) synonymized the latter genus with the former, thus restoring '*gigas*' to its previous status. However, Repenning (1967: 56), in his review of the Soricidae, retained *Megasorex* as a valid genus, with *M. gigas* the monotypic species.

Notiosorex crawfordi is reported in the fossil record only from Late Pleistocene deposits of Kansas and California, Cragin Quarry in Kansas, and Rancho La Brea in California, according to Hibbard and Taylor (1960: 158). Undoubtedly, extensive screening operations at promising localities will greatly expand the knowledge of fossil

distribution of this species. The second species, *N. jacksoni*, is an extinct form named by Hibbard (1950: 129). It is reported from Blancan and possibly Irvingtonian age deposits, only from Kansas and California. *Notiosorex* sp. has recently been discovered in Plio-Pleistocene deposits of the San Pedro Valley in Arizona (G. Lammers, 1968, personal communication).

The Costeau shrew (see Fig. 3) differs from *Sorex* by its reduced dentition (I3/2, C1/0, P1/1, M3/3 as opposed to I3/1, C1/1, P3/1, M3/3), generally larger C1/, more anteriorly inclined coronoid process, and distinctly more lingually emarginate intercondylar area. It differs from descriptions of *Megasorex* by its much smaller size, relatively more slightly built rostrum, lesser arching of the skull, more emarginate posterior borders on P4/ - M2/ (especially on P4/), and its less anteriorly inclined and less spatulate coronoid process. The Costeau specimens are distinguished from Hibbard's (1950: 123, 130-133) type description and illustrations of *N. jacksoni* by smaller size, less triangular-shaped (occlusally) C1/, presence of a valley between the principal cusp and lingual cingulum of the unicuspid teeth, a groove on the posterior portion of the first and second unicusped teeth for reception of the anterior portion of the second and third, having the anterior portion of the P4/ metaconal blade continuous with the paracone rather than its being a distinct cusp (this feature is not apparent in the illustration of the type; Hibbard, 1950: 123), and less distinct cingula on the lower teeth.

Morphologically, the shrew from Costeau Pit cannot be distinguished from Recent specimens of *Notiosorex crawfordi*.

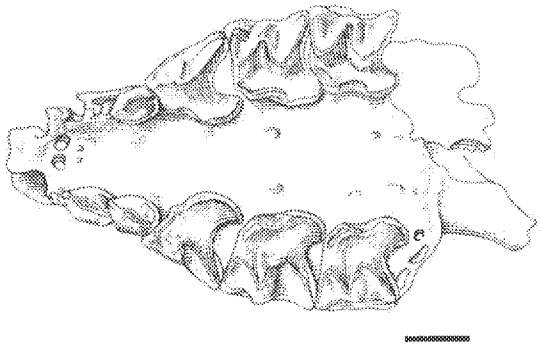


FIGURE 3. *Notiosorex crawfordi*, occlusal view of palate, LACM 18943, Costeau Pit, Loc. 65129. Line beneath figure represents 1 mm.

Order EDENTATA
Family MYLODONTIDAE
Paramylodon cf. *harlani* (Owen)

Abundance: Nine individuals based on adult right humeri and fourth left upper cheek teeth of three juveniles. 181 specimens, including one posterior portion of a skull and nine skull fragments, five incomplete jaws, 32 isolated teeth, nine dermal ossicles, 71 complete and incomplete vertebrae, five incomplete pelves, six incomplete scapulae, one clavicle, one ulna, one radius fragment, 16 incomplete femora, two tibiae (one complete) and 12 foot elements.

Habitat: Stock (1925: 27; 1963: 51) stated that the mylodontid sloths occupied open land in both North and South America and were probably grassland forms. This idea is reiterated by Hibbard and Taylor (1960: 163). I also subscribe to the idea that these ground sloths, as typified by the genus *Paramylodon*, commonly frequented grasslands. As noted below in the discussion on environment, the Costeau area was exclusively a grassland during the Late Pleistocene.

Discussion: Only three genera of ground sloths have been described from the Pleistocene of western North America, *Paramylodon*, *Megalonyx* and *Nothrotherium*. Although all three forms are recorded at Rancho La Brea, only the first named genus has been recovered from Costeau (the latter two are not common at Rancho La Brea). *Paramylodon* can be distinguished from *Nothrotherium* and *Megalonyx* by its lobate teeth, simple ectotympanic ring, larger size, shorter but more massive epipodial elements, presence of dermal ossicles and lack of discrete lumbar vertebrae, as well as by numerous other features. The species *P. harlani* is known throughout the North American continent.

The *Paramylodon* species from Costeau is of slightly smaller average size than the one from Rancho La Brea (Figs. 128-155) but morphologically the two are indistinguishable. One small difference between the two samples was observed--the single ectotympanic found at Costeau (Fig. 4) is distinctly more massive than any of the three known Rancho La Brea homologues.

The teeth of *Paramylodon* are composed of a thin outer layer of cement (0.7mm-1.0mm) which encloses a layer of dense dentine that encircles the vascular dentinal core. The dense layer of dentine stands out in relief above the softer internal type forming a resistant ridge for more efficient grinding. The denser dentine seems to serve the same function as the enamel in grazing ungulates.

It should be pointed out that *Paramylodon*, as well as sloths in general, is extremely variable in

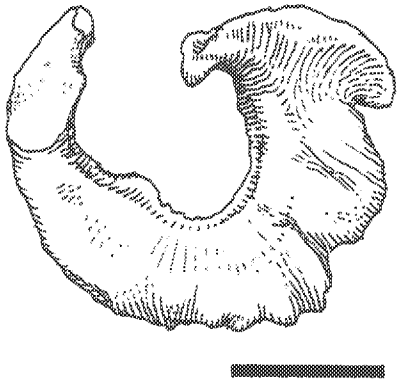


FIGURE 4. *Paramylodon* cf. *harlani,* medial view of ectotympanic, LACM 18002, Costeau Pit, Loc. 65129. Line beneath figure represents 10 mm.

configuration of its bones, probably as much or more so than any other Cenozoic mammal (for variation in *Paramylodon* elements in the samples from Costeau Pit and Rancho La Brea, see Figs. 5, 128-155).

Apparently, remains of juvenile *Paramylodon* are not common. Relatively few are to be found among the numerous Rancho La Brea specimens. Of several juvenile specimens from Costeau, one, a maxillary fragment, LACM 17989, Fig. 6, shows an interesting characteristic of *Paramylodon* teeth; that is, at an immature stage the teeth expand toward the base and, like adult forms, are rootless. Two juvenile specimens from Rancho La Brea (Fig. 7), a nearly complete jaw, UCMP 33103, and a maxillary fragment, UCMP 33110, display teeth with similar features. These individuals are smaller, show little tooth wear and are evidently younger than the Costeau specimen but, like it, present an occlusal tooth pattern identical to adult forms. The size of the occlusal outlines in the Costeau specimen is comparable to a section taken near the base of the tooth in these juveniles. It thus appears that the rootless teeth of juveniles are tapered from base to crown until adult size is reached, at which time they become parallel-sided. If deciduous teeth do occur, they are lost at a very early stage, possibly in the embryo.

Order LAGOMORPHA
Family LEPORIDAE

Two genera and three species of leporid are recognized in the Costeau fauna, *Lepus* cf. *californicus, Sylvilagus* cf. *audubonii* and *S.* cf. *bachmani.* The presence of these three forms in a given

FIGURE 5. Occipital profiles of selected adult *Paramylodon harlani* skulls from Rancho La Brea showing variation in shape. Line beneath figure represents 20 mm.

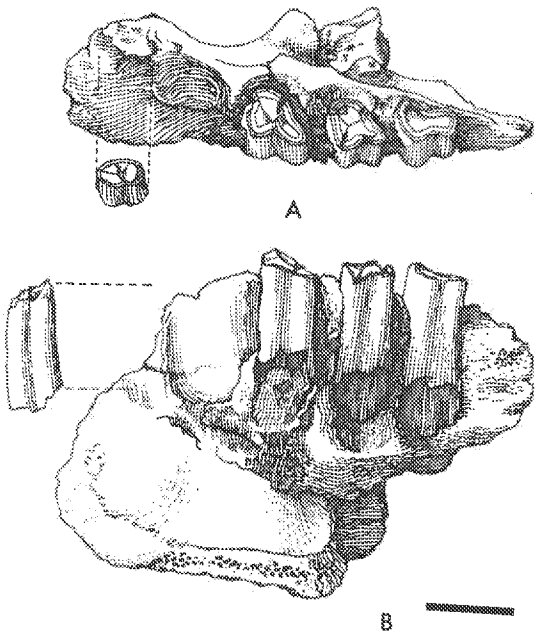


FIGURE 6. *Paramylodon* cf. *harlani,* left maxillary fragment, LACM 17989, Costeau Pit, Loc. 65129: A, occlusal view; B, lingual view. Line beneath figure represents 20 mm.

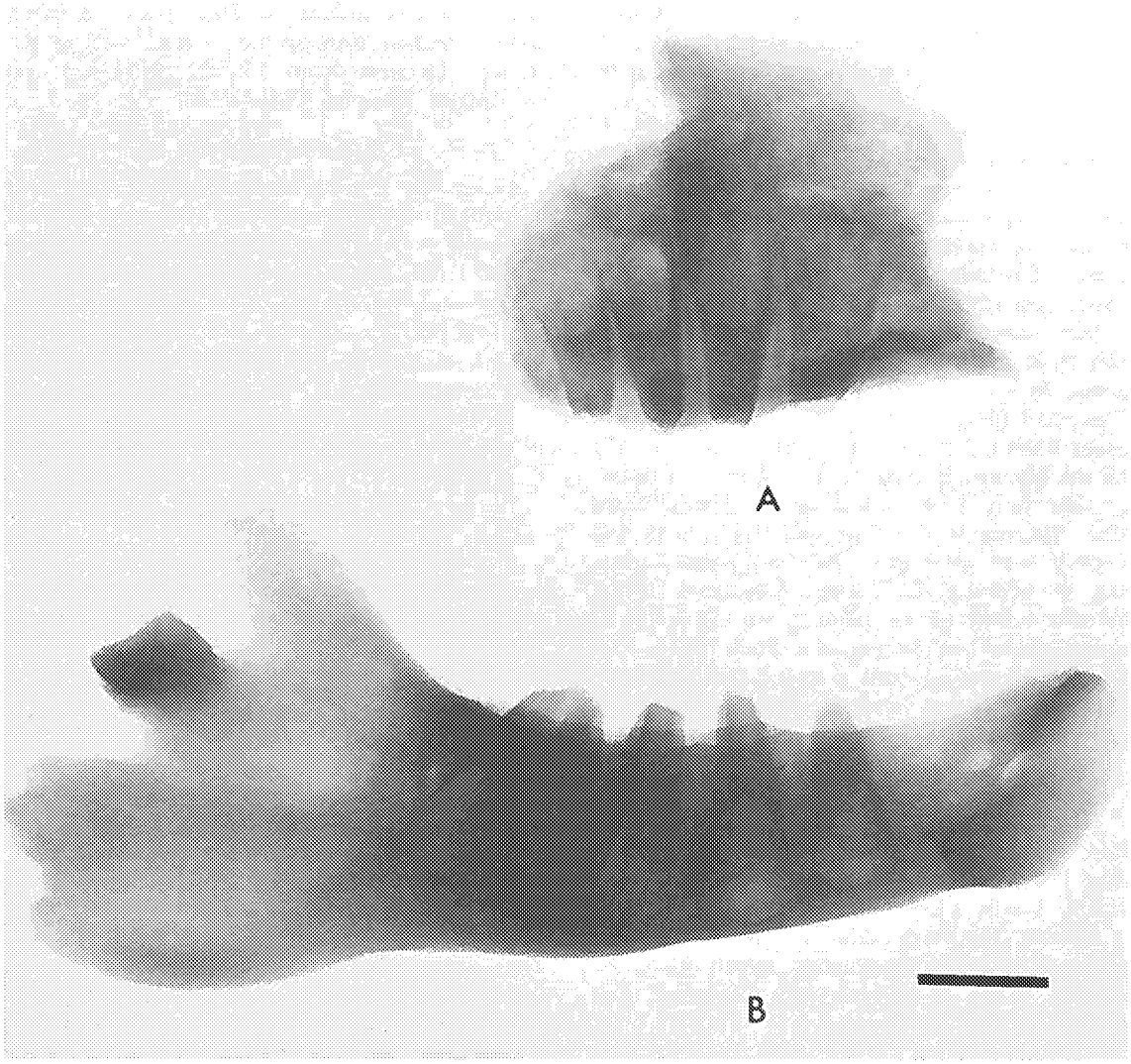


FIGURE 7. X-ray photograph of juvenile *Paramylodon harlani* maxillary and jaw from Rancho La Brea: A, UCMP 33110, lateral view of maxillary fragment; B, UCMP 33103, medial view of jaw. Line beneath figure represents 20 mm.

area is quite common today in many parts of southern California; and judging by their coexistence at Costeau Pit, Rancho La Brea and McKittrick, this condition also prevailed during the Late Pleistocene.

Lepus cf. *californicus* Gray

Abundance: Two individuals, based on wear stages of teeth. 12 specimens, including teeth, an astragalus and a proximal end of a humerus, LACM 18584, 18585 and 18955.

Habitat: The blacktail jackrabbit is found chiefly in grasslands and deserts.

Discussion: Specimens of *Lepus* are distinguished from *Sylvilagus* mostly by their much larger size. There is also an apparent difference in the configuration of the occlusal surface of P3/ to M2/, as the former genus possesses a more distinct change in slope near the labial border (an almost step-like effect) than does the latter.

Specimens of *Lepus* from Costeau do not show significant differences from *L. californicus,* the

one large rabbit found in southern California today. The only other species now inhabiting California are found in the northern part of the state.

Sylvilagus Gray

Abundance: Eight individuals, based on the left P/3. 128 specimens, including five skull fragments, six jaw fragments, 89 isolated teeth, one vertebra, six humeri, one radius, six fragmented pelves, three femora, five tibiae and six astragali, LACM 18601-18637 and 18956-18960.

Discussion: As previously mentioned, two species from the Costeau fauna are assigned to this genus, *Sylvilagus* cf. *bachmani* and *S. audubonii*. The fossil forms of these species show no differences when compared to their living counterparts. Of the Costeau specimens, *S. audubonii* is distinguished from *S. bachmani* by its slightly larger size, relatively deeper jaws and larger teeth and slightly more anteroposteriorly compressed trigonid. In addition the enamel re-entrants of the anterior border of the talonids are usually more crenulated in the former species (Hall, 1951: 143). Despite these differences in dental characteristics, many specimens of *Sylvilagus* could not be specifically differentiated.

Sylvilagus cf. *bachmani* (Waterhouse)

Abundance: Four individuals, based on the left P/4. 19 specimens, including one maxillary and four jaw fragments and 14 cheek teeth, LACM 18621, 18628, 18636, 18956 and 18958.

Habitat: The brush rabbit is found in areas with moderate to heavy brush cover, mainly along the western coasts of Oregon and California, and throughout Baja California.

Discussion: Based on size alone, the great majority of *Sylvilagus* specimens probably are assignable to the smaller species, *S. bachmani*. The presumably greater abundance of this type, which requires a good brush cover, can be explained by the presence of dense vegetation adjacent to the Late Pleistocene water courses.

Sylvilagus cf. *audubonii* (Baird)

Abundance: One individual. Six specimens, including a jaw fragment and isolated cheek teeth, LACM 18957 and 18959.

Habitat: Grasslands and open sage are the preferred habitat of the desert cottontail, found throughout most of the western United States and northern Mexico.

Discussion: Although this species may not have frequented the water supply at Costeau, it probably was abundant just a short distance away if the numbers of *S. audubonii* in the immediate area today are any indication. This species is much more abundant than *Sylvilagus bachmani*, in the Rancho La Brea fauna (Stock, 1963: 41) and McKittrick (Schultz, 1938: 210).

Order RODENTIA

Discussion: Nine genera of rodents have been identified in the Costeau fauna. In general they are the same as those from Rancho La Brea; *Ondatra* is noted only in the former fauna, however, and *Onychomys* only in the latter. These two genera are very poorly represented but the absence of the former at Rancho La Brea may have environmental significance.

The total number of specimens for each rodent genus given, except *Ondatra*, excludes all postcranial elements.

Family SCIURIDAE

Citellus beecheyi (Richardson)

Abundance: Four individuals, based on the left M/1. 40 specimens, including three maxillary and three jaw fragments in addition to 34 isolated teeth, LACM 18961-18967.

Habitat: The California ground squirrel lives along the western Coast from northernmost Oregon to northern Baja California in regions where grasslands, open slopes and rocky ridges predominate.

Discussion: Citellus beecheyi fossils from Costeau were compared with a number of species of this genus, especially those found in and around southern California. They are considerably larger than specimens of *C. lateralis* (Say) and the median ridge of the M/3 protoconid is more pronounced and its base is directed more toward the protolophid. In addition to exceeding specimens of *C. leucurus* (Merriam) in size, they have a relatively less reduced P3/ as discerned by the alveoli. The Costeau species is also considerably larger than *C. mohavensis* (Merriam). With the possible exception of a less distinct metaconule on P4/, no dental characters were observed which would allow a separation of these two species. *Citellus tereticaudus* (Baird) is equivalent to *C. leucurus* in size and differs from the fossil species by a poorly defined metaloph on P4/ (on the P4/ of specimens from Costeau Pit the metaloph is very prominent due to a large, well defined metaconule; this cuspule is incipient to absent in *C. tereticaudus*). The basin of M/3 in *C. tereticaudus* is relatively smaller and less flat bottomed when compared to the Costeau Pit specimens in a similar stage of wear.

The Costeau species was compared to and found identical with *Citellus beecheyi*, which is currently very abundant in the area. According to Dice

(1925: 126), the ground squirrel from Rancho La Brea is referable to this species.

Family GEOMYIDAE

Thomomys bottae (Eydoux and Gervais)

Abundance: 36 individuals, based on incisors. 389 specimens, including three incomplete skulls, 13 incomplete palates, 65 complete and incomplete jaws and 308 isolated teeth.

Habitat: This highly diversified pocket gopher occupies most habitats in the southwestern United States and northern Mexico. It prefers loamy soil.

Discussion: Absence of a prominent groove or grooves on upper incisors helps distinguish this genus from every other living geomyid. All upper incisors referable to gopher from the Costeau fauna bear only the very faint medially positioned groove on the anterior surface, typical of *Thomomys*. This genus is represented by more individuals than any other animal from Costeau Pit.

The Costeau gopher (Fig. 8) is noticeably larger than *Thomomys monticola* Allen which inhabits mountain meadows in northern and northeastern California at present. The anterior surface of the P4/ talon in this latter species is flat to concave anteriorly, but the same surface in the former species is slightly to distinctly convex. In *T. monticola* the isthmus joining the trigon and talon of P4/ is distinctly lingual to the anteroposterior midline; the position of this isthmus is nearly central in all Costeau specimens. This feature seems unaffected by stage of wear. Another characteristic separating these two species is the bilaterally symmetrical P/4 trigonid in the Costeau form; it is asymmetrical in *Thomomys monticola*.

T. talpoides (Richardson) was also compared to the fossil species. It too is a slightly smaller form. The P4/ of this species displays characters of both *T. monticola* and the Costeau *Thomomys*. Like *T. monticola*, and unlike the fossil species, the trigonid of P/4 is not bilaterally symmetrical.

The extant *T. townsendii* (Bachman), now living in the Pacific Northwest, is noticeably larger than the species under investigation. Dental characteristics of these two forms are quite similar although there is a tendency toward asymmetry in the P/4 trigonid of the larger species.

Numerous specimens of *Thomomys bottae* were compared with the fossil species and in no way were they found to differ. This species of gopher has been observed living at the fossil site and has been recorded from many Pleistocene deposits in California, including Rancho La Brea and McKittrick.

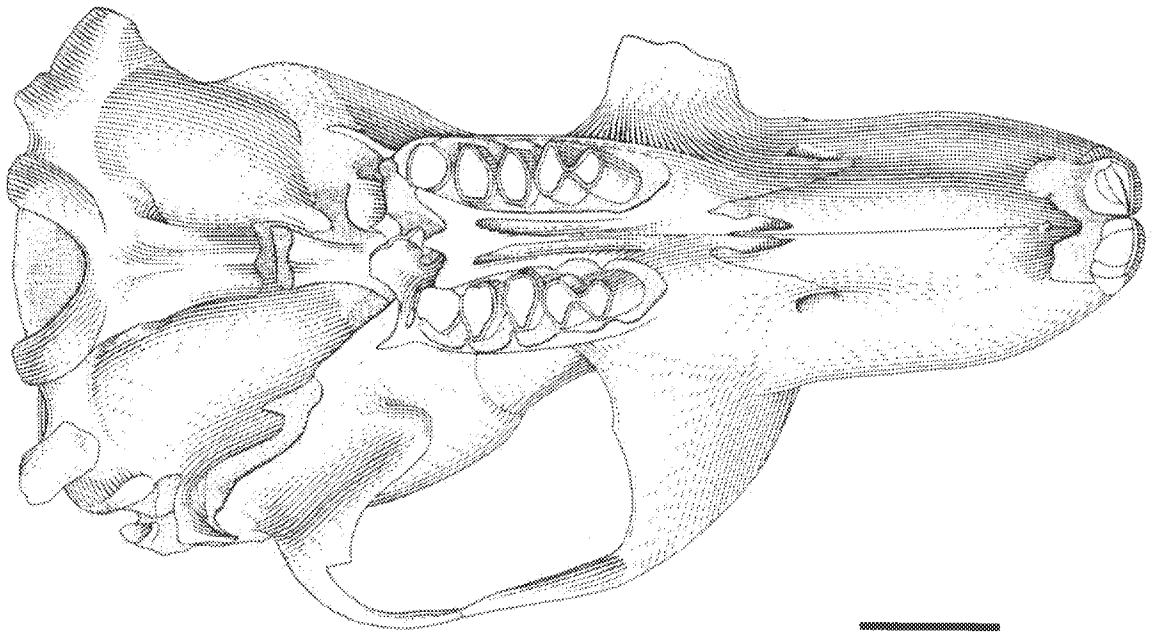


FIGURE 8. *Thomomys bottae*, occlusal view of skull, LACM 20573, Costeau Pit, Loc. 65129. Line beneath figure represents 5 mm.

Family HETEROMYIDAE

Perognathus cf. *californicus* Merriam

Abundance: 26 individuals, based on incisors. 272 specimens, including one skull fragment, three incomplete palates, 11 maxillary fragments, 51 jaws and jaw fragments and 206 isolated teeth.

Habitat: The California pocket mouse is commonly found in grasslands of semiarid regions in central and southwestern California.

Discussion: Many species of *Perognathus* were compared with the relatively abundant specimens from the area of investigation. Just three closely approach the fossil species, *P. baileyi* Merriam, *P. fallax* Merriam and *P. californicus* Merriam. All now inhabit areas in southern California. They are similar in size to each other and to the fossil form, but *P. baileyi* and *P. fallax* possess a wider P/4 trigonid. P4/ of the latter species is also more reduced than in the fossil form. The Costeau pocket mouse appears to fall within the range of variation of *P. californicus*. However, the labial inflection of M3/ seems to be more posteriorly directed on the average than in the recent specimens.

Dipodomys Gray

Abundance: Four individuals, based on incisors. 21 specimens, including a jaw, LACM 18968, and isolated teeth, LACM 18969.

Habitat: Kangaroo rats occur mainly in the western United States and northern Mexico in semiarid to arid regions where slight ground cover prevails. Sandy soils are preferred.

Discussion: Over one-half the existing species of *Dipodomys* can presently be found in California. The fossil specimens have been compared with each of these. *D. ingens* (Merriam) and *D. deserti* Stephens are decidedly larger, *D. elephantinus* (Grinnell) is slightly larger with narrower lower incisors, and *D. merriami* Mearns, *D. nitratoides* Merriam and *D. ordi* Woodhouse are distinctly smaller than the fossil species. The remaining species are nearly the same size. Of these *D. microps* differs by possessing noticeably wider, flatter-tipped lower incisors, and *D. hermanni* Le Conte and *D. venustus* (Merriam) can be distinguished by a greater constriction between the trigonid and talonid of P/4 and a slightly more reduced M/3. Apparently, the specimens from Costeau Pit cannot be separated from either *D. agilis* Gamble or *D. panamintinus* (Merriam). *Dipodomys stephensi* (Merriam) is quite possibly a subspecies of *D. panamintinus* (Hall and Kelson, 1959: 520). If recognized as a separate species it too would closely compare with the Costeau form. Although *D. agilis* is now living in the area of investigation, only one of many studied jaws was as large as LACM 18968 (Fig. 9). *D. panamintinus*, now living north and east of the Santa Ana Mountains, is represented by some specimens which equal the fossil species in size; the average appears slightly smaller, however.

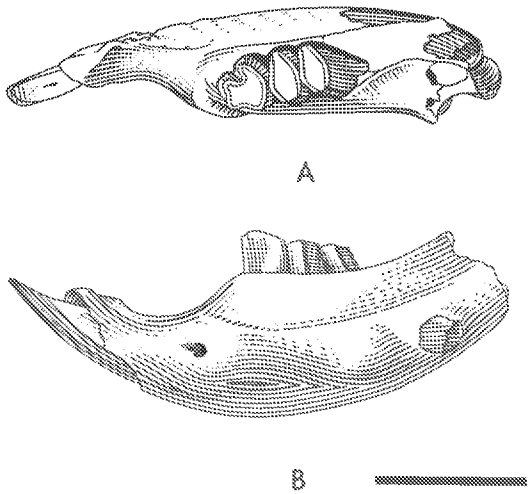


FIGURE 9. *Dipodomys*, left mandible, LACM 18968, Costeau Pit, Loc. 65129: A, occlusal view; B, labial view. Line beneath figure represents 5 mm.

Family CRICETIDAE

Peromyscus maniculatus (Wagner)

Abundance: Nine individuals, based on incisors. 48 specimens, including three maxillary fragments, 16 jaws and 29 isolated teeth (mostly incisors).

Habitat: The deer mouse occupies all terrestrial habitats throughout most of North America.

Discussion: Six species of *Peromyscus* can presently be found in southern California: *P. crinitus* (Merriam), *P. eremicus* (Baird), *P. boylii* (Baird), *P. truei* (Shufeldt), *P. californicus* (Gamble), and *P. maniculatus*. Many individuals of these and of additional species were compared with the fossil material. Only the last-named species was found to be identical, within the range of variation of its subspecies, to the Costeau *Peromyscus*.

Peromyscus crinitus is the only species smaller than the fossil one. It further differs in the absence of an anteroconule, a less reduced M/3 and a

much less pronounced anterointernal inflection of the anteroconid. *P. eremicus, P. boylii* and *P. truei* are similar to the fossil species in size. The M/3 in each of these species is less reduced and the anterointernal inflection of the anteroconid is usually less developed, although the first-named species differs least in the latter character. A small anteroconule on M1/ is found in each of these three species. It is often lacking in the first, usually present in the second two and most prominent in the last. However, each of these species differs from *P. maniculatus* in this character by having it directly attached to the anterocone rather than joined to it by a distinct loph.

Peromyscus californicus and the extinct *P. irvingtonensis* are much larger than any of the above species. Both have a less reduced M/3 (especially the latter) than the Costeau *Peromyscus*. The Irvington species also differs in its lack of the anterointernal inflection and the presence of a lake in the anterocone. *P. californicus* has the anterointernal inflection but it is not as well developed.

A number of specimens of *Peromyscus* from Rancho La Brea were studied. These appear identical to those from Costeau. Although Dice (1925: 123) gave a new specific name, *P. imperfectus*, to the La Brea specimens, no characters that would allow it to be distinguished from *P. maniculatus* were given. A large quantity of specimens representing nearly all the subspecies of *Peromyscus maniculatus* now living in and around California possess characters which encompass all those seen in the specimens from Costeau Pit and Rancho La Brea, including the type of *P. imperfectus* (UCMP 21879). I consider *Peromyscus imperfectus* to be a synonym of *P. maniculatus*.

Reithrodontomys cf. *humulis* (Audubon and Bachman)

Abundance: Eight individuals, based on left jaws. 31 specimens, including two maxillary fragments, 14 jaws and jaw fragments and 15 isolated teeth (mostly incisors).

Habitat: This particular harvest mouse is associated with wet grasslands and marshes.

Discussion: Although *Reithrodontomys* is evidently very closely related to *Peromyscus*, it can be separated from this genus by its grooved upper incisors, minor dental characters and generally smaller size.

Reithrodontomys raviventris Dixon, currently restricted to a small region in west central California, is distinctly larger than the fossil species. It also differs in possessing a relatively wider anterocone and anteroconid on M1/1, for a given wear stage, and commonly has a slightly (relatively) larger M/3. *R. fulvescens* Allen of the southern United States and Mexico is much larger than the fossil species and also possesses a relatively wider M1/1 anterocone and anteroconid. M/3 in this species is usually much less reduced. *R. megalotis* (Baird) is the only species in addition to *R. raviventris* now present in California and is statewide in distribution. It has been identified at Rancho La Brea (Dice, 1925: 123). Although Schultz (1938: 207) does not give a specific designation to the McKittrick species, a close study of the specimens from the latter deposit shows that it is probably *R. megalotis*. The Costeau harvest mouse differs from numerous (over 100) Recent specimens assigned to this species by its distinctly smaller size and relatively less massive teeth. In addition some of the Recent and fossil specimens of *R. megalotis* possess an ectostylid on M/1 that is not present in the Costeau material.

All North American species of *Reithrodontomys* were observed and *R. humulis* is the only one as small as the one under investigation. This species compares favorably in size and in dental characters to the one from Costeau. Both forms display a labial cingulum on M/1-M/2 which bears incipient cusps. One other species, *R. burti*, possesses a labial cingulum, but it is much less pronounced and manifests no cusplets. Also, *R. burti* averages slightly larger than *R. humulis* and specimens from Costeau. The present geographic range of *R. humulis*, however, is limited to the southeastern United States, with eastern Texas the westernmost boundary for this species. Although it is conceivable that the fossil material represents a new species, it will require more complete specimens than are now available to ascertain this.

Neotoma Say and Ord

Abundance: Three individuals based on the right M1/. 16 specimens, including two edentulous jaw fragments, LACM 18970, and 14 isolated teeth, LACM 18971.

Habitat: The woodrat can be found in deserts, forested mountains and near jungle conditions throughout much of North America. Various species, however, are restricted to fairly definite habitats.

Discussion: Because of the marked variability in species and individuals of this genus and lack of diagnostic material, only a generic designation is given. Of the species used in comparison, *Neotoma cinerea* (Ord), *N. albigula* Hartley, *N. lepida* Thomas and *N. fuscipes* Baird, only the latter two now coinhabit southwestern California. *N. fuscipes* is nearest to the fossil species in size although rep-

resentative specimens are generally a little smaller. Specimens of the first three species, especially *N. lepida,* are all distinctly smaller than the fossil form. Also, the lingual and labial inflections of the Costeau species' M1/ appear a little more open than do those in any of the compared species for a similar wear stage.

Microtus californicus (Peale)

Abundance: 14 individuals, based on the right M1/. 70 specimens, including six incomplete palates, 11 incomplete jaws and 53 isolated teeth.

Habitat: The California vole is chiefly a grassland animal that now inhabits most of California. It apparently prefers grassy areas near streams, lakes or marshes.

Discussion: Shape of the incisive foramina and the occlusal enamel pattern seem to be the most diagnostic features that allow differentiation between species of *Microtus.* The first named character is commonly considered the most reliable and is present in six specimens from Costeau, LACM 18972.

The fossil species was compared with species of *Microtus* that occur in California or near the southern part of the state, as well as with *M. pennsylvanicus* (Ord), currently the most widespread species. Of these compared species only *M. montanus* (Peale), *M. townsendii* (Bachman), *M. longicaudus* (Merriam) and *M. californicus* approach the fossil material closely enough for consideration here. The first named species differs by its slightly smaller size, posteriorly constricted incisive foramina and anteromedially directed anteriormost lingual inflection of M/1. Although *M. townsendii* is similar in size to the fossil form, its incisive foramina and anteriormost lingual inflection of M/1 closely resemble those of *M. montanus. M. longicaudus* more nearly approaches the fossil species than do the other two but is generally a little smaller and has narrower incisive foramina which commonly show some degree of posterior constriction.

Only *M. californicus,* among its subspecies, possesses all the characters noted in the fossil material. Over 150 specimens of this species, representing all its extant subspecies, were used in comparison. The Costeau specimens differ from most of these subspecies by their more posteriorly widened incisive foramina. Incisive foramina that approach the fossils in width have been observed in just one of many studied palates of *M. californicus californicus.* None of the observed *M. c. sanctidiegi* Kellogg specimens (the only subspecies now living in the area) has as wide foramina, while half of a limited number (eight) of *M. c. kernensis* Kellogg specimens approach the Costeau ones in this character. A possibility exists that the fossil material represents another subspecies within *Microtus californicus.*

Ondatra Link

Abundance: One individual, based on a complete right femur, LACM 18973.

Habitat: Muskrats inhabit lakes, marshes and streams throughout most of North America from northernmost Mexico to Alaska. They are found in semiarid as well as humid regions.

Discussion: The Costeau muskrat is evidently the first one reported from fossil deposits in California. The presumed native muskrat distribution in this state is very limited, occurring only in the extreme northeast, *Ondatra zibethicus mergens* (Hollister), and in the extreme southeast along the Colorado River, *O. z. pallidus* (Mearns). Man, however, has introduced muskrats into other areas in California because of the economically important fur.

The fossil specimen (Fig. 10) measures 43.6 mm in greatest length, 11.5 mm in greatest distal width and 5.7 mm in least width of shaft. These measurements fall within the lower limits of the only widespread living species of *Ondatra.* The only species other than *O. zibethicus* now living is *O. obscurus* (Bangs), which is restricted to the Newfoundland area. Although the fossil femur is similar in size to *O. zibethicus,* it differs from the 52 studied specimens in possessing a distinctly longer third trochanter, one that joins the greater trochanter at its lateralmost extension. Recent specimens have a third trochanter that either does not extend dorsally to the greater trochanter, or else joins it near the base.

Several fossil species of *Ondatra* have been recognized but the descriptions do not include discussions or illustrations of femurs with the exception of one listed by Hibbard and Dalquest (1966: 23) from the Seymour Formation of Texas. The femur discussed by them was found as part of an incomplete adult skeleton, which included the skull, that was identified as *Ondatra annectens* (Brown). This femur, greatest length recorded as 35.5 mm, is six millimeters shorter than the smallest *O. zibethicus* seen.

The Costeau femur, like all comparative material, shows a distinct suture between the shaft and the distal epiphysis. Whether an incomplete fusion of these elements in fully adult forms is related to the muskrat's aquatic habits is not known.

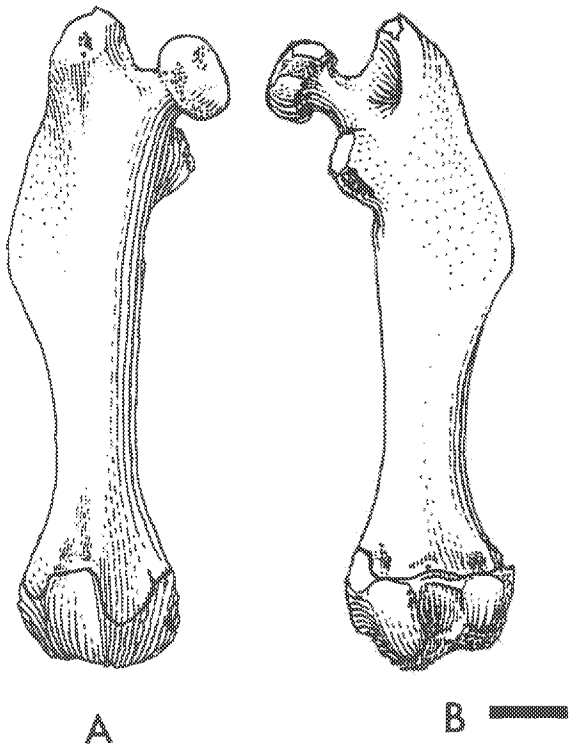


FIGURE 10. *Ondatra*, right femur, LACM 18973, Costeau Pit, Loc. 65129: A, anterior view; B, posterior view. Line beneath figure represents 5 mm.

including a squamosal, two teeth, a jaw fragment, four vertebrae, a partial pelvis, major portions of a humerus, ulna, femur and tibia and a second phalanx, LACM 18217-18226.

Habitat: The coyote is ubiquitous throughout its range of central and western North America.

Discussion: The Costeau coyote was compared with and found indistinguishable from specimens of Recent *Canis latrans*. It was also compared with the large assemblage of this species from the Late Pleistocene brea deposits of southern California and found similar to all. *Canis latrans* is generally recognized as the only species of coyote existing at present; this probably applies to the Late Pleistocene as well (Giles, 1960: 373-375).

Family MUSTELIDAE

Mustela frenata Lichtenstein

Abundance: Two individuals, based on jaws. Three specimens, including two incomplete jaws with dentition, LACM 18215 and 18678, and a complete canine, LACM 18216.

Habitat: The longtail weasel is present in most terrestrial habitats near water from Central America to southwest Canada.

Discussion: Only one species of weasel now inhabits southern California, *Mustela frenata*. The Costeau specimens were compared with this and other species in western North America.

Mustela erminea Bonaparte and *M. rixosa* (Bangs) are much smaller than the Costeau spe-

Order CARNIVORA

Family CANIDAE

Canis cf. *dirus* (Leidy)

Abundance: One individual, based on a P4/ talon, LACM 18214.

Habitat: The habitat of the dire wolf is not definitely known but its remains have been uncovered throughout North America associated with different faunas representing varied habitats.

Discussion: The carnassial fragment (Fig. 11) was compared with all available canid and felid types. It most closely resembles *Canis dirus*. Upon comparison with numerous similar elements it was found to differ slightly from them by lacking a small but distinct posteroventral cingulum.

Canis cf. *latrans* Say

Abundance: Three individuals, based on size of elements and type of preservation. 14 specimens,

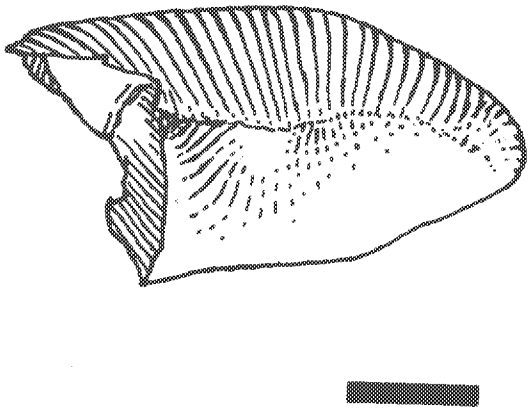


FIGURE 11. *Canis* cf. *dirus*, occlusal view of right P4/talon, LACM 18214, Costeau Pit, Loc. 65129. Line beneath figure represents 5 mm.

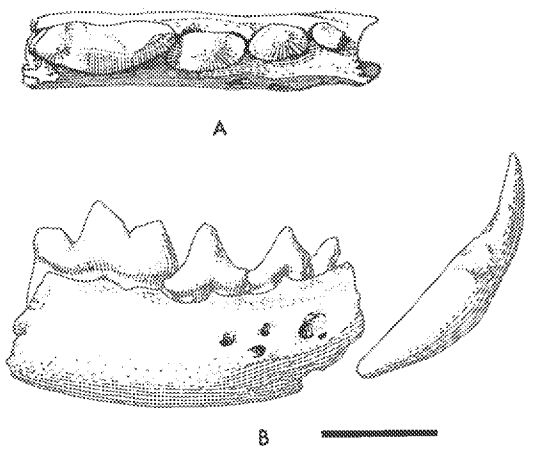


FIGURE 12. *Mustela frenata*, right jaw fragment, LACM 18678, Costeau Pit, Loc. 65129: A, occlusal view; B, lateral view. Line beneath figure represents 5 mm.

cies, while *M. nigripes* (Audubon and Bachman) and *M. vison* Schreber are larger. Only *Mustela frenata* compares favorably in size with the fossil specimens. The single difference noted between the Costeau weasel and those of *M. frenata* used in comparison is the size of the canine in one of the jaws (LACM 18678, Fig. 12). This tooth is distinctly more slender than any of the 34 canines observed. Because the root of this tooth is very large and M/1 shows noticeable wear, it evidently is not deciduous. This is further substantiated by Hall's (1951: 16-17) description and discussion of weasel canines. It is possible that this tooth represents an abnormal condition. The isolated canine recovered from Costeau Pit, LACM 18216, as well as the two incomplete jaws, are indistinguishable from comparative specimens of *Mustela frenata*. This species is known from Late Pleistocene deposits of California including Rancho La Brea where it is the most abundant mustelid (Stock, 1963: 35).

In each instance the weasel specimens from Costeau were recovered with abundant rodent material.

Family FELIDAE

Smilodon cf. *californicus* Bovard

Abundance: Two individuals, based on two incomplete upper canines, one juvenile and one adult.

Habitat: The saber-toothed cat probably lived in varied habitats as suggested by representative fossils recovered from upland caves and fissures and lowland stream and lake deposits and brea accumulations. The Rancho La Brea fauna, which contains an abundance of *Smilodon* material, reflects largely a grassland environment (this has been pointed out previously by Stock, 1963: 30).

That *Smilodon* was primarily a ground rather than an arboreal form is suggested by habits of similar-sized cats (e.g., the tiger and African lion) living today. Also, there is no evidence for more than scattered trees in the Rancho La Brea area during the Late Pleistocene.

Discussion: The adult specimen (LACM 18212) is an upper canine fragment, 56 mm in greatest length, from the area of the alveolar border, as indicated by curvature and lack of enamel. The juvenile specimen (LACM 18213) is a large portion of a deciduous upper canine which measures 66 mm from tip to broken base and is 28 mm in greatest width. It is identical to several of the many milk canines in the Rancho La Brea collection.

Although these deciduous canines have moderately long roots that are closed, they are relatively more hollow and considerably smaller than the ones that replace them. These juvenile canines are also more laterally compressed, unserrated and commonly warped, thus differing further from the replacement teeth. An additional feature found only in the milk canine is a broad sulcus (see Fig. 13) on the lingual side which tapers and shallows distally. This sulcus forms in response to the juxtaposed developing permanent tooth; some illustrations of this can be seen in the plates of the Felidae of Rancho La Brea (Merriam and Stock, 1932).

Order PROBOSCIDEA

Family ELEPHANTIDAE

Mammuthus cf. *columbi* (Falconer)

Abundance: Seven individuals, based on jaw symphyses. 153 specimens, including five skull fragments, numerous tusk fragments, eight jaws, 47 isolated teeth, 43 vertebrae, 22 rib fragments, 14 limb bones and eight foot bones.

Habitat: Based on associated faunas, this widespread species probably occupied primarily grassland and savanna regions.

Discussion: A survey of the literature shows that an intensive review of the mammoths is very desirable. At present there is no agreement on generic names that should be applied (e.g., Slaughter,

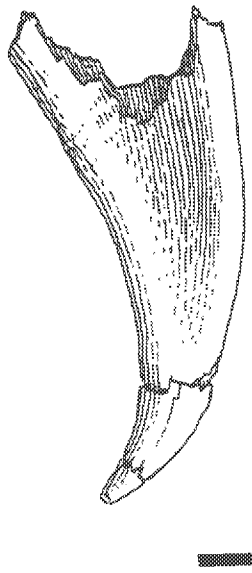


FIGURE 13. *Smilodon* cf. *californicus*, lingual view of left C1/, LACM 18213, Costeau Pit, Loc. 65129. Line beneath figure represents 10 mm.

1966: 79; Webb, 1967; 10; Hibbard and Dalquest, 1966: 29). Of the many specific names assigned to the mammoths probably only a few are valid, as a single tooth may commonly show characters of two and possibly more species. Mammoth teeth from Costeau Pit (Fig. 14) and Rancho La Brea transcend characters given for both *M. columbi* and *M. imperator* (Leidy). This is best typified by third molars.

Some supposed diagnostic features separating *Mammuthus imperator* from *M. columbi* (Falconer, 1863: 43-52; Leidy, 1858b: 29; Osborn, 1942: 1074-1077) are crenulation of enamel ridges, thickness of enamel plates, number of ridge plates per given distance, total ridge-plate count and dentinal expansion at the occlusal center of the ridge plates. The crenulation of enamel is quite variable, at times even in a single tooth. Thick enamel plates are given as a character in the description of the type of each species (Leidy, 1858b: 29 and Falconer, 1863: 45). The number of ridge plates per given distance (usually 100 mm) is problematical; this is because the number will vary significantly depending upon which part of the

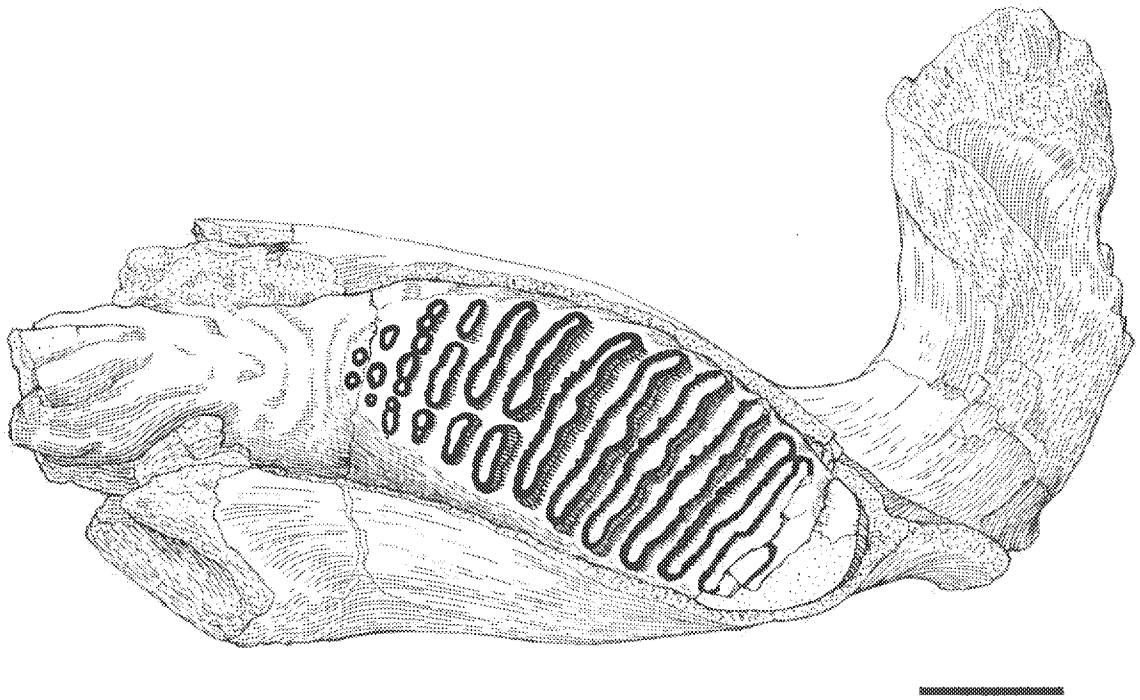


FIGURE 14. *Mammuthus columbi*, occlusal view of mandible, LACM 18677, Costeau Pit, Loc. 65129. Line beneath figure represents 60 mm.

tooth is measured. Commonly, the region of the tooth measured is not stated by the author. The ridge-plate formula for M3/ as pointed out by Savage (1951: 237) is nondistinctive in a separation of these species. Expansion of dentine at the occlusal center of a ridge plate can be faint or distinct in both types.

Since the characters proposed to separate *M. columbi* from *M. imperator* are evidently not diagnostic, it appears that only a single species is represented. If this is substantiated, *M. columbi* (Falconer, 1857) would have priority. Individual variation, age and sex differences might account for all the variability observed in these two species. This possibility has been suggested by E. Gunther (1967, personal communication) and by S. Olsen (1967, personal communication). Falconer (1863: 67) indicated that *M. columbi* and *M. imperator* were one species; and Leidy (1869: 254-255) regarded his own type of *M. imperator* as being conspecific with *M. columbi*.

All the Costeau mammoths seem referable to *Mammuthus columbi*. Those from Rancho La Brea apparently should all be placed in this species, too, rather than in both *M. columbi* and *M. imperator* as is the current situation (Stock, 1963: 50). Specimens from both deposits display the characters given for the type of *M. columbi*.

It was noted during collection of the Costeau fauna that mammoth bones were generally in a worse state of preservation than those of any other animal. In most instances they disintegrated upon removal (juxtaposed bones of other animals were often recoverable). That mammoth bones tend to be poorly preserved may be because of their relatively less dense outer wall.

As also noted in collecting, mammoth jaw symphyses are quite durable. Identification of this element can be important in establishing a minimum individual count. If it had not been for more complete mammoth jaw specimens, two symphyses from Costeau Pit would probably not have been identified. The weakest points of a mammoth jaw seem to be on either side of the symphysis just anterior to the alveoli. This is where all the breaks were made in the fossil specimens. The weight of the jaws when complete with teeth apparently caused a breaking on one or both sides of the symphysis during transport, leaving it attached to a single ramus or as an isolated element. This tendency probably applies to young individuals also, as a Recent specimen of *Elephas* (LACM 0-25), which retains its first deciduous teeth, shows no trace of a suture at the symphysis. If the entire lower mandible of a mammoth is found intact, it probably is indicative of very little transport.

Two mammoth teeth from Costeau Pit warrant special mention. They are unusual in that the transverse diameter is extremely narrow. LACM 25230 is an estimated 200 mm in greatest anteroposterior length (the posterior portion is incomplete) and measures 71 mm in greatest transverse width. Both measurements were taken along the occlusal surface. The corresponding measurements of LACM 18239 are 185 mm (estimate) and 60 mm. Specimen 25230 shows evidence of eleven plates, specimen 18239 shows eight. However, the excessive wear on the posterior part of the last named specimen prevents an accurate determination of the plate count. Each plate of this specimen is not transversely continuous but is divided into two loops. LACM 25230 suggests this division in the anterior six plates, but the posterior ones are continuous. Although both lower teeth are unusual in their narrowness, they are dissimilar enough from each other to represent possibly two individuals (the teeth were found approximately 25 yards apart). Both teeth evidently indicate an abnormal condition and are probably assignable to the one species of mammoth, *Mammuthus columbi*, recognized from this site.

Order PERISSODACTYLA

Family EQUIDAE

Equus Linnaeus

Abundance: 24 individuals, based on upper cheek teeth (excluding P2/ and M3/). Total number of specimens, 798, including a complete skull, 39 skull parts, 464 teeth, 27 jaws, 143 vertebrae, 24 ribs, 12 scapulae, 26 pelves, two humeri, nine femora, three radii-ulnae, five tibiae, five patellae and 38 foot bones.

Habitat: Horses are known to inhabit grasslands throughout much of the world.

Discussion: Horse specimens are more abundant at Costeau than are those of any other large animal. The quantity of equid material lends much support to the supposition that a grassland environment prevailed in the area during the period of deposition.

As indicated above, teeth are numerous, although most are isolated. The range in variation of these teeth, both upper and lower, coincides with that observed in the teeth of the Rancho La Brea horse. The enamel pattern is simple, although in a few specimens a fossette exhibits slight to moderate crenulation. Pli caballins are distinct on approximately one-sixth of the teeth, a figure which closely corresponds to that in the La Brea form. Shapes of protocones are quite variable but, excluding terminal and some deciduous teeth, there is always

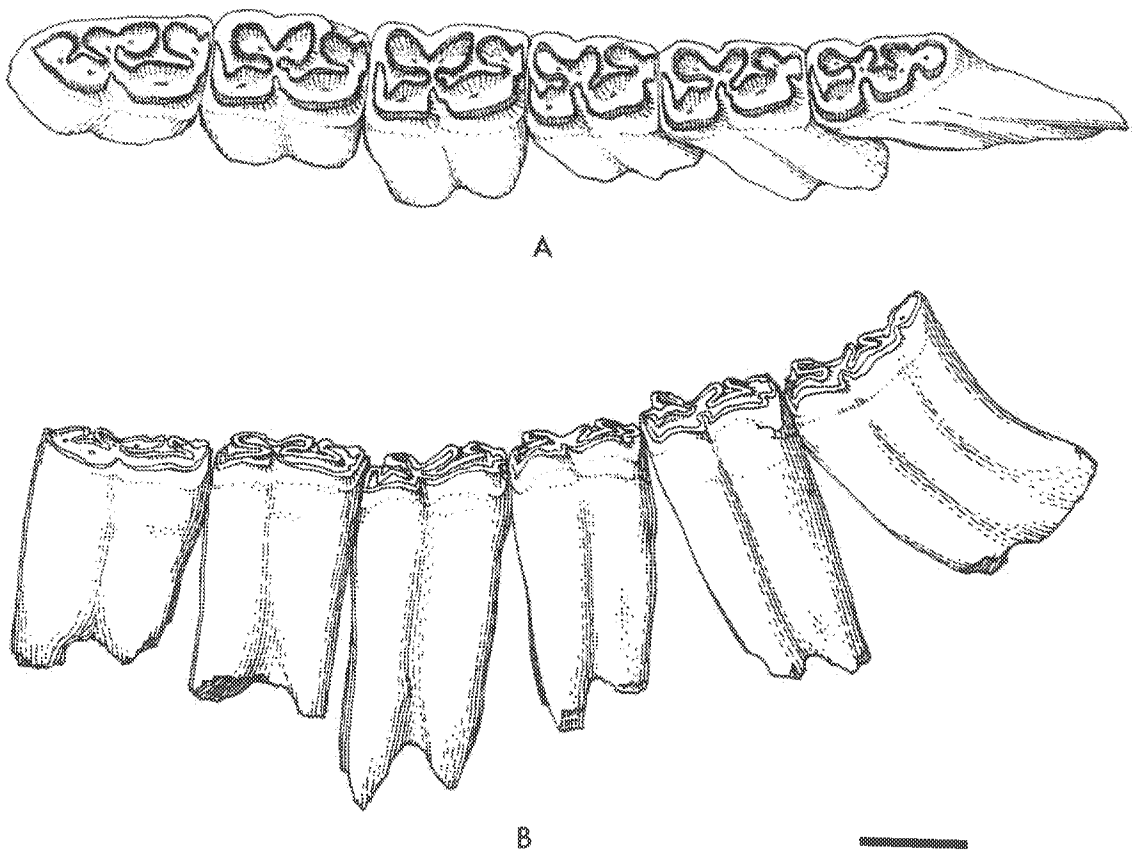


FIGURE 15. *Equus*, left lower cheek-tooth series (P/2 to M/3 inclusive), LACM 20857, Costeau Pit, Loc. 65129: A, occlusal view; B, labial view. Line beneath figure represents 20 mm.

a distinct heel. The anteroposterior length of the protocone diminishes with wear and there is usually a broad, distinct groove along its lingual border.

As in the upper cheek teeth, the lowers have a very simple enamel pattern (see Fig. 15). The metaconid is commonly a little larger and more rounded than the metastylid which usually possesses a posterolingually directed angle. The metaconid-metastylid groove varies from a wide V-shape to a broad U-shape. Pli caballinids are present on a few specimens; these are always single and usually not too prominent. The entoconid generally parallels the metaconid in size and shape. All the abundant postcranial material of the horse, except one vertebra, is identical to that from Rancho La Brea.

Although much has been written concerning Pleistocene horses, a great deal of confusion still persists. This is especially true in the case of the Rancho La Brea horse. Leidy (1865: 94) described a new species of *Equus, E. occidentalis*, on the basis of two teeth. Both were reported as second upper molars (third premolars by current usage); one came from Tuolumne County, California, and the other from an asphalt bed in Kern County, California.[1] Leidy in effect regarded these two

[1]A lower molar (M/3) was also mentioned in association with the second upper molar from the asphalt deposit. The few measurements and meager description that Leidy gave, however, concerned only the upper teeth.

teeth from different localities as co-types. However, Merriam (1913: 413-414), the first person to refer the Rancho La Brea horse to *Equus occidentalis* (his identification was based on the simple enamel pattern and size of the cheek teeth), stated that Leidy based this species on just the Tuolumne County specimen. He further said that Leidy later referred the Kern County material to the type. Apparently, Gidley (1901: 114) was the first person to formally designate a single type from the two co-types. He selected the Tuolumne specimen because it had been figured. Merriam (1913: 410) indicated two specimens in a table of measurements despite the fact that he recognized just one elsewhere in the article (p. 414). The matter is further complicated because he lists one of the types as an M2/, the other as a P3/.

Leidy (1869: 267) synonymized *E. occidentalis* with his earlier named (1858) *E. excelsus*, stating that the types could not be distinguished. However, Gidley (1901: p. 115) felt that both species should be recognized. His reason for separating them was based almost entirely on geographical differences (*E. occidentalis* from California, *E. excelsus* from Nebraska). He mentioned that *E. excelsus* had a slight tendency for greater enamel plications, but elsewhere in the article it was stated that this is a variable factor. Later Savage (1951: 247) considered *Equus excelsus* a *nomen vanum*.

Savage (1951: 246) stated that the La Brea horse shows a remarkable likeness to *E. occidentalis* but should be considered a true caballine as demonstrated by the character of its deciduous dentition. Azzaroli (1966: 4), commenting on the horse from Rancho La Brea, said that it shows a remarkable relationship in skull features to the hippotigrine zebras. Willoughby (1967, personal communication), in his detailed study of the genus *Equus*, assigned the La Brea equid, because of its very strong zebrine affinities, both cranially and postcranially, to a new subgenus, *Equus (Quaggoides)*, which includes the living burchelline zebras. He does not discuss the validity of retaining the specific designation but follows earlier workers who have referred the Rancho La Brea horse to *E. occidentalis* (Merriam, 1913; Stock, 1963, and others).

A new genus of equid, *Amerhippus*, was proposed by Hoffstetter (1950) to include all the Quaternary horses of California and South America, excluding *Hippidion*-like forms; *(Equus occidentalis* was renamed *Amerhippus occidentalis*, p. 442 in this article). The only character used by Hoffstetter to distinguish *Amerhippus* from *Equus* was the absence of the enamel-lined pit or "lake" in all lower incisors, permanent and deciduous. I believe this single character does not justify the erection of a new genus. Also, according to Quinn (1957), the absence of enamel-lined pits in the lower incisors, ". . . has occurred in species of *Hippotigris, Onager* and probably *Equus*."

The Costeau Pit horse and most others from the vicinity of the Los Angeles basin are evidently specifically similar to the one at Rancho La Brea. And as Savage (1951: 252) has indicated, the La Brea horse is probably a distinct species. Since the type of *Equus occidentalis* is a single tooth from an unknown deposit, it seems best to relegate this species to a status of *nomen dubium*. It is here suggested that, if a new species is designated to include the horse from Rancho La Brea, the type specimen selected should be that of the best adult skull and jaws in that collection.

EQUIDAE, (gen. indet.)

Abundance: One individual. Two specimens, including a lower molar, LACM 18846, and a partial vertebra, LACM 18847.

Discussion: A problematical lower molar of a small equid is present in the Costeau fauna. Although the posterior edge is missing, there can be no doubt that it represents a smaller horse than the characteristic one from the fossil site (Fig. 16). The estimated greatest anteroposterior length is 21.0 mm and the transverse width is 13.1 mm. A simple enamel pattern is evinced. The metaconid-metastylid groove is very shallow and presents a wide V-outline. The metaconid and metastylid are subequal, with the latter a little smaller and slightly angular. The hypoflexid extends nearly to the metaconid-metastylid isthmus (this character was found to be highly variable in comparative material).

Equus conversidens Owen apparently represents the smallest North American species of this genus (Hibbard, 1960: 191, synonymized *E. littoralis* Hay and *E. francisci* Hay with *E. conversidens*). The Costeau tooth was compared with the abundant material of this species from San Josecito Cave in Mexico. While it compares favorably in anteroposterior length to the San Josecito teeth, the transverse width is less than the smallest of these by 2.0 mm (stream abrasion has worn some of the outer margin on the Costeau tooth, however). One other difference between the two types is a much more angular metastylid in all *E. conversidens* specimens seen. To date no *E. conversidens* has been reported from California, although it may be present in some of the State's cave deposits, (Downs et al., 1959: 9-11; and Sinclair, 1904: 21).

The Costeau molar has slightly thicker enamel

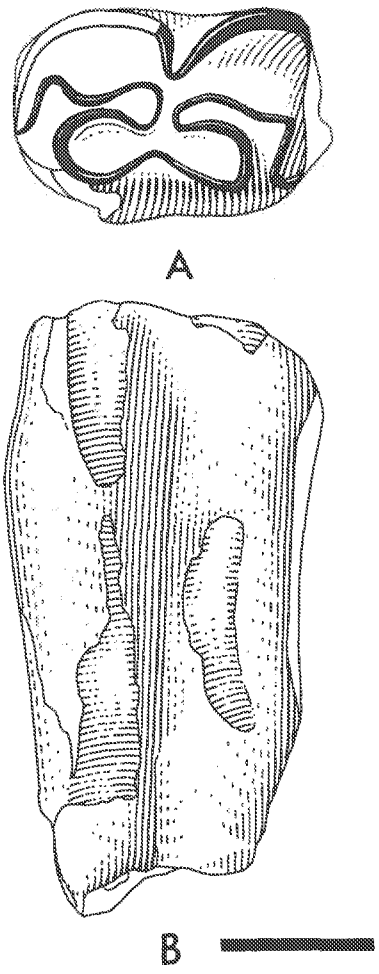


FIGURE 16. Small equid, right lower molar, LACM 18846, Costeau Pit, Loc. 65129: A, occlusal view; B, labial view. Line beneath figure represents 10 mm.

on the labial border and the metaconid-metastylid groove is less pronounced but otherwise it also closely resembles specimens of *Nannippus*. This genus has been recorded in the Pliocene (Clarendonian) of southcentral California (Stirton, 1940: 186) but never in the state's Pleistocene deposits.

As mentioned previously, the tooth is waterworn. It is therefore possible that the specimen was redeposited from older sediments. Only marine beds are exposed around the perimeter of the Costeau area but land mammals are occasionally found in deposits of this type.

An incomplete anterior thoracic vertebra, LACM 18847, of a small equid is also present in the fauna. This specimen may belong to the same type of equid as represented by the small tooth. Some stream wear is evident on this vertebra also but it does not exceed that seen on numerous other specimens from the site.

Order ARTIODACTYLA
Family CAMELIDAE
Camelops cf. *hesternus* (Leidy)

Abundance: Three individuals, based on size of elements. 38 specimens, including one maxillary fragment, five teeth, 19 vertebrae, one scapula fragment, six pelvic fragments, one incomplete humerus, femur, radius-ulna and tibia, a malleolus, a scaphoid and a proximal phalanx.

Habitat: According to Hibbard and Taylor (1960: 186), *Camelops* inhabited open shrub and grassland country. Its frequent association with animals that typically inhabited these areas seems to substantiate this.

Discussion: Camel specimens from Costeau Pit were compared with those from Rancho La Brea, McKittrick and other faunas, mostly from California. They apparently agree with *Camelops hesternus* from these localities as no significant differences were observed in any element. According to Webb (1965: 1), *C. hesternus* is near the upper size limit for the genus. One lumbar vertebra, LACM 18681, from Costeau is slightly longer (greatest anteroposterior length of centrum 87 mm) than any of the comparative vertebrae. Since lumbar vertebrae are not abundant in the collections of the Los Angeles County Museum of Natural History and the size difference is small, it is probable that the Costeau element lies within the size limits of the species.

It is generally accepted that the most diagnostic features distinguishing various species of camels concern the skulls and jaws. Since material of this type is very scarce in the present fauna, the specific identification given it tentative.

Tanupolama Stock

Abundance: One individual. Three specimens, including a premolar fragment, LACM 19010, an unciform, LACM 19009, and a proximal phalanx, LACM 15225.

Habitat: Probably open shrub and grassland, based on associated faunas (e.g., McKittrick fauna; see Schultz, 1938).

Discussion: Tanupolama remains seem nowhere to be abundant except at the McKittrick deposits

where the genotypic species, *Tanupolama stevensi*,[1] was selected (Stock, 1928). Since the total fauna at this locality suggests a grassland environment (Schultz, 1938) and as *Tanupolama* is abundant there, it might be surmised that this camel was principally a grazing form. Its teeth, too, reflect a grazing habit. Caution should be used in judging an animal to be a grazing or browsing form on the basis of teeth alone, however. Estes' (1967) study of living antelopes in Africa shows that two closely related species, *Gazella granti* and *G. thomsonii*, have different ecological requirements. The former is chiefly a browser, the latter a grazer. Yet, as would be expected, the dentitions of these two species are nearly identical; both have hypsodont molars.

Only three genera of camels are currently recognized (Webb, 1965) from post-Blancan deposits in North America: *Tanupolama, Camelops* and *Titanotylopus* (a fourth type, slender and extremely long-limbed, from the Vallecito fauna of southern California is as yet unreported in the literature). The Costeau specimens resemble *Tanupolama* and differ from other genera of camels in their much more slender build and smaller size.

Family cf. CERVIDAE

One ungual phalanx, LACM 19011, is present in the Costeau fauna that could belong to a cervid about the size of a small *Odocoileus* (greatest anteroposterior length, 30.4 mm, greatest transverse width, 09.5 mm, greatest dorsoventral height, 16.7 mm). This specimen resembles *Odocoileus* more than *Tetrameryx* or *Antilocapra* in its relatively narrow dorsoventral dimension. It greatly exceeds *Capromeryx* in overall size.

As the ungual phalanx in cervids and antilocaprids is evidently not a diagnostic element, the identification of the Costeau specimen will have to remain in doubt.

Family ANTILOCAPRIDAE

Capromeryx Matthew

Abundance: Two individuals, based on stage of tooth wear; an M1/, LACM 19012, and an M/3 (Fig. 17), LACM 19013.

Habitat: Based on associated faunas and the habitat of the living pronghorn, this diminutive antilocaprid probably occupied open sage and grassland regions.

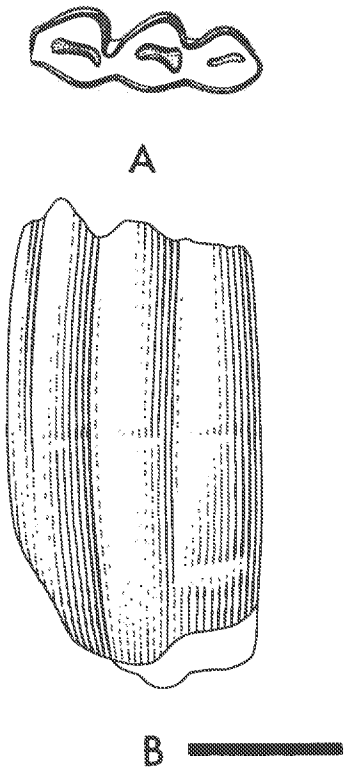


FIGURE 17. *Capromeryx*, right M/3, LACM 19013, Costeau Pit, Loc. 65129: A, occlusal view; B, lingual view. Line beneath figure represents 10 mm.

Discussion: A study of the various types of antilocaprids shows that teeth are not diagnostic in distinguishing species and, in some instances, even genera. This view is supported by Stirton (1932: 49-51), Colbert and Chaffee (1939: 8), Savage (1951: 273) and others. Consequently, only a generic identification seems justified on the basis of the present material. The very small size of the recovered teeth seems to exclude them from all Pleistocene genera except *Capromeryx*. Although the genus *Breameryx* was proposed by Furlong (1946: 137) for the tiny antilocaprid from Rancho La Brea, it seems most likely that it is synonymous with the earlier described *Capromeryx* (Matthew, 1902: 318). This opinion has also been expressed by Schultz and Stout (1948: 566), Hibbard and Taylor (1960: 188-189) and D. E. Savage (1965, personal communication).

[1]Hibbard and Dalquest (1962: 88) proposed synonomy for *Tanupolama stevensi* with *T. macrocephala*. However, Webb (1965: 34-35) in his work on Pleistocene camels recognized each as a distinct species.

Both Costeau specimens show only a slight amount of wear on the occlusal surface; M/3 (LACM 19013) shows the most. The greatest anteroposterior diameter on the occlusal surface of this tooth is 15.6 mm; the M1/ (LACM 19012) measures 09.6 mm for this same dimension. The greatest transverse width at the occlusal surface is M/3, 05.5 mm and M1/, 06.0 mm.

Family BOVIDAE

Bison Smith

Abundance: Ten individuals, based on nine right lower third molars (all showing wear) and one unworn right upper third molar. 292 specimens, including most skeletal elements.

Discussion: Two species of *Bison* exist in the Costeau fauna, *Bison latifrons* and *Bison antiquus*. To my knowledge, there is but one other report of the joint association of these genera in one fauna (Miller, 1968). Most of the specimens from Costeau Pit are assignable to *B. latifrons*, a number are specifically indeterminate (mostly fragments), and a few belong to *B. antiquus*. The descriptions as well as the measurements of the material (Figs. 44-127 and Tables 2-15) show that *B. latifrons* can be distinguished from *B. antiquus* in most, but not all, postcranial elements.

The *Bison* specimens from Costeau Pit were compared with the known North American species of this genus. This was done by direct comparison of material in the collections of the Los Angeles County Museum of Natural History and by consulting numerous descriptions and illustrations in the literature; the comprehensive work by Skinner and Kaisen (1947) was extensively used. Some material was compared with that in the collections of the Museum of Paleontology at the University of California.

In comparing species of *Bison* it was discovered that *B. chaneyi* (Cook) does not differ significantly from *B. alleni* (Marsh). This was first noted by Dalquest (1957: 350-351). Skinner and Kaisen (1947: 197-198) use the first-named species as the subgenotype of *Bison (Platycerobison) chaneyi*. As Dalquest pointed out, when the descriptions and discussions of *B. alleni* and *B. chaneyi* are compared, there is little distinction left. As I have found, of the measurements given by Skinner and Kaisen for *B. alleni* (1947: 184) and *B. chaneyi* (1947: 198) only two, spread of horn-cores and width of cranium between horn-cores and orbits, fail to coincide with each other. The first of these two measurements cannot be compared between the two holotypes as the one for *B. alleni* is just a single horn-core. The specimens referred to this species have a greater horn-core spread than *B. chaneyi* but the difference is slight (*Bison alleni* minimum spread, 1100 mm; spread of the holotype of *B. chaneyi*, 1071 mm). Also, only five specimens of *B. alleni* are used in comparison. The second of the two measurements also could not be made between holotypes. Using referred specimens again (five) for this measurement, width of cranium between horn-cores and orbits, *B. alleni* is found to be only a little larger than *B. chaneyi* (*B. alleni* minimum distance, 334 mm; distance in holotype of *B. chaneyi*, 325 mm). Skinner and Kaisen (1947: 199) state that one of the major characters separating these two species is the much greater dorsoventral compression of the horn-cores of *B. chaneyi*. However, their figures show (p. 184-198) that this compression is greater in some specimens of *B. alleni* than in the holotype of *B. chaneyi*! The geographic range of species given by Skinner and Kaisen (1947: 154) shows that the holotype of *B. chaneyi*, which is from northern Texas, is very close to the southern range of *B. alleni*, which is from southern Oklahoma. These authors indicate that the two species were contemporaneous. Additional specimens have been referred to *B. chaneyi* by Hibbard and Villa (1950: 245), Hibbard (1955: 74-75), Slaughter and McClure (1965: 412) and Slaughter (1966: 86).

It appears quite doubtful that *Bison chaneyi* should be recognized as a separate species. I regard it as a synonym of *B. alleni*.

Bison latifrons (Harlan)

Abundance: Five individuals, based on the seventh cervical vertebra. 134 specimens, including one incomplete skull, 12 incomplete horn-cores, three mandibles, 68 vertebrae, two sacra, four scapulae, two humeri, five radii, two proximal ends of ulnae, three femora, four tibiae, six metapodials and 24 foot elements. Teeth are not used in determining the minimum number of individuals at the species level because it was found that those of *B. latifrons* and *B. antiquus* usually could not be differentiated with certainty. However, since the great majority of elements are referable to the former species, it is very probable that the teeth are also.

Habitat: Based on the habitat of the living bison, *B. latifrons* occupied grassland areas.

Discussion: The presence of *B. latifrons* at Costeau marks the second occurrence of this species in southern California. It has previously been identified at Rancho La Brea (Wyman, 1926: 32 and Miller, 1968: 4). The Costeau assemblage represents the largest sample of this species reported from a single locality. Unreported deposits from sediments around American Falls reservoir

in Idaho may contain more, but both *B. alleni* and *B. latifrons* occur and are undifferentiated postcranially (M. Hopkins, 1968, personal communication). *Bison latifrons* is also rarely associated with as large a number of species of other mammals as occurs at Costeau Pit.

Recognition of *Bison latifrons* in the Costeau fauna is based primarily on horn-cores, the chief means for distinguishing species of *Bison* (Skinner and Kaisen, 1947: 132), and secondarily on the very large size of the elements. The largest horn-core fragment (LACM 15461, Fig. 18) represents a section of which some of the tip and much of the base are lacking. It measures 560 mm along the lower curve and the vertical and transverse diameters at the broken basal section are 115 and 118 mm respectively; the basal circumference is 370 mm. The proximal end of this specimen is broken well above the area of attachment to the skull, as indicated by the interior bony structure (the strong bony partitions that interconnect to form relatively large spaces are lacking, only cancellous bone is present, see Figs. 18 and 19) and by the estimated diameter of specimen LACM 16060 (Fig. 19). This last mentioned specimen is a basal fragment of a horn-core with a projected circumference of 480 mm. This measurement agrees very closely with the one given by Skinner and Kaisen (1947: 205) for the average *B. latifrons* (listed at 481 mm).

Specimen LACM 15461 was compared with a cast of *Bison latifrons* from Florida (UF 2263) which represents a broken male skull with both horn-cores. It cannot be distinguished from a horn-core section of this cast. A similar dorsal flattening of the horn-core near the distal end and pronounced furrows are present in both specimens. These features were also observed in a nearly complete skull from Shasta County, California, in the Museum of Paleontology at the University of California. This skull was described by Vanderhoof (1942).

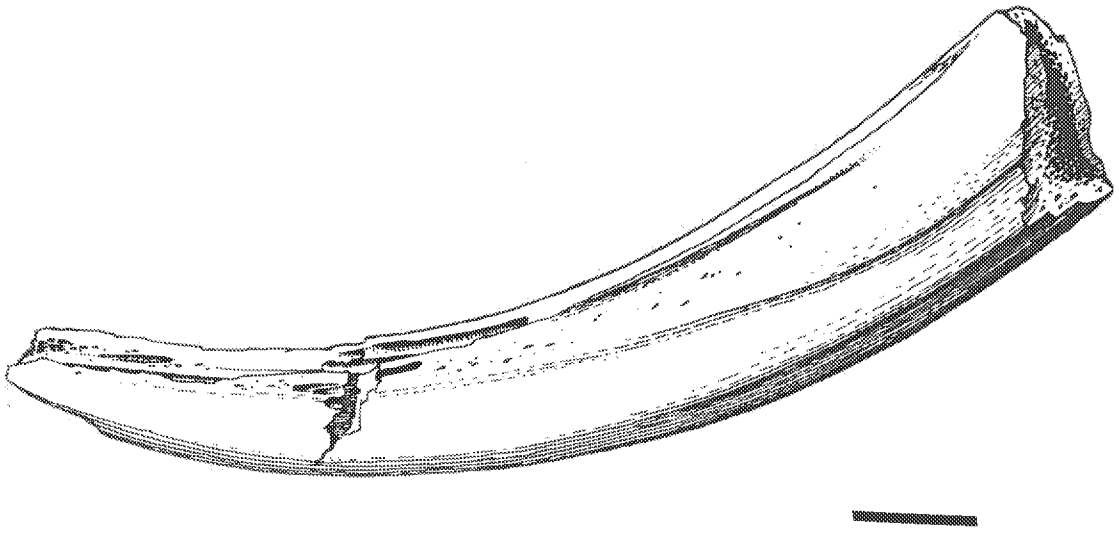


FIGURE 18. *Bison latifrons*, horn core, LACM 15461, Costeau Pit, Loc. 65129. Line beneath figure represents 60 mm.

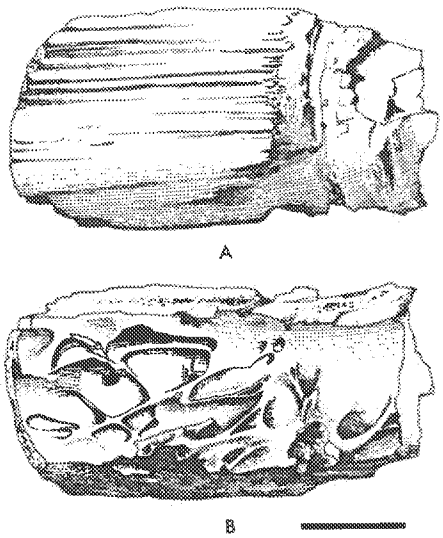


FIGURE 19. *Bison latifrons*, horn core, LACM 16060, Costeau Pit, Loc. 65129: A, external view of base; B, internal view of base. Line beneath figure represents 60 mm.

The horn-cores from Costeau are not referable to *Bison crassicornis* (Richardson) as LACM 15461 has a minimum restored length along its upper curve of 860 mm. *B. crassicornis* has an average length for this same measurement of 409 mm; its maximum is 610 mm (Skinner and Kaisen, 1947: 188). This species is known only from Alaska and northwest Canada, although there is a possibility of the occurrence of one specimen in Massachusetts (Romer, 1951: 230). *B. alleni*, which is second in size of horn-cores to *B. latifrons*, has an average length of horn-core along the upper curve of 561 mm and a maximum of 720 mm (Skinner and Kaisen, 1947: 184). Even though the extreme tip of the horn-core of the largest Costeau specimen is missing, it still is not as blunt as the tips in *Bison alleni*. The unrestored length of LACM 15461 from Costeau Pit exceeds that of the remaining species of *Bison*.

A posterior portion of a skull from Costeau containing the basal section of the left horn-core, LACM 19055, apparently represents a relatively small female as evidenced by its lack of massiveness, slight protuberance of orbits, smooth surfaces and lack of a distinct horn-core burr or deep horn-core striations. Complete fusion of sutures demonstrates that this specimen is an adult. Its left horn-core is broken 198 mm above the base along the upper curve. At this point the circumference is 240 mm. The circumference at the base of the horn-core is 322 mm. The transverse diameter at the base of this core is 100 mm and its vertical diameter is 93 mm. The width of the cranium between horn-cores and orbits is 275 mm. This incomplete female skull was compared with all the female and male skulls of *Bison antiquus* from the Rancho La Brea collection at the Los Angeles County Museum of Natural History. While it is not as large as the largest male skulls, it does surpass the largest female ones. In the La Brea forms, male and female, the horn-cores are depressed and the tips either do not rise above the plane of the frontals or else exceed them but little. The Costeau specimen has a core that is not depressed and extends 60 mm above the plane of the frontals before the break. At this point the circumference is greater than the largest *Bison antiquus* males. If the horn-core was complete, the height above the frontals would undoubtedly be much more. All indications are that the restored length of the horn-cores would be much greater than in *B. antiquus*. The female skulls from the Rancho La Brea deposits all had a greater vertical than transverse dimension at the core base. The Costeau specimen evinces a vertical measurement here that is noticeably less than the transverse.

Skinner and Kaisen (1947: 206) state that no female skulls of *Bison latifrons* are known; subsequent literature also does not indicate any females of this species. It is possible that the incomplete female skull recorded at Costeau represents this species, although it is unexpectedly small. It is doubtful, however, that no female skulls have been found, as this sex outnumbers the males in living herds of *Bison* (Palmer, 1954: 310). And in the Rancho La Brea collection (LACM) there are 27 female skulls but only 11 males. Possibly female skulls of *B. latifrons* have been misidentified.

The incomplete female skull from the Costeau site is thought possibly to be *Bison latifrons* on the basis of the identified associated male specimens and the marked dissimilarity to either female or male *B. antiquus* skulls. Since fossil species of *Bison* are based on male skulls, it is not possible to identify this specimen with certainty. However, it seems very doubtful that three species of *Bison* would coexist in a single, temporally restricted deposit. Occurrence of two species of this genus in one deposit is rare.

Since identified postcranial elements of *Bison latifrons* are so uncommon, it seems advisable to include here descriptions of as many as possible in addition to detailed measurements (Figs. 44-127 and Tables 2-15). Specimens of *Bison antiquus* from Rancho La Brea are used for a comparison and detailed measurements of them are also included (although only adult specimens are represented in the measurements, it was observed that most of the *Bison* material in the Museum's collection is juvenile). Also, the few *B. latifrons* specimens from Rancho La Brea are included.

Atlas: Four atlas vertebrae have been recovered from Costeau, one complete, LACM 15218, one nearly complete, LACM 18284, and two fragmental, LACM 15438 and 18333. One complete specimen occurs in the Rancho La Brea fauna, LACM Y 6737.

Bison latifrons atlases are disproportionately large as are the cervicals in general. This is evidently in response to the greater need for muscle attachments to support the very heavy head. Although the structure is generally as in *B. antiquus,* it differs in possessing posteriorly expanded wings which present a trapezoidal rather than a rectangular form (dorsal and ventral view). This element is more rugose in the larger species and the dorsal and ventral tubercles are usually much more pronounced.

Axis: Two specimens are present in the Costeau fauna, LACM 18334 and 18335. One complete axis is present in the Rancho La Brea fauna, LACM Y 6734.

The axis, like the atlas, is much larger than in *B. antiquus.* It differs also by its relatively taller neural spine whose anterior surface is much steeper. The rugosity, too, is more pronounced in the larger species.

Seventh cervical vertebra: Five specimens, LACM 18375-18378, and one from a private collection, have been recovered from the area of study. Two have complete neural spines (LACM 18375, 354 mm in greatest length of spine; the specimen from a private collection, about 340 mm long). Surprisingly, they are not as long as those on the distinctly smaller vertebrae of *Bison antiquus.* Although no anterior thoracic vertebrae from Costeau have complete neural spines, it appears from the parts present that they, too, would not be as long as similar elements in *B. antiquus.* VanderHoof (1942: 11) identified a third or fourth thoracic vertebra from northern California as belonging to *B. latifrons.* He gave the measurement of the complete neural spine as 685 mm, which is noticeably shorter than several observed in corresponding elements of *B. antiquus,* several of which in the Rancho La Brea fauna averaged about 800 mm. The reality of shorter neural spines in the shoulder region indicates a lesser hump for *B. latifrons* than for *B. antiquus.*

The general appearance of the seventh cervical, along with other anterior vertebrae, offers a markedly more massive structure than a comparable element in *B. antiquus.* A relatively greater rugosity is again noted on the neural spine for the larger species.

Fifth (last) lumbar vertebra: Two specimens, both nearly complete, are present in the fauna, LACM 18580 and 18581.

As in other lumbar and in posterior thoracic vertebrae, there is a size overlap between the two species of *Bison.* However, *B. latifrons* is larger in average size. The fifth lumbar (as well as other posterior vertebrae) is noticeably less rugose than are anterior vertebrae and is similar in texture to the corresponding element in *B. antiquus.* It can be seen in Figs. 76-81 that this bone is more variable than the other ones measured.

Scapula: Three proximal sections of scapulae have been recovered, LACM 18582, and two from a private collection. One is also present in the Rancho La Brea collection, LACM Y 6738.

Available material suggests no overlap in size between the two present species of *Bison.* The relative proportions of this bone are apparently the same, however.

Humerus: One complete element, LACM 15217, and one fragment, LACM 19056, have been collected. One specimen from Rancho La Brea probably is assignable to *B. latifrons.*

The configuration of this bone appears to be identical with that in *B. antiquus,* disregarding its greater rugosity. However, its size distinctly exceeds the humeri in that species.

Radius: Two complete specimens, LACM 15221 and 18638, and two incomplete ones, LACM 18639 and 18640, exist in the fauna.

As was true of the humerus, the radius differs from that of the smaller species by its distinctly larger size and greater rugosity. One measurement, least anteroposterior width of shaft (Table 9), indicates a slight size overlap between the two species.

Metacarpal: A single complete bone, private collection, and a distal fragment, LACM 18579, exist in the fauna.

The limited evidence of this bone suggests that it is only slightly longer than the corresponding one of *Bison antiquus.* Seemingly the biggest difference between the species exists in the greater shaft width of *B. latifrons* (Table 10).

Femur: Five incomplete femora have been re-

covered, LACM 18416-18418, 19057, and one in a private collection.

The lesser trochanter is more pronounced than in *B. antiquus* but the overall size and the rugosity are similar in the two types. Although no complete femur is present in the Costeau fauna, the available measurements (Table 11) suggest that this bone is not appreciably longer than the femur of the smaller species.

Tibia: There are three incomplete specimens from the fauna, LACM 15216, 18422 and 18423.

The tibia, like the femur, does not appear to be much larger in *B. latifrons*. Evidently, the configurations of this element in the two species are identical.

Astragalus: Two complete astragali, LACM 18488 and one in a private collection have been recovered. A third, LACM 18489, probably represents a juvenile and is not included in the measurements (Table 13).

This element, like the others of the posterior limb, is not much larger than astragali of *B. antiquus*. Some overlapping in size occurs between the two types. The greatest difference between them appears to be the relatively thicker (anteroposteriorly) astragalus of *Bison latifrons*.

Metatarsal: Three specimens represent this element, LACM 18424, and two in a private collection.

The length of the complete metatarsal is very little longer than the average noted for *B. antiquus* in the Rancho La Brea fauna (275 mm as compared to 272 mm). The greatest difference between species is the greater mediolateral width of *B. latifrons* metatarsals.

Ungual phalanx: A single complete hoof, LACM 15222, is all that has been recovered. It is noticeably larger than any of the ungual phalanges seen of *B. antiquus* but it is of similar proportions.

As the anterior postcranial elements of all the bison from Costeau and Rancho La Brea fell into two distinct, nonoverlapping groups, it is assumed that all but three specimens from the former locality are referable to *Bison latifrons* on the basis of their much larger size. However, since there is some size overlap in the posterior elements, there could conceivably be additional specimens in the Costeau fauna that represent *B. antiquus*. Because of the extremely high ratio of *B. latifrons* material to that of *B. antiquus* in the easily separable anterior elements, I believe that unrecognized remains of the latter species in the fauna are rare. The relatively greater mediolateral width of posterior limb elements also helps to distinguish the hindquarters of the two species.

The available data indicate that in life *Bison latifrons* was distinctly more massive and taller than *B. antiquus* in the forequarters but only slightly so in the hindquarters, suggesting an animal of somewhat different proportions. This difference in proportions might have been minimized, though, by the presumably higher hump in *Bison antiquus*. It is generally assumed that *B. latifrons* was the largest bison to have lived (Skinner and Kaisen, 1947: 206). Although this may be true, there is a definite possibility that another type was larger. The measurements given by Skinner and Kaisen (1947: 134) of an assemblage of metacarpals and metatarsals, mostly belonging to *Bison crassicornis*, include many that are larger than those recorded here of *B. latifrons*. Among domestic cattle the Texas Longhorn has by far the greatest horn spread, yet it is not the largest form. This may also apply to *Bison latifrons*.

Bison antiquus (Leidy)

Abundance: One individual. Four specimens, including a horn-core, LACM 19058, an anterior thoracic vertebra, LACM 19059, a proximal end of a scapula, LACM 18583, and a second phalanx, LACM 18680.

Habitat: Probably grassland as indicated by the living bison and associated animals in fossil assemblages.

Discussion: Presence of *Bison antiquus* in the Costeau fauna is demonstrated by a major portion of a horn-core (Fig. 20). It measures 240 mm along the upper curve from tip to broken base. The circumference at the basal break is estimated at 260 mm. As indicated by the internal bony structure here, the break occurred not far from the basal burr.

The incomplete horn-core exceeds living bison in size and differs from the other two species of *Bison* which have comparable-sized horn-cores, *B. occidentalis* Lucas and *B. preoccidentalis* Skinner and Kaisen, by lack of any twisting. *B. preoccidentalis* is known only from Alaska and *B. occidentalis* is not positively known in California (Skinner and Kaisen, 1947: 173, mention a single possible occurrence). The Costeau specimen, probably a male as demonstrated by its size and configuration, was compared to all available *B. antiquus* horn-cores and found to compare favorably with them. It is not as strongly curved as most specimens observed but does exist within the variability noted.

The scapula fragment is listed in the table of measurements (Table 7). The thoracic vertebra and second phalanx are slightly smaller than the majority of similar elements with which they were compared. Nevertheless, they are well within the limits of variation seen for *Bison antiquus*.

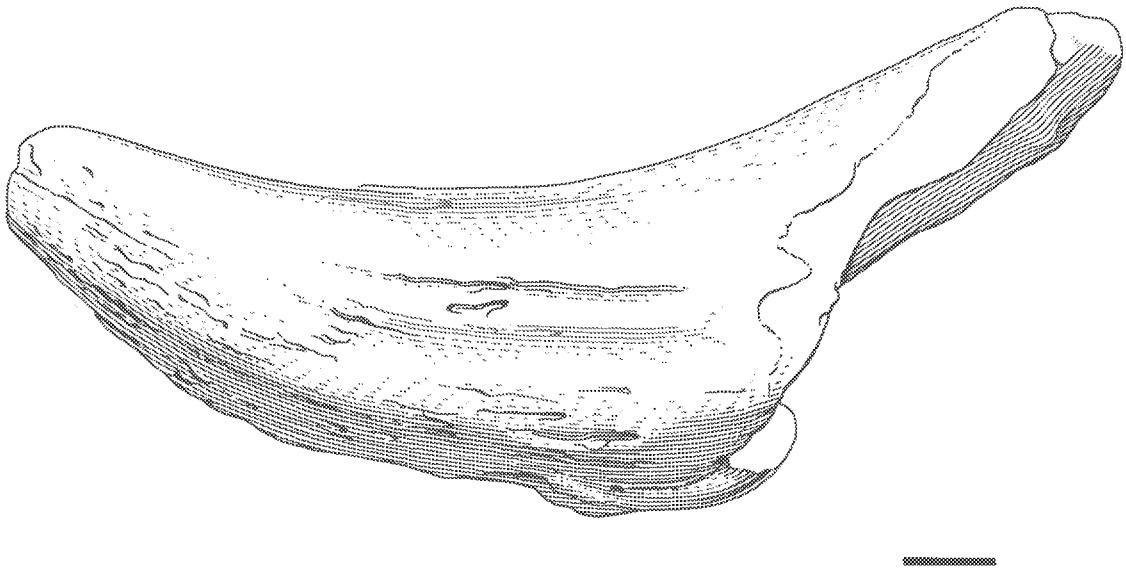


FIGURE 20. *Bison antiquus,* horn core, LACM 19058, Costeau Pit, Loc. 65129. Line beneath figure represents 20 mm.

Age and correlation of the Costeau fauna

Age: Radiocarbon dates based on wood samples indicates that the age of the Costeau fauna is greater than 40,000 years B.P. (Geochron Laboratories, Cambridge, Mass.); just how much greater is not known. However, the presence of *Bison,* as well as of all the species of small mammals still having living representatives, indicates a Late Pleistocene (Rancholabrean) age. That the genus *Bison* is a guide to the Late Pleistocene was first suggested by Savage (1951: 277) and later by Savage, Downs and Poe (1954: 57), Hibbard et al. (1965: 513) and others. *Bison latifrons* is thought to be indicative of a Kansan age according to Schultz and Frankforter (1946: 8) and Prescott (1951: 81). An opposing view is taken by Savage (1951: 277) and Hibbard (1955: 221) who state that the presence of bison in North America cannot be demonstrated before the Late Pleistocene. Several investigators (Stephens, 1960, Dalquest, 1961, and Green, 1962) indicate *B. latifrons* had a probable chronologic range of Illinoian through Sangamon. Green (1962: 559) reports "all the available evidence indicates that *Bison latifrons* has a temporal range from Illinoian through Sangamon." Dalquest (1961: 77-78) arranges the North American bison into three groups: giant forms, *B. latifrons, B. alleni* and *B. chaneyi;* medium-sized forms, *B. antiquus* and *B. occidentalis;* relatively small form, *B. bison.* According to this author, "the three size groups seem to be well separated in time; giant forms in the Sangamon, medium-sized species in the Wisconsin and the relatively small buffalo in the Recent." The occurrence of *Bison latifrons* and *B. antiquus* in the Rancho La Brea and Costeau faunas demonstrates a temporal overlap between these two species. Their joint association in Pit 4 of the first-named fauna is dated (unpublished work currently being done at the UCLA Radiocarbon laboratory) at 28,000 years B.P., which supports the existence of *B. latifrons* in later Wisconsin time. A date of 32,000 B.P. for *B. latifrons* in Idaho has been recorded by Hester (1960). Radiocarbon dates indicate that the Costeau fauna is older than the typical deposits of Rancho La Brea (as shown in Stock, 1963). This suggests that *Bison latifrons,* which is very abundant at Costeau and scarce at Rancho La Brea, was the earlier of the two species of *Bison* in the Los Angeles area

and probably was displaced by *B. antiquus*. To my knowledge, the latter species has not been reported from deposits older than Wisconsin.

The presence of *Tanupolama* at Costeau possibly has temporal significance. Its very scarce but definite representation occurs in a few deposits in and adjacent to the Los Angeles basin; Rancho La Brea (Miller, 1968), Newport Beach and San Pedro. Each occurrence is represented by a date in excess of 40,000 years (Costeau Pit, in this report; Rancho La Brea (Pit 9), Berger and Libby (1966: 492); San Pedro (Palos Verdes Formation and equivalent beds at Newport Beach). Fanale and Schaeffer (1965: 314) and unpublished reports). Possibly *Tanupolama* might have been absent in the Los Angeles area during the Late Wisconsin. However, this genus is present at the McKittrick deposits (Stock, 1928), Manix Lake beds (G. Jefferson, 1967, personal communication) and at Maricopa (J. R. Macdonald, 1967: 36) where radiocarbon dates indicate a Late Wisconsin age (McKittrick, Berger and Libby, 1966: 492; Manix Lake beds, Fergusson and Libby, 1962: 113, and Maricopa, Macdonald, 1967: 36). These deposits are all separated from the Los Angeles region by mountain ranges. Competition by *Camelops* could have been responsible for the earlier absence of *Tanupolama* in and around the Los Angeles basin. It is probable that displacement does not occur simultaneously over a widespread area but is accomplished in sections, thus giving a possible explanation why *Tanupolama* could be missing from the semi-isolated Los Angeles area and present a little more than 100 miles away during the Late Wisconsin.

The apparent smaller average size of *Paramylodon* specimens from Costeau (Figs. 128-155, Tables 16-19) as compared to those from Rancho La Brea, suggests a time difference between the two deposits, the former being older.

Presence of *Notiosorex crawfordi* in the Costeau fauna could conceivably have an important temporal significance. According to Hibbard and Taylor (1960: 158) the geologic range of this species is Sangamon to Recent. *Felis concolor* is also reported as having a geologic range of Sangamon to Recent according to the above authors (1960: 182).

No faunal element in the Costeau fauna seems to prohibit an age assignment of Late Pleistocene.

Correlation: The Costeau fauna seems to compare temporally most favorably with the faunas of Jinglebob and Cragin Quarry in Kansas. It also shows some similarity to the Doby Springs fauna of Oklahoma, the Mt. Scott fauna of Kansas and the earlier deposits at Rancho La Brea. A site near Danville, California (UCMP V 3406), could be correlative, with the presence of *Bison latifrons, Mammuthus* cf. *columbi* and *Equus* sp. (Savage, 1951: 282). But this fauna is too limited for meaningful comparison.

The Cragin Quarry and Jinglebob faunas of the Meade basin in Kansas have been assigned a Sangamon age by Hibbard and Taylor (1960: 7). The combined faunas are very similar to the one at Costeau. The joint occurrence of *Bison latifrons, Notiosorex crawfordi, Felis concolor, Tanupolama* and other genera in all these localities seems significant. Although only teeth of *Paramylodon harlani* occur at Cragin Quarry, two tibiae of this species have been identified in the Jinglebob fauna. They measure 233 mm and 240 mm in greatest length (Hibbard, 1955: 206). These measurements are shorter than corresponding ones in any *Paramylodon harlani* from Rancho La Brea, comparing more favorably in length with the Costeau material (Table 18).

While the Mt. Scott and Doby Springs faunas contain *Bison* cf. *latifrons*, they differ from the Costeau fauna in not containing *Notiosorex, Felis concolor, Bison antiquus* and several other genera.

Although the Rancho La Brea fauna is very similar (Table 1) to that at Costeau, it appears temporally significant that *Bison latifrons* is rare while *B. antiquus* is common. Just the opposite is true of the Costeau fauna. Based on all the above evidence, the Costeau fauna is probably Sangamon or Early Wisconsin in age.

Late Pleistocene climate and environment at Costeau

Climate: Presence of the pond turtle *Clemmys* and the muskrat *Ondatra* is very suggestive of perennial streams in the Costeau area during the Late Pleistocene. The large mammals would also require perennial water from some source. According to Hibbard and Taylor (1960: 183) the Columbian mammoth needed a habitat with permanent water in the streams. *Notiosorex crawfordi, Dipodomys, Sylvilagus audubonii, Perognathus californicus, Cnemidophorus* and the desert tortoise all live in arid to semiarid regions. Although the living conditions of the two groups of animals seem opposed, both can be met in some semiarid regions where perennial streams exist. The Los Angeles basin and vicinity which are considered semiarid, possessed perennial streams during the early settlement of the area. An increasing population soon depleted local water supplies, causing previous ever-flowing rivers (e.g., Los Angeles, San Gabriel and Santa Ana rivers) to become ephemeral (Weymouth, 1939: 8-11). If human consump-

tion of water in the area ceased, the streams undoubtedly would flow throughout the year again, as the earliest rainfall records (Weymouth, 1939: 11) show yearly precipitations similar to those at present. Therefore, the climate during the deposition of the Costeau beds was probably very similar to that today.

Environment: Preliminary pollen studies at Costeau show that most of the plant types are contained in the Compositae group. This is indicative of grassland conditions.

All herbivorous constituents of the Costeau fauna are either exclusively grassland forms (e.g., *Speotyto, Microtus, Equus* and *Bison*) or else include grasslands as probable or possible habitats (e.g., *Lophortyx, Lepus, Sylvilagus, Citellus, Perognathus, Reithrodontomys* and others). Typical browsers such as peccary, tapir, ?deer, mastodon and megalonychid ground sloths are conspicuously absent. Since the entire fauna represents a grassland environment (i.e., no distal community suggesting different environmental requirements is present), this condition must have been widespread. It possibly prevailed over the entire area from the foot of the Santa Ana Mountains to the sea.

Newport Bay Mesa

General Statement

Two vertebrate faunas are recognized in the vicinity of Upper Newport Bay. One is adjacent to its easternmost extension, LACM Loc. 1066 (also known as LACM Invertebrate Locality 66), and the other, LACM Loc. 1067, is approximately three-fourths of a mile farther east (see Fig. 1). Additional Pleistocene vertebrate sites have been recorded in the general area but a paucity of specimens and lack of definite stratigraphic relationships to the above mentioned sites necessitate their being listed in the section on miscellaneous localities. While the two major Newport Bay Mesa faunas may be one, there is as yet insufficient evidence to unite them.

The area around and including locality 1066 has been extensively reworked in recent years by earth moving equipment for various construction purposes. Earth has been removed and fill added, so that the original collecting site no longer exists. Locality 1067, a highway road cut, has been destroyed by recent road widening. A recent search in the area has failed to yield additional vertebrates.

Stratigraphy

G. P. Kanakoff (1967, personal communication) who collected many of the vertebrates in addition to numerous invertebrates at LACM Loc. 1066 stated that both fossil groups jointly occurred in flat-lying sands and gravels of the Palos Verdes Sand, near the base of a ravine 14 to 18 feet beneath the land surface. Tributary gullies also yielded vertebrate and invertebrate fossils at this depth.

The geology and invertebrate paleontology of this site have been discussed by Kanakoff and Emerson (1959) and that of the general area by several other investigators (e.g., Arnold, 1903; Bruff, 1946; and Poland et al., 1956). Although Howard (1949, 1955, 1958 and 1964) made a detailed study of the birds from locality 1066, only passing mention has been given to the mammals (Lance, 1948; and Savage, Downs and Poe, 1954).

T. Downs (1952-1957, field notes, and 1967, personal communication) has stated that the bulk of the fauna from LACM Loc. 1067, which consists almost entirely of small mammals, was contained in a small pocket at and below the present road level, along which it was located. He further reported that the fossils were recovered from thin lenses of sand and argillaceous silt, being by far more abundant in the latter. In part these lenses were affected by small scale warping. The total vertical thickness yielding these Pleistocene terrestrial vertebrates has been given at three to four feet for the major assemblage. Although a majority of the sediments were listed as buff in color, many of the small mammals were collected from dark bands. A few specimens representing large vertebrates have been recorded in the buff-colored sediments slightly higher in the section.

All the nonmarine sediments at locality 1067 occur below a one to two inch gravel layer, which may mark a local disconformity. Presence of fairly abundant marine mollusk and fish specimens and absence of terrestrial animals above this layer indicate a Late Quaternary marine transgression at Newport Bay. In the southern portion of the exposed sediments an angular unconformity is in evidence. The inclined beds have an apparent ten degree dip to the north and are composed largely of silts and sands that have the same general appearance as the horizontal beds.

Preservation and Method of Fossil Recovery

Most of the bones collected at LACM Loc. 1066 show evidence of permineralization. They vary in color from buff to moderate dark brown. A number of them are encrusted with sand and marine shells, including bryozoa, and a few specimens are greatly abraded. This abrasion was caused either by stream

or by wave action, or possibly both. Because the preservation of the specimens was good, they were easily exhumed using standard digging tools. Many of the smaller fossils were recovered by sifting dry matrix through screens.

An extreme abundance (tens of thousands) of fossils were recovered from the small vertebrate pocket at LACM Loc. 1067. For this reason only cranial material, exclusive of isolated teeth, was critically examined. This fauna would lend itself well to a detailed population study which is, however, beyond the scope of the present paper.

The great concentration of small, diverse vertebrate fossils, predominantly mammalian, is most reasonably explained as the result of reworked owl pellets; the bones were so closely positioned as to appear matted. These pellets were possibly dropped in a stream, as shown by the sorting of the enclosing sediments, then deposited in a nearby pond. The distance of stream transport was probably not great, as the bones show little or no trace of corrasion.

The fossils from locality 1067 are slightly permineralized and reddish brown to brown in color, being nearly identical in these respects to the bones from Costeau Pit about ten miles east-southeast. Most of them were recovered by screen washing, although many were obtained by breaking matrix from the bone.

Systematic Discussion of Fauna

Locality 1066

Class PISCES

A number of unidentified specimens, mostly vertebrae, are indicative of bony fish at this locality. Some teeth and spines of sharks and rays are also present.

Class REPTILIA

A single shell fragment, LACM 20542, representing a large turtle, is the only evidence of this class in the deposit. The size of the specimen indicates a marine turtle that probably belongs to the family Cheloniidae. Two genera assigned to this family currently are found in coastal waters of southern California, *Chelonia,* the Pacific green turtle and *Caretta,* the Pacific loggerhead.

Class AVES

There is a relatively good representation of birds at locality 1066, most of which have been reported by Howard (1949 and 1958). These are: *Gavia stellata, Gavia ?arctica, Gavia immer, Aechmophorus occidentalis, Diomedea albatrus, Puffinus griseus, Puffinus ?opisthomelas, Fulmarus glacialis, Phalacrocorax penicillatus, Moris reyana, Branta ?canadensis, Anser ?albifrons, Aythya valisineria, Melanitta ?deglandi, Chendytes lawi, Stercorarius* sp., *Larus* sp., and *Catoptrophorus inornatus.* An incomplete carpometacarpus of *Mancalla* evidently was reworked from Pliocene sediments (Howard 1958: 136).

Additional specimens have been collected that as yet are unreported. Most of these are assignable to previously recognized species but two are not. As identified by Howard, a nearly complete humerus, LACM 13103, belongs to an alcid (small auklet or murrelet), and a humerus shaft, LACM 1578, is probably referable to the genus *Haliaeetus* (eagle). A few unidentified passerine specimens are also present in the fauna.

Class MAMMALIA

Order EDENTATA

Family MEGALONYCHIDAE

Megalonyx cf. *jeffersoni* (Desmarest)

Abundance: One individual, based on an incomplete right jaw, which contains the posteriormost cheek tooth (private collection; specimen now on loan to LACM).

Habitat: According to Stock (1925: 23, and 1963: 54), *Megalonyx* was probably a browsing form that inhabited wooded areas.

Discussion: The *Megalonyx* jaw is the only specimen definitely assignable to this genus from the Newport Bay Mesa fauna. It was compared with the very limited *Megalonyx* and abundant *Nothrotherium* material in the collections at the Los Angeles County Museum of Natural History. This specimen differs from the latter genus by its greater size and lack of lateral and medial grooves on the teeth. Vertical bony ridges exist in the alveoli of *Nothrotherium* jaws that fit these grooves; they of course are lacking in *Megalonyx.* Although the anterior portion of the jaw on the Newport specimen is missing, the posteriormost portion of the alveoli for the tusk is present. No tusks occur in the genus *Nothrotherium.* The *Megalonyx* jaw was compared with and found very similar to *M. Jeffersoni.*

Nothrotherium shastense Sinclair

Abundance: One individual. Three specimens, including a large portion of a skull, LACM 16395, an ungual phalanx, LACM 1590, and an incomplete caudal vertebra, LACM 20533.

Habitat: According to Martin et al. (1961: 118-119), *Nothrotherium shastense* excelled as a browser, occupying primarily Sonoran regions. It was also stated that at least some species of this genus inhabited mesic forests or savannas.

Discussion: The posterior two-thirds of a skull contrasts with similar cranial portions of *Megalonyx* and *Paramylodon* in its much smaller size, relatively narrower occiput, and very low profile. Even though the dentition is lacking, the available evidence indicates this specimen is identical to *Nothrotherium shastense* from Rancho La Brea.

The greatest height of the occiput measured from the dorsal border of the foramen magnum is 50 mm; the greatest width of the cranium, across the periotics, is 130 mm; and the greatest external width of the occipital condyles is 50 mm.

Order LAGOMORPHA
Family LEPORIDAE
Sylvilagus cf. *audubonii* (Baird)

Abundance: One individual, based on an isolated cheek tooth, LACM 20534.

Discussion: Of the two leporid genera, *Lepus* and *Sylvilagus*, recognized in the Pleistocene and Recent of southern California, the present specimen most closely approaches the latter. The tooth is questionably assigned to the species *S. audubonii* because of its highly crenulated enamel re-entrants on the posterior border of the trigonid and on the anterior border of the talonid. These re-entrants are usually simple on the cheek teeth of *Sylvilagus bachmani*, the only other species of this genus known from the area.

Order RODENTIA
Family SCIURIDAE
Citellus cf. *beecheyi* (Richardson)

Abundance: One individual, based on a right, second upper molar, LACM 20535.

Discussion: The tooth is assigned to the species *C. beecheyi* largely on the basis of size. This species is the largest ground squirrel known in southern California. The present specimen also agrees well in details of configuration with the M2/'s of this form from Rancho La Brea and Costeau Pit which are identified as *Citellus beecheyi*.

Family GEOMYIDAE
Thomomys cf. *bottae* (Eydoux and Gervais)

Abundance: One individual. Six specimens, based on cheek teeth and one upper incisor, LACM 20536.

Discussion: The gopher from Newport Bay Mesa is tentatively identified as *Thomomys bottae* on the basis of P4/4 configuration and size, previously discussed. All six teeth correspond well with similar ones of *T. bottae* from Costeau Pit, Rancho La Brea, and specimens now living in the area. This is the only pocket gopher recorded, living or extinct, in the vicinity of the Los Angeles basin.

Family HETEROMYIDAE
cf. *Perognathus* Maximilian

Abundance: One individual, based on a right, upper incisor, LACM 20537.

Discussion: On the basis of size, radius of curvature and position of the groove, the fossil incisor compares very favorably with specimens of *Perognathus*. *Reithrodontomys* is smaller and has a radius of curvature that is much less. *Dipodomys*, which also has single grooved incisors, is distinctly larger and has a more medially positioned groove than *Perognathus*.

This genus is recorded at Costeau and Rancho La Brea.

Family CRICETIDAE
Neotoma Say and Ord

Abundance: One individual, based on a right, upper first molar, LACM 20538.

Discussion: Initial wear stages are evidenced on this specimen, indicating a young individual. Of the recent comparative material used, the tooth most closely resembles a young *Neotoma fuscipes*. However, the lingual and labial inflections are a little more open than in that species, as is true of the specimens from Costeau Pit.

Order CETACEA

Discussion: Three incomplete vertebrae from Newport Bay Mesa represent a relatively small cetacean. Based on limited comparative material they most closely resemble the genus *Tursiops*. One complete epiphysis is evidently from a larger individual. This specimen, LACM 20540, is circular and has a diameter of 63 mm.

Order CARNIVORA
Family CANIDAE
Canis cf. *dirus* (Leidy)

Abundance: One individual, based on two distal phalanges, LACM 20539.

Discussion: The two claws listed above probably represent the same individual. They are too large for a coyote but compare well with a moderate-sized *Canis dirus*. *Canis lupus*, the gray wolf, might have occurred in southwestern California but it evidently was very rare (Stock, 1963; 33).

Family MUSTELIDAE
Enhydra lutris (Linnaeus)

Abundance: One individual, based on the complete crown of the left upper molar, LACM 20541.

Habitat: The sea otter currently inhabits the Pacific coastal area from California north to the Aleutian Islands. It seems to prefer kelp beds and rocky shores.

Discussion: According to Mitchell (1966: 1897), fossils of the sea otter are extremely rare; only twelve bones and one tooth have been reported. These specimens are known only from San Pedro and Santa Rosa Island in southern California and from southern Oregon.

The M1/ in sea otters is a unique tooth. It has an expanded surface with a bunodont pattern, which evidently is an adaptation for crushing and eating molluscs. This tooth (Fig. 21) is quite distinct from teeth of any other form, including the river otter. The present specimen is identified as *Enhydra lutris* which is currently the only recognized species for fossil and living sea otters.

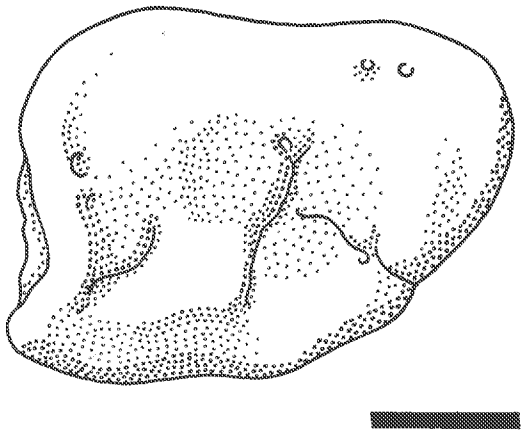


FIGURE 21. *Enhydra lutris*, occlusal view of left M1/, LACM 20541, Newport Beach, Loc. 1066. Line beneath figure represents 5 mm.

Family OTARIIDAE

Discussion: A few otariid specimens have been taken from the Newport site; a proximal end of a radius, LACM 20544, two vertebrae, LACM 20546 and 20547, an incomplete calcaneum, LACM 20545, and a complete phalanx, LACM 20543.

Three types of sea lions are known from the Pleistocene and Recent of southern California: *Arctocephalus philippii* (Peters), *Eumetopias jubata* (Schreber), and *Zalophus californianus* (Lesson). *A. philippii* is much smaller than the other two species and does not approach any of the fossil specimens in size. Although *Eumetopias jubata* males are noticeably larger than those of *Zalophus californianus*, many individuals representing these two species are comparable in size. Postcranial elements of both are very similar and none of the fossil material can be assigned to either species with certainty. The proximal end of the radius is slightly larger than any *Z. californianus* radii seen but it is possibly within the size limits of this type.

Family PHOCIDAE

Mirounga cf. *angustirostris* (Gill)

Abundance: Two individuals, based on size. Four specimens, including the major portion of an adult skull (without dentition), LACM 1977, a juvenile axis, LACM 1611, an atlas, LACM 4564, and a cervical vertebra, LACM 4563.

Habitat: The elephant seal prefers warm waters and sandy beaches throughout its breeding-ground range, from northern (Pacific) Baja California to Año Nuevo Island of central California (on occasion individuals have been seen as far north as Vancouver Island). Scheffer (1958: 133) states that prior to extensive hunting by man, this species ranged from southwest Baja California to Point Reyes, California.

Discussion: An adult elephant seal can be distinguished from all other phocids by its vastly greater size. It is larger than the walrus. The Newport skull differs from large otariids such as *Eumetopias* by having a pronounced depression in the nasal bones. These bones form a V-shape where they contact the frontals, with the apex pointing posteriorly. A V-shape is also found in otariids where the nasals contact the frontals but the apex is anteriorly directed. In the specimens observed, the saggital crest, when present, was much better developed in the sea lions than in the seals (including *Mirounga*). The tympanic bulla of the fossil skull is partly inflated, relatively large and thick-walled. In otariids it is uninflated, relatively small and thin-walled. The fossil skull has a relatively small posterior lacerate foramen and no median ridge on the basioccipital, whereas in otariids this foramen is large and usually a basioccipital ridge is present. Three Recent skulls of *Mirounga angustirostris*, the only extant species in the Northern Hemisphere, were used in comparison and the present fossil does not seem to differ significantly from them. However, E. D. Mitchell (1968, personal communication), who had previously studied the Newport specimen, stated that it could possibly belong to the living Southern Hemisphere species, *M. leonina* (a detailed discussion with illustrations of the above specimen will be made by Mitchell in a forthcoming paper).

Order PROBOSCIDEA

Discussion: A proximal end of a scapula, LACM 20532, and a vertebra fragment, LACM 20548, are the only specimens of this order from locality

1066. The scapula fragment represents a juvenile which compares most closely to a young individual of the genus *Mammut*. However, no juvenile mammoth scapulae were available for comparison. The vertebra fragment cannot be distinguished from either *Mammut* or *Mammuthus*.

Order PERISSODACTYLA

Family EQUIDAE

Equus Linnaeus

Abundance: Three individuals, based on size. 20 specimens, including nine teeth, one metacarpal, one proximal phalanx, a calcaneum and an incomplete scapula, rib, pelvis, humerus, femur, radius, metatarsal, and hoof.

Discussion: With the exception of one specimen, all the Newport equid material is indistinguishable from the horse at Rancho La Brea and Costeau Pit. The teeth manifest the very simple enamel pattern as well as the other dental characters previously discussed for the horses from these localities. Although the postcranial elements correspond well to those from Rancho La Brea in details of configuration, they all appear smaller than the estimated average of the La Brea sample.

One specimen, LACM 1359, a metatarsal with a broken distal end, is much smaller than similar elements of the La Brea horse. Even though it is abraded and the distal end is broken, the evidence indicates it is not juvenile. Of the numerous *Equus* metatarsals studied all immature specimens that even closely approached the present one in size had a very distinct constriction of the shaft. No hint of this constriction is present in specimen 1359.

The small Newport metatarsal was compared with and found similar to the corresponding element of *Equus conversidens* from San Josecito Cave in Mexico. It measures 46.6 mm in greatest transverse width at the proximal end and 39.7 mm in greatest anteroposterior diameter.

Family TAPIRIDAE

Tapirus Brisson

Abundance: One individual. Four specimens, including a jaw fragment, LACM 20549, two incomplete teeth, LACM 1360 and 1606, and a complete proximal phalanx, LACM 20550.

Discussion: The specimens were compared to the recent Asian tapir, *Tapirus indicus*, the only one available for study. They are smaller and the phalanx (manus, digit three) is relatively more slender (greatest length, 112 mm, greatest transverse width at the distal end, 26.2 mm and greatest transverse width at the proximal end, 31.0 mm). As the comparative material was so limited, only a generic designation is given to the Newport specimens.

Apparently the genus *Tapirus* includes all tapirs of the Pleistocene and Recent Epochs in the Western Hemisphere and possibly the Eastern Hemisphere as well (Simpson, 1945b: 140, recognizes *Megatapirus* of the Asian Pleistocene; however, Romer, 1966: 388, indicates this genus is synonymous with *Tapirus*). Tapir material is scarce in southern California but it has been found at several localities including Rancho La Brea (Stock, 1963: 43).

Order ARTIODACTYLA

Family CAMELIDAE

Camelops Leidy

Abundance: Two individuals, based on size. 13 specimens, including three teeth, three vertebrae fragments, one sacrum and six limb bone fragments.

Discussion: The size and shape of the present material indicates the genus *Camelops*. Although two specimens, LACM 20458, the proximal end of a radius-ulna, and LACM 1610, a sacrum, lie within the size variation noted for *C. hesternus* from Rancho La Brea, the others are slightly smaller. Unfortunately the fragmental nature of the fossils does not allow a distinction to be made between mature and immature individuals.

Tanupolama Stock

Abundance: One individual, based on a metacarpal, LACM 1589.

Discussion: The *Tanupolama* specimen from Newport Bay Mesa is slightly larger than the corresponding element of the McKittrick *Tanupolama* but not so much so as to consider it beyond the range of variation for the genus. It was compared to numerous *Camelops* metapodials, representing very young to fully adult forms, and was found to differ from them by being much more slender (some very young *Camelops* specimens are as slender, but they have incompletely fused digits and a different configuration). As both ends of the metacarpal are broken, only the measurements for the greatest transverse and anteroposterior diameters are given; these are 37.0 mm and 36.6 mm, respectively.

Family CERVIDAE

Odocoileus cf. *hemionus* (Caton)

Abundance: One individual. Three specimens, including the basal section of an antler, LACM 1592, the distal end of a humerus, LACM 20558, and a proximal phalanx, LACM 13972.

Habitat: The habitat of the blacktail deer is varied, as it includes coniferous forests, chaparral, and grasslands with shrub cover.

Discussion: Evidently only one species of deer, Pleistocene and Recent, is known in southern California. *Odocoileus hemionus*. The elk, *Cervus*, ranges as far south as Kern County, California, at present but the much smaller size of the blacktail deer allows it to be separated easily from this form. The three fossil specimens are identical with equivalent elements of this deer.

Family BOVIDAE

Bison cf. *latifrons* (Harlan)

Abundance: One individual. Five specimens, including two lower molars and a fragment of a premolar, LACM 1591, 20559 and 20560, a metacarpal, LACM 1357, and several fragments of a pelvis, LACM 20561.

Discussion: Although lack of horn-cores may prevent unequivocal assignment to *Bison latifrons*, two of the specimens are at least highly suggestive of this species. Both ends of the metacarpal are worn but its width and thickness approximate *B. latifrons* more closely than *B. antiquus* (see Table 10). The least anteroposterior shaft thickness measures 36.5 mm and the least transverse shaft width is 62.4 mm.

Many specimens of *Bison latifrons* and *B. antiquus* possess teeth that are similar in size and pattern. However, the largest teeth of the former species do exceed the largest ones of the latter. Hibbard (1963: 219-220) recognizes *B. latifrons* in the Mt. Scott local fauna of Kansas primarily on the basis of a large lower molar (M/3). The anteroposterior length is reported as 49.5 mm. The same measurement on the Newport M/3, which shows only a moderate stage of wear, is 53.6 mm. The remaining three specimens are not sufficiently diagnostic for species determination.

Locality 1067

Class PISCES

A few unidentified fish vertebrae and shark teeth are present in the fauna. All were evidently reworked from nearby marine deposits.

Class AMPHIBIA
Order ANURA
Family BUFONIDAE
cf. *Bufo*

The proximal one-half of a humerus, the distal one-half of a tibio-fibula and the major portion of an ilium, LACM 20562, indicate the presence of a small toad. When compared to a limited variety of frogs and toads, the present elements most resembled the genus *Bufo*. Other anuran elements undoubtedly would be revealed upon a bone by bone inspection of the extensive assemblage from locality 1067.

Order URODELA
Family SALAMANDRIDAE
cf. *Taricha*

A single jaw fragment including five posterior teeth, LACM 20563, is questionably assigned to *Taricha*. The specimen is very similar to the urodelan recovered from Costeau Pit and shows the same even breaking at the tips of the teeth.

According to Stebbins (1966: 37), *Taricha* is one of the most common salamanders on the Pacific Coast at the present time.

Class AVES
Order ANSERIFORMES
Family ANATIDAE
Aythya cf. *affinis*

The lesser scaup is tentatively represented by the proximal half of a humerus, LACM 20568. Salt water bays are a common habitat for this scaup.

Order FALCONIFORMES
Family ACCIPITRIDAE
Accipiter

The only hawk from locality 1067 is represented by the distal two-thirds of a tarsometatarsus, LACM 20567. It cannot be separated from living representatives of the genus.

Order GALLIFORMES
Family PHASIANIDAE
Lophortyx

A quail is identified at Newport Bay Mesa on the evidence of two incomplete humeri, a corocoid and a carpometacarpus, LACM 20564.

Order PASSERIFORMES
Family CORVIDAE
Corvus

A carpometacarpus, LACM 20566, indicates the presence of crow at the fossil site.

Family ICTERIDAE
Agelaius

The red-winged blackbird is represented by two carpometacarpi and an ulna, LACM 20565. A few unidentified passerine elements of smaller types are also present in the Newport fauna.

Class MAMMALIA
Order INSECTIVORA

Family SORICIDAE

Sorex ornatus Merriam

Abundance: 12 individuals, based on right jaws. 32 specimens, including jaws and palate fragments, LACM 20571.

Habitat: The ornate shrew inhabits wet meadows and near-stream environments.

Discussion: Of the two species of shrews at Newport, *Sorex ornatus* (Fig. 22) and *Notiosorex crawfordi* (Fig. 23), the former is much more numerous. This condition is reversed in the Rancho La Brea fauna. Thus far, only the two above-mentioned shrews have been recorded in the vicinity of the Los Angeles basin.

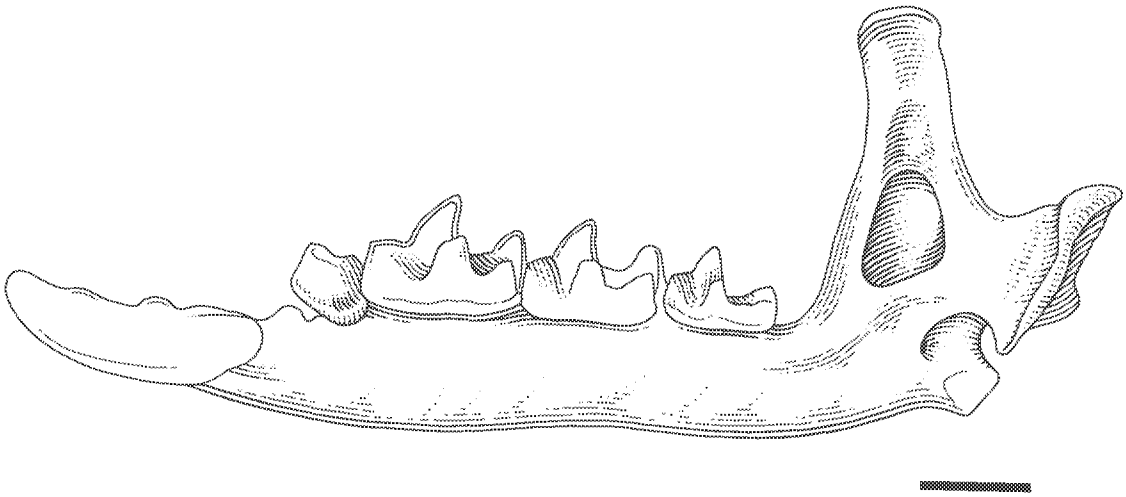


FIGURE 22. *Sorex ornatus*, medial view of right mandible, LACM 20571, Newport Beach, Loc. 1067. Line beneath figure represents 1 mm.

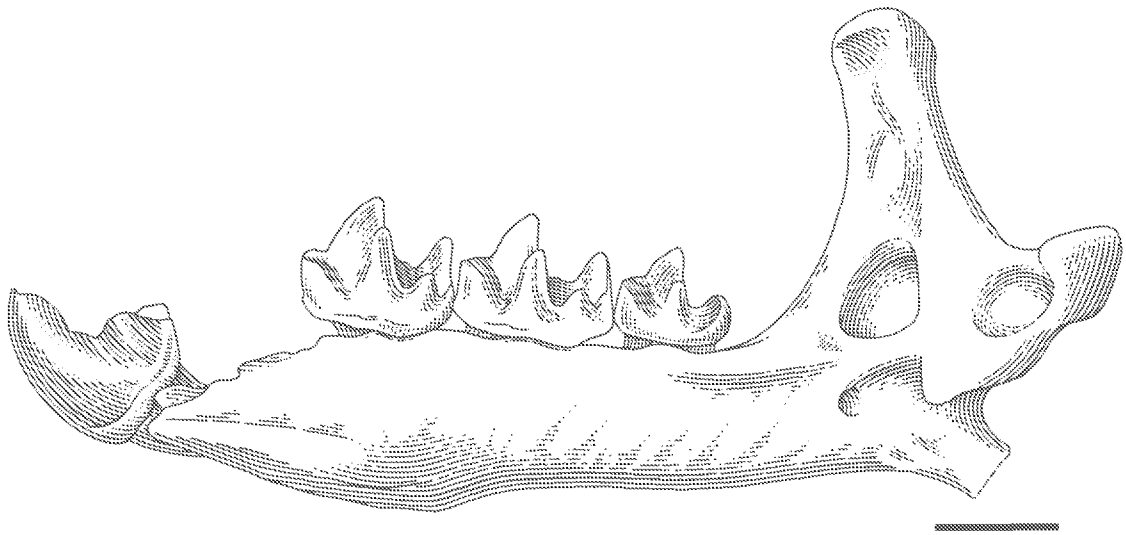


FIGURE 23. *Notiosorex crawfordi*, medial view of right mandible, LACM 20570, Newport Beach, Loc. 1067. Line beneath figure represents 1 mm.

The Newport specimens were compared with several types of shrews. Those that most closely resemble the fossil species are *Sorex cinereus, S. pacificus, S. trowbridgei* and *S. ornatus*. The first named species is slightly smaller and has relatively less massive lower cheek teeth. *S. pacificus* is decidedly larger and has relatively larger upper premolars. *S. trowbridgei* is similar in size to the Newport species but has larger upper premolars. Only *S. ornatus* compares favorably in all details with the fossil specimens.

Notiosorex crawfordi (Coues)

Abundance: Four individuals, based on left jaws. Eight specimens, including jaws and two palate fragments, LACM 20570.

Discussion: The desert shrew from Newport is identical to the living form and to the one recovered at Costeau Pit. (For a discussion of this genus and comparisons with other types, including *Sorex*, see page 8.)

Family TALPIDAE

Scapanus latimanus (Bachman)

Abundance: One individual. Five specimens, including the distal half of a humerus, a radius, a proximal and medial phalanx and a palmer sesamoid, LACM 20839.

Habitat: The California mole prefers damp porous soils.

Discussion: While other members of the Newport fauna are based on cranial material, only postcranial elements of the mole have thus far been recognized. Just two genera of moles, *Neurotrichus* and *Scapanus*, are presently known in California and the former is restricted to the northern part of the state. The exclusively northern form is distinctly smaller than all species of *Scapanus*. Although the radius is in sufficiently good condition for meaningful comparisons, the humerus is not. The humerus differs from similar elements of *Scapanus townsendii* (Bachman) in its distinctly smaller size and a proportionately lesser length between the groove for the abductor pollicis longus tendon and the glenoid fossa. The radius also differs from that of *S. orarius* True by a slightly (relatively) shorter length between the tendonal groove and the glenoid fossa. In addition the shaft of the fossil radius is relatively narrower. However, the bone does closely resemble *S. latimanus* in all the above features. The proximal phalanx, digit 2, of the Newport specimen is about 10 per cent shorter than either *S. townsendii* or *S. orarius* but it is within the size range of *S. latimanus*. Only these three species of *Scapanus* are currently recognized and the Newport material represents the first fossil mole from Pleistocene deposits in southwestern California. *S. latimanus* is the only species of mole now living in southern California.

Order CHIROPTERA

Family VESPERTILIONIDAE

Antrozous pallidus (Le Conte)

Abundance: One individual, based on a matching right and left jaw, LACM 20569.

Habitat: The pallid bat frequents areas which provide caves and/or rock crevices. It will sometimes roost in trees.

Discussion: The Newport bat (Fig. 24) was compared to all forms living in southern California. Of these, *Pipistrellus, Myotis* and *Plecotus* are noticeably smaller than the fossil specimen. The first genus also differs in possessing an anterolingual accessory cusp on the lower canine and having a more anteroposteriorly symmetrical last premolar. The two latter genera differ in possessing three rather than two premolars and an M/3 talonid that is as large or larger than the trigonid. The M/3 talonid in the fossil jaws is much smaller than the trigonid. *Eumops* is much larger than the Newport genus and further differs in the nearly equal size of its two premolars; the anterior premolar in the fossil jaws is greatly reduced.

Of the specimens used for comparison, only *Lasiurus, Tadarida* and *Antrozous* are of similar size; *Lasiurus cinereus* (Palisot de Beauvois) compares favorably in size to the fossil form but *L. borealis* (Muller) is much smaller. The first two genera have more slender jaws than does the Newport genus and the M/3 of *Lasiurus*, unlike that of the fossil, has a distinct hypoconid and entoconid that are well separated. Some species of *Tadarida* are larger than the one from locality 1067 but all possess a relatively larger anterior premolar and a larger M/3 talonid. The jaws of the Newport bat cannot be distinguished from Recent specimens of *Antrozous pallidus* now living in southern California. Hall and Kelson (1959: 203) and others have stated that *A. bunkeri* Hibbard, the only other species of *Antrozous* reported from the United States, is probably a subspecies of *A. pallidus*.

The only reference to fossil bats in southwestern California is from the McKittrick asphalt deposit. Schultz (1938) identified the single species recognized there as *Antrozous pallidus*.

Order LAGOMORPHA

Family LEPORIDAE

Sylvilagus bachmani (Waterhouse)

Abundance: Two individuals, based on palates.

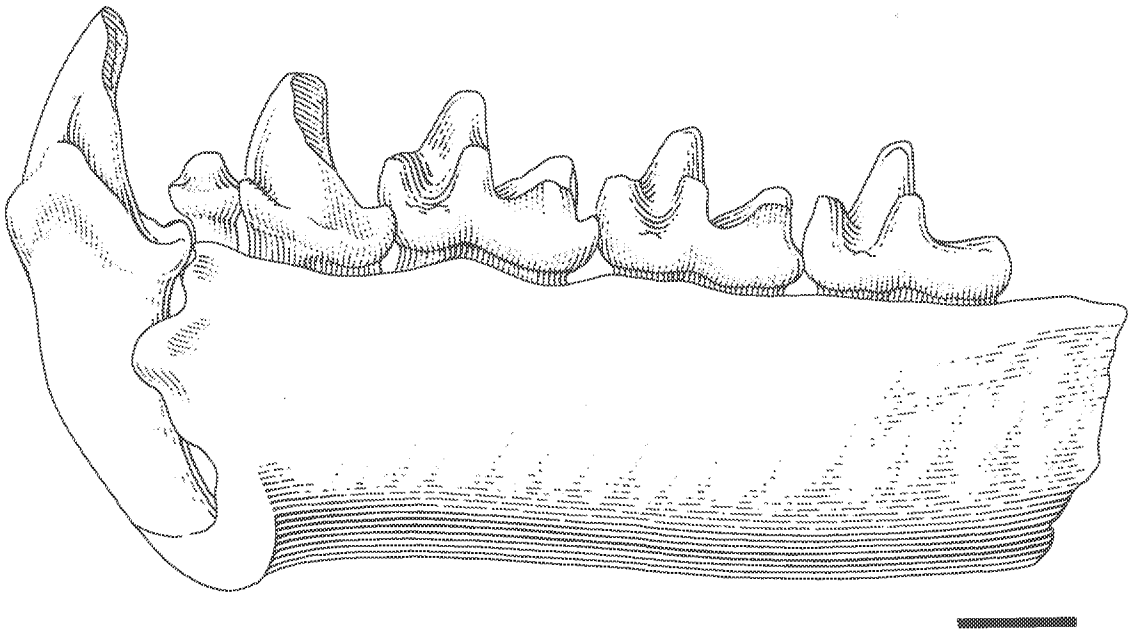


FIGURE 24. *Antrozous pallidus*, lateral view of left mandible, LACM 20569, Newport Beach, Loc. 1067. Line beneath figure represents 1 mm.

Seven specimens, including three palatal fragments, a horizontal ramus with dentition and three isolated teeth, LACM 20572.

Discussion: Based on their relatively small size and simple enamel re-entrant patterns on the cheek teeth, the fossil specimens compare favorably with *Sylvilagus bachmani* and differ from *S. audubonii*. Although the genus *Sylvilagus* is represented by several species, only these two are known from southwestern California, fossil or Recent.

Order RODENTIA

Family GEOMYIDAE

Thomomys bottae (Eydoux and Gervais)

Abundance: 99 individuals, based on left jaws. 237 specimens, including two skulls, and numerous palates and jaws, LACM 20573.

Discussion: A comparison of the numerous fossil specimens with the species of *Thomomys* demonstrated that they are specifically identical with *T. bottae*. Size and configuration of cranial and dental features in the Newport material coincide with Recent and fossil representatives of this species from southern California.

Family HETEROMYIDAE

Perognathus cf. *californicus* Merriam

Abundance: 12 individuals, based on left jaws. 27 specimens, including palatal fragments and jaws, LACM 20574.

Discussion: Although this species is relatively abundant at Costeau Pit, it is not abundantly represented at locality 1067. Only with difficulty can the specimens be separated from *Perognathus fallax*.

Dipodomys cf. *agilis* Gamble

Abundance: Minimum number of individuals, 201, based on left jaws. Total number of specimens, 517, including palates and jaws, LACM 20575.

Discussion: The fossil specimens appear very similar to both *Dipodomys agilis* and *D. panamintinus* with respect to all available cranial elements. However, it was noted upon comparison that the Newport species and *D. agilis* commonly display a slight to distinct lingual inflection on P4/. Although many Recent individuals of both species were observed, this feature was rarely seen in *D. panamintinus*.

Family CRICETIDAE

Peromyscus cf. *crinitus* (Merriam)

Abundance: 59 individuals, based on left jaws. 118 specimens, including palates and jaws, LACM 20576.

Habitat: The canyon mouse is found in the southwestern United States where rocky crevices are available.

Discussion: Peromyscus crinitus is the smallest species of the genus that was observed. Its size and dental characters compare very well to the fossil species, although the comparative material seemed to average slightly larger. The other species of white-footed mouse from Newport, *P. maniculatus*, differs in its larger size, usually larger and more recurved coronoid process and in other characters already given for the species. *Reithrodontomys fulvescens*, Allen, the largest harvest mouse north of southern Mexico, has some individuals as large as the fossil specimens but the majority are smaller. Those individuals that are as large have less massive teeth and a greater depth of jaw beneath M/1, however.

P. crinitus is not currently recognized along the coastal portions of California but does occur farther inland.

Peromyscus maniculatus (Wagner)

Abundance: 22 individuals, based on left jaws. 39 specimens, including palatal fragments and jaws, LACM 20577.

Discussion: Presence of an anteroconule on M1/ which is joined to the anterocone by a distinct loph is diagnostic of *Peromyscus maniculatus*. Although *P. boylii* (Baird) and *P. truei* (Shufeldt) have an anteroconule, it is not separated from the anterocone as in the first named species. The evidence offered by the lower jaws also suggests that the Newport species is identical to *P. maniculatus*. Because of its larger average size, it is probably assignable to a different subspecies than the one recovered from Costeau Pit and Rancho La Brea. It most closely resembles *P. m. sonoriensis* (Le Conte). Like *P. crinitus*, this subspecies occurs inland of coastal southern California.

Reithrodontomys megalotis (Baird)

Abundance: 36 individuals, based on left jaws. 94 specimens, including palates and jaws, LACM 20578.

Habitat: The western harvest mouse inhabits grasslands, usually preferring thick stands of tall grass.

Discussion: The harvest mouse from Newport Bay Mesa is not distinguishable from the one now inhabiting the area, *Reithrodontomys megalotis*. This species occurs at Rancho La Brea but not at Costeau Pit, where a smaller species is in evidence.

Neotoma fuscipes Baird

Abundance: Eight individuals, based on right jaws. 25 specimens, including jaws and palate fragments, LACM 20579.

Habitat: Heavy chaparral, deciduous and mixed woods are the usual habitat of the dusky-footed woodrat.

Discussion: Species of *Neotoma* that are known from California and adjacent states were compared to the Newport woodrat. *N. albigula* Hartley, *N. stephensi* Goldman and *N. mexicana* Baird, all occurring outside California, are smaller in size. *N. cinerea* (Ord), which inhabits northern California, is generally larger and has a medially directed first lingual inflection on M/1. Of the two species existing in southern California, *N. lepida* and *N. fuscipes*, the former is markedly smaller and has the first lingual inflection of M/1 directed as in *N. cinerea*. Also, the medial inflection in the M3/ of this species does not extend far beyond the lingual border; in *N. fuscipes* this inflection usually extends to about the middle of the tooth. Each of the above characters is shared by both *Neotoma fuscipes* and the fossil specimens.

Microtus californicus (Peale)

Abundance: 139 individuals, based on right jaws. 320 specimens, including palates and jaws, LACM 20580.

Discussion: Based on width of the incisive foramina, dental characters and size, the specimens from locality 1067 are referable to *Microtus californicus*. As in the Costeau specimens, the posterior portion of the incisive foramina is wider than in most of the observed Recent representatives of the species. Nevertheless, the fossil specimens are contained within the variability noted for *M. californicus*. *M. c. kernensis* Kellogg, of the subspecies studied, most closely compares to the one from Newport.

Order CARNIVORA
Family MUSTELIDAE
cf. *Spilogale* Gray

Abundance: One individual, based on a humerus, LACM 20581.

Habitat: The spotted skunk is found in various habitats, including grasslands and sparsely wooded areas.

Discussion: The humerus most closely resembles humeri of *Spilogale* than of any other compared mustelid. *Mephitis*, the only other skunk inhabiting California, is much larger and presents a slightly different muscle-scar pattern. The deltoid tuberosity, for example, does not extend relatively as far down the shaft in *Spilogale*. *Mephitis* also

has a relatively more massive lateral tuberosity. Although the fossil humerus approximates the smaller genus more closely, it is slightly larger than any of the three individuals available for comparison.

A majority of workers regard *Spilogale* as monotypic, *S. putorius* being the only species. Others recognize as many as four valid species (Hall and Kelson, 1959: 929).

Order PROBOSCIDEA
Family cf. MAMMUTIDAE

Discussion: One juvenile specimen, LACM 20582, the proximal end of a scapula, may indicate a very young mastodon at the 1067 site. Lack of definition of details prohibits a positive identification.

Order PERISSODACTYLA
Family EQUIDAE
Equus Linnaeus

Abundance: One individual. Two specimens, including a sixth cervical vertebra, LACM 20584, and an incisor, LACM 20583.

Discussion: The vertebra is similar to the corresponding cervical in the *Equus* from Rancho La Brea and Costeau Pit. Like the majority of specimens from locality 1066, this one is smaller than the estimated average in the Rancho La Brea collection, approximating the smallest in size.

Order ARTIODACTYLA
Family CAMELIDAE
Tanupolama Stock

Abundance: One individual, based on a tibia, LACM 1368.

Discussion: Although the tibia is lacking the proximal end, most of the element is present. It is much more slender than any observed *Camelops* tibia (the distal extremity measures 73 mm in greatest width and 49 mm in greatest anteroposterior diameter). Unfortunately, no *Tanupolama* tibiae were available for comparison, even in the McKittrick fauna. However, since several *Tanupolama* astragali were available from this fauna, they were used for a size determination. These elements indicate that the Newport tibia is just slightly larger than the size estimated for the McKittrick tibiae. Since the difference is minor, the tibia from locality 1067 probably does not exceed the maximum size for the genus. The size of the camel from this locality is of the same magnitude as the *Tanupolama* identified at Newport locality 1066.

Age and Correlation of the Newport Faunas

Age: There are no radiometric dates available for the faunas from localities 1066 and 1067. However, U:He and U:Th datings have been made on material from the Palos Verdes Sand (Palos Verdes Peninsula) which yield an age of 100,000 to 130,000 years B.P. (Fanale and Schaeffer, 1965: 314, and unpublished reports of the U.S. Geological Survey). The deposit which contains the fauna at locality 1066 is considered a correlative of the Palos Verdes Sand by most investigators (Kanakoff and Emerson, 1959: 10; Poland et al., 1956: 55; Lance, 1948: 1375, and others). Therefore, the above listed date suggests that the 1066 fauna is probably Late Pleistocene (Rancholabrean) in age. Presence of *Bison* helps to support this contention.

Although the terrestrial deposits at the 1067 locality may be contemporaneous with the contiguous marine deposits at 1066, their relationship has not definitely been established. The fauna from the former locality is evidently Pleistocene, though, as all the identified small species can be ascribed to living representatives. Even though a marine bed overlies this deposit, the evidence is suggestive of a Late Pleistocene age (*Notiosorex crawfordi* and *Reithrodontomys megalotis*, for example, are reported as having a temporal range of Sangamon to Recent by Hibbard and Taylor, 1960: 158 and 170).

Correlation: Because of the converse relationship between large and small mammals as well as type of deposits at the 1066 and 1067 localities, the two faunas are lacking sufficient species in common to permit a meaningful mutual comparison.

The terrestrial fauna from the 1066 locality at Newport is similar to the one from Costeau Pit. Presence of tapir and megalonychid ground sloths at the first named site and their absence at the latter can probably be accounted for by environmental rather than temporal differences. A perusal of the faunal lists (Table 1) demonstrates the propinquity between the two assemblages. This also applies to the relationship between the land mammals from locality 1066 and the ones from Rancho La Brea, as all the taxa contained in the former are represented in the latter.

Although large mammals (which apparently cannot be identified as to species) are scarce at Newport locality 1067, they are all generically similar to taxa from Rancho La Brea. The abundant small mammal specimens from the former site correspond well to those from the La Brea deposits as shown by the faunal lists (Table 1). The differences are the presence of *Antrozous pallidus* and *Peromyscus crinitus* at the Newport site and their absence at Rancho La Brea, and the

presence of *Onychomys, Citellus, Lepus* and *Sylvilagus audubonii* at the latter site while they are apparently absent at the former.

The single occurrence of a bat at the 1067 locality and its absence at Rancho La Brea can be attributed to chance preservation. Bias in collecting prey by owls, especially size limitations, can perhaps account for the small mammal types at the La Brea site which are excluded from the Newport fauna. There is one difference: the exclusive presence of *Peromyscus crinitus* at the last named site may have chronologic significance as this species now occupies more inland areas in California. Meager as this evidence is, it suggests a possible older age for the 1067 fauna since the only *Peromyscus* from Rancho La Brea, *P. maniculatus*, is still living in the area.

Late Pleistocene Climate and Environment at Newport

Climate: Kanakoff and Emerson (1959: 33 and 42) concluded that a greater thermal diversity than now exists is indicated by marine invertebrates from the Late Pleistocene of Newport (locality 1066). They stated that many faunal components are presently limited in range to areas either north or south of this location and that the protected bay water was warmer and the open coastal water cooler than is true currently. They further stated that similar conditions are now met along parts of the west coast of Baja California. The marine carnivores from locality 1066 possibly could give strength to this contention. According to Mitchell (1966: 1907), all known Pleistocene sea otters from southern California have been found in association with cool-water faunas. The elephant seal, conversely, has a preference for warm water. Although these two mammals are known to have had geographic ranges that overlapped in the Newport area during historic times, *Enhydra lutris* is almost always found north of this site and major populations of *Mirounga angustirostris* to the south.

The terrestrial vertebrates at both Newport localities, like those at Costeau, seem to indicate a semiarid climate. *Notiosorex crawfordi, Sylvilagus audubonii, Perognathus californicus, Dipodomys* and *Peromyscus crinitus* are usually found today where this type of climatic condition exists. Apparently, all other living species in the faunas have at least part of their geographic range under a similar condition. The larger mammals must have required a perennial water source, so the climate probably very closely approximated that in the neighboring Costeau area during the period of deposition there. Existence of tapir remains at Newport does not negate the postulated semiarid climate. Simpson (1945: 53) stated that although most tapir fossils in North America occur where the rainfall is now over twenty inches annually, a few, probably strays from more moist upland areas, did survive under semiarid conditions.

Environment: Herbivorous elements from the Newport faunas, especially locality 1066, indicate a grassland with nearby wooded areas. The grassland portion of the environment is reflected in part by such grazing forms as the horse, bison and camel, while the wooded segment is represented by megalonychid ground sloths, deer, tapir and the dusky-footed woodrat. The environment was probably very similar to the one at Rancho La Brea during the period of deposition there, as based on its faunal constituents.

San Pedro

General Statement

The Pleistocene vertebrate fauna from San Pedro was collected at UCMP Locality V-2047 in 1912, and is now on loan to the Los Angeles County Museum of Natural History. Locality records at the University of California Museum of Paleontology concerning this site are very sketchy and no data revealing the nature of the sediments containing the fauna are given. The location is simply listed as, "... immediately adjacent to the yards of the San Pedro Lumber Company." This site is evidently the lumber yard locality mentioned by Arnold (1903: 27). The Late Pleistocene sediments designated at this location by him (Plate 22) are marine sands and gravels. Since the only matrix adhering to some of the specimens is sand and gravel which include marine shells, the evidence tends to support the equivalence of the two localities. Also, marine vertebrates are included in the fauna.

Arnold (1903: 27) formally named the above-mentioned Late Pleistocene sands and gravels the upper San Pedro series. His type section, which no longer exists owing to commercial excavations, was presumably the old lumber yard locality (Fig. 1) at the north end of San Pedro bluff (about three-fourths of a mile north of San Pedro city hall).

Stratigraphy

According to Woodring, Bramlette and Kew (1946: 56), the name "San Pedro" was restricted to Arnold's (1903) lower San Pedro series in a manuscript report by Kew, who proposed the name

"Palos Verdes formation" for the upper San Pedro series. The new formational name was first used in print by Tieje (1926). Woodring et al. (1946) proposed the name "Palos Verdes sand" to replace "Palos Verdes formation" since sand is the prevailing sediment (both names are used currently, however). They restricted this formation to the marine sediments on the first emergent terrace, whereas Arnold included both marine and nonmarine deposits in his upper San Pedro series.

The following stratigraphic account of the Palos Verdes Sand, the formation containing the San Pedro fauna listed in this report, is taken from Woodring et al. (1946: 56). "The Palos Verdes sand, like the older marine terrace deposits, consists of a thin veneer on the terrace platform, which bevels formations ranging in age from lower Pleistocene to Miocene. Also like the older marine terrace deposits, the strata consist generally of coarse-grained sand and gravel but include silty sand and silt. Limestone cobbles are the prevailing constituent of the gravel, but granitic and schist pebbles are locally abundant. The Palos Verdes [Sand] generally ranges in thickness from a few inches to 15 feet and is usually less than 10 feet. At places it consists of thin lenses, and at other places it is absent. In San Pedro the terrace and the deposits lying on it have the expectable gentle seaward slope. Along the north border of the [Palos Verdes] hills they are deformed, mildly in the eastern part of the area, more strongly in the western part. In the area where they are deformed the deposits were originally terrace deposits, but the platform on which they rest has no longer the usual form of a terrace."

Systematic Discussion of Fauna

Class PISCES

Two spines and a vertebra of a bony fish and a tail spine of a ray, probably *Urolophus,* are the only representatives of this class in the fauna.

Class AMPHIBIA
Order ANURA
Family RANIDAE
cf. *Rana*

An incomplete tarsus of a moderately large frog is contained in the San Pedro fauna, UCMP 19755.

Class REPTILIA
Order SQUAMATA

The only reptilian elements recovered from San Pedro are five snake vertebrae representing an unidentified genus. One vertebra is isolated, and the other four are articulated in pairs.

Class AVES
Order ANSERIFORMES
Family ANATIDAE
Anas

The proximal portion of a carpometacarpus and the distal one-half of a humerus, UCMP 19737, indicate the presence of *Anas* in the fauna. Size and configuration of the bones closely correspond to the teal, a relatively small duck.

Class MAMMALIA
Order EDENTATA
Family MEGALONYCHIDAE

Discussion: The two edentate specimens in the San Pedro fauna, both second phalanges, have been described and discussed in Stock's monograph on Cenozoic gravigrade edentates (1925: 118-119). One, UCMP 38194, apparently represents *Megalonyx* as identified by its transversely compressed and dorsoventrally expanded trochlea. Although its configuration closely compares to other *Megalonyx* second phalanges, its size (measurements given by Stock, 1925: 119) is a little larger than the few corresponding elements of this genus from Rancho La Brea. The other phalanx from San Pedro, UCMP 19720, was reported by Stock (1925: 119) as being similar to *Nothrotherium* but much larger. He indicated that this specimen might represent a new genus or species of ground sloth. A study of the copious *Nothrotherium shastense* material from San Josecito Cave in Mexico, however, shows that specimen 19720 is neither larger nor different in morphology than some second phalanges in that fauna. As mentioned previously, the variation in Pleistocene ground sloths is very great.

Order LAGOMORPHA
Family LEPORIDAE
Lepus Linnaeus

Abundance: Two individuals, based on right calcanea, UCMP 19736 and 19754. Three specimens, including an incomplete ulna (unnumbered).

Discussion: Although the species of jackrabbit from the fauna may be *Lepus californicus,* the only one known (fossil or Recent) from southwestern California, the type of material does not seem to warrant an identification to the species level. Each of the specimens was found similar in size and form to *Lepus* and much larger than the only other genus of rabbit reported from the area, *Sylvilagus.*

Sylvilagus cf. *bachmani* (Waterhouse)

Abundance: Two individuals, based on palates. 10 specimens, including three palates, a jaw frag-

ment, three distal ends of humeri, two tibiae and a femur fragment.

Discussion: The specimens are tentatively referred to *Sylvilagus bachmani* on the basis of small size and simplicity in the enamel pattern of the cheek teeth. Despite the fact that *S. bachmani* is the only species recognized in this fauna, it is possible one or more of the postcranial elements could represent *S. audubonii*.

Order RODENTIA
Family SCIURIDAE
Citellus beecheyi (Richardson)

Abundance: One individual. Two specimens, including a palate with complete dentition, UCMP 38175, and a humerus, UCMP 19734.

Discussion: Based on its large size and the well defined metaloph on P4/, the San Pedro ground squirrel is assigned to *Citellus beecheyi*. It is the only species recognized in Pleistocene deposits in and around the Los Angeles basin. For a more complete discussion of this squirrel and a comparison with other forms, see page 12.

Family GEOMYIDAE
Thomomys bottae (Eydoux and Gervais)

Abundance: 19 individuals, based on right jaws. 50 specimens, including jaws and palates.

Discussion: The most abundant representative of the San Pedro fauna is the pocket gopher. Its cranial and dental features, especially the configuration of P4/4, coincide only with *Thomomys bottae*. The size range of the fossil specimens is well encompassed by the numerous extant subspecies. *T. bottae* is the only gopher recognized in any of the deposits discussed in this paper.

Family CRICETIDAE
Neotoma cf. *fuscipes* Baird

Abundance: Two individuals, based on right jaws, UCMP 38199 and 38200.

Discussion: Although the variation in species of *Neotoma* is apparently great, the two present specimens closely resemble only *N. fuscipes*. These jaws are relatively large but do not exceed the maximum size noted for the species. Dental characters, too, are circumscribed within the variability of the species.

Microtus cf. *californicus* (Peale)

Abundance: Three individuals, based on palates. Six specimens, including palates and jaws, UCMP 19737.

Discussion: Based on the unconstricted condition of the posterior portion of the incisive foramina and the size of the specimens, the San Pedro *Microtus* is tentatively assigned to *M. californicus*. The width of the posterior portion of the incisive foramina in the three existing palates is not as great as that observed in specimens from Costeau Pit and Newport. It does correspond well with living representatives now in the area, however.

Order CETACEA

Discussion: The only known cetacean specimens from the San Pedro site are not sufficiently diagnostic to allow more than ordinal classification. UCMP 38208, a caudal vertebra, represents a moderately small whale, while UCMP 19762, a vertebra epiphysis, is indicative of a large cetacean.

Order CARNIVORA
Family CANIDAE
Canis cf. ***dirus*** (Leidy)

Abundance: One individual, based on a right calcaneum, UCMP 38195.

Discussion: The calcaneum is shown to be canid rather than felid by its lack of a distinct peroneal tubercle and by the configuration of the sustentacular and astragalocalcaneal facets. Its size greatly exceeds that of the coyote but does compare favorably with the dire wolf, to which it is tentatively referred. The calcaneum could belong to the gray wolf possibly but that species is very poorly known from southern California.

Family MUSTELIDAE
Enhydra lutris (Linnaeus)

Abundance: One individual, based on the proximal half of a humerus, UCMP 38215.

Discussion: This specimen was discussed in some detail by Mitchell (1966: 1901-1904) in his recent paper on sea otters. Since the genus *Enhydra* is generally considered monotypic and the humerus corresponds well with recent material, the specimen is placed in the living species, *E. lutris*.

Family FELIDAE
Smilodon cf. *californicus* Bovard

Abundance: One individual, based on a basicranial fragment, UCMP 19729.

Discussion: This specimen consists of the mastoid and the portion of the squamosal bearing the glenoid fossa. It was compared to all available large felids and differs from true cats by the prominent mastoid which is in close proximity to the postglenoid process. This basicranial fragment, which is abraded on the edges, compares very favorably with the Rancho La Brea saber-tooth cat, *Smilodon californicus*. It was noted during comparison that the mastoid region in this species is highly variable.

Felis cf. *atrox* (Leidy)

Abundance: One individual, based on a lower second incisor, UCMP 38212.

Discussion: A comparison with various felid types indicates that this specimen represents a large cat, larger than the cougar. The incisor differs from the I/2 of *Smilodon* by being distinctly shorter and relatively wider. However, it is indistinguishable from the same tooth of *Felis atrox*. The giant jaguar is not known in any other site discussed in this report, even though the brea deposits in southern California yield many specimens of this animal.

Felis cf. *concolor* Linnaeus

Abundance: One individual, based on metacarpal II.

Discussion: This specimen is as long as the corresponding bone in the few available specimens of *Felis concolor* studied but it is more slender. However, the difference is not great and probably does not exceed the limits of variation for the species (greatest length, 75.0 mm; greatest proximal anteroposterior diameter, 15.8 mm; greatest proximal transverse diameter, 11.0 mm and greatest distal transverse diameter, 12.7 mm).

Order PERISSODACTYLA
Family EQUIDAE
Equus Linnaeus

Abundance: One individual. Six specimens, including a lower deciduous premolar, UCMP 19722, an incomplete upper molar, UCMP 38197, a thoracic vertebra, UCMP 38210, a second phalanx, UCMP 19721, and two femoral shafts, UCMP 19760 and 19761.

Discussion: Because the upper molar is greatly weathered, no meaningful comparisons to other *Equus* teeth can be made. The deciduous premolar compares very favorably to specimens from Rancho La Brea in all details of size and configuration. Unlike the equid specimens from Newport, all six elements from San Pedro correspond with average rather than smaller individuals from the Rancho La Brea deposits.

Order ARTIODACTYLA
Family CAMELIDAE
Camelops cf. *hesternus* (Leidy)

Abundance: Two individuals, based on size. Six specimens, including three vertebrae, UCMP 19725, 38213 and 38209, two metacarpals, UCMP 38192 and 38214, and an astragalus, UCMP 38196.

Discussion: An adult and a juvenile individual are represented by the specimens which correspond well with similar ones of *Camelops hesternus* from Rancho La Brea and McKittrick. *Camelops minidokae* Hay, also known from Pleistocene deposits in California, is noticeably smaller and thus far has not been recognized in sediments postdating an Irvingtonian age. Although *Tanupolama* is present in Pleistocene deposits of southern California, it is represented by animals eminently more slender than the last named genus.

Family CERVIDAE
Odocoileus cf. *hemionus* (Caton)

Abundance: Two individuals, based on size. Five specimens, including two vertebrae, UCMP 38205 and 19730, the distal half of a humerus, UCMP 38206, a metapodial fragment, UCMP 19730, and a phalanx, UCMP 38195.

Discussion: Only one type of deer has been reported from the Pleistocene and Recent of southern California, *Odocoileus hemionus*. Each element from San Pedro was compared with its counterpart in individuals of this species; no differences were evidenced.

Family ANTILOCAPRIDAE
Capromeryx Matthew

Abundance: One individual. Two specimens, including an M1/, UCMP 38193, and the distal end of a humerus, UCMP 38215.

Discussion: On the basis of limited comparative material, the humerus fragment differs only in being slightly smaller than *Capromeryx minor* Taylor from Rancho La Brea. The nature of this specimen does not allow meaningful measurements to be made. The present molar, which shows only a small amount of wear, appears very similar to the M1/ of *Capromeryx* from Rancho La Brea, McKittrick and Costeau Pit. The greatest anteroposterior diameter is 10.2 mm and the greatest transverse width is 6.4 mm (both measurements were made on the occlusal surface).

Family BOVIDAE
Bison cf. *latifrons* (Harlan)

Abundance: One individual. Two specimens, including an M/1, UCMP 38195, and a third cervical vertebra UCMP 38207.

Discussion: Although the tooth is not diagnostic to species, the vertebra apparently is. It is much larger than the third cervical of *Bison antiquus* but agrees well in size and rugosity with *B. latifrons* from Costeau Pit. Measurements taken on UCMP 38207 are: greatest width of head, 44.0 mm; greatest height of head, 69.2 mm; greatest length of centrum, 105 mm and greatest width and height of

the posterior articulating surface of the centrum, 58.2 mm and 58.4 mm, respectively.

Age and Correlation of the San Pedro Fauna

Age: The Palos Verdes Sand, from which the San Pedro fauna was recovered, has been dated by radiometric means and assigned an age of 100,000 to 130,000 years (Fanale and Schaeffer, 1965: 314), and unpublished reports of the U.S. Geological Survey). Presence of bison in the fauna is also indicative of a Late Pleistocene age. In fact no faunal constituent seems to contradict this time assignment. The small mammals are all referable to species now inhabiting the area.

Correlation: Although there is not an abundance of specimens in the San Pedro fauna, it is diverse taxonomically and compares very favorably with the fauna from LACM Loc. 1066 at Newport Bay Mesa, approximately twenty-five miles southeast. The great similarity of the two faunas helps to substantiate the contention that the deposits which contained them are the same age.

The terrestrial components from San Pedro also show great similarity to the taxa from Rancho La Brea. Since the only bison in the San Pedro fauna is apparently *Bison latifrons*, there is a suggestion, supporting the radiometric determinations, that this fauna is slightly older than the La Brea assemblage.

Presumed environmental differences and the limited aspect of the coastal assemblage tend to obscure the temporal relationship between the San Pedro and Costeau faunas. The two probably are in accord.

Late Pleistocene Climate and Environment at San Pedro

Climate: Arnold (1903: 29) stated that the marine invertebrate fauna from the upper San Pedro series (Palos Verdes Sand) in the vicinity of the San Pedro lumber yard indicated climatic conditions that are now approached two to three hundred miles farther south. He concluded that the climate on the coast near San Pedro during the period of deposition was as warm, if not warmer, than that at the present time. Valentine and Meade (1961: 38-39), however, pointed out that northern San Pedro (including the lumber yard locality of Arnold) was in a protected area and exhibited a very striking temperature contrast to the coastal waters of southern San Pedro, as shown by the contemporaneous species from the two areas. They concluded that the Late Pleistocene fossil assemblages from San Pedro, as well as others from southern California and northwestern Baja California, represent a time when near-shore water temperatures were more diverse (both warmer and cooler) than at present. As mentioned previously, Kanakoff and Emerson (1959: 33 and 42) reached this same conclusion concerning the invertebrates from Newport Bay, which reportedly come from the Palos Verdes Sand.

The San Pedro terrestrial fauna, because of its limited nature, does not offer a good basis for climatic interpretation. However, its similarity to the Rancho La Brea and Newport faunas suggests a semiarid condition for this area during the time of deposition. All the small mammals in the Rancho La Brea assemblage are currently living in southwestern California.

Environment: The terrestrial environment around San Pedro during the Late Pleistocene probably consisted of both grassland and wooded areas, much like that presumed for Rancho La Brea and Newport. Wooded areas could have existed in the adjacent Palos Verdes Hills (highest elevation at present is 1,480 feet) and a grassland probably extended to the northern border of San Pedro. The wooded portion of the environment is reflected by megalonychid ground sloths, the dusky-footed woodrat and deer, while the grasslands are suggested by horse, bison, camel and antilocaprid.

La Mirada

General Statement

The La Mirada site is situated in the easternmost part of the city of that name at the boundary of Los Angeles and Orange counties (Fig. 1). It was exposed in the banks of Coyote Creek, a tributary of the San Gabriel River, juxtaposed to Highway 39 from about Stage Road to Rosecrans Avenue. In this district there are presently floodplains and hills, with the Coyote Hills bordering the site to the northeast. These hills are a little in excess of 500 feet elevation and the Puente Hills, about four miles to the north, attain an elevation exceeding 1400 feet.

Unfortunately, I was able to make only a preliminary study of this locality before it was lined with cement as part of a flood control project. The indication from those who recovered fossils at this site is that only a small portion of the fauna has been collected. Most recovered fossils belong to private collectors who made them available for study.

Stratigraphy

According to Yerkes et al. (1965: A45), the

exposed deposits in the area of the La Mirada site, including the Coyote Hills, represent a thick succession (up to 2,300 feet) of Late Pleistocene sediments. These include a breccia-conglomerate, sandstone, siltstone and mudstone. The siltstone is reported as a Late Miocene detritus that is mixed in with various other sediments. These deposits, which are exposed at the headwaters of Coyote Creek along the south flank of the Puente Hills, overlie marine beds of Early Pliocene to Early Pleistocene ages. Marine mollusks and fragments of cetacean bones found at the fossil site probably represent a reworking of these sediments.

Before the La Mirada locality was covered with cement, some of the collectors pointed out to me the general zone of fossil recovery. It extends upward four to six feet from the base of the stream bed, the top of the zone being about fourteen feet beneath the land surface. Specimens were recovered over a distance measuring several hundred yards. The sediments encasing the fossils are mostly silts and sands which vary in color from grayish green to reddish brown and are nearly horizontal in attitude. Locally, plant debris is common. Unfossiliferous silts and sands, dark brown to buff in color, overlie the fossiliferous deposits. The entire exposed section reveals numerous facies.

Preservation and Method of Fossil Recovery

Some bones from the La Mirada site show traces of permineralization and many appear leached. The former tend to be light to dark brown, while the latter are nearly white to buff in color. A few specimens are encrusted with a calcareous sandy silt. Abrasion is noticeable on many but not all specimens. A large number of the recovered bones are too fragmental for identification.

Initially, fossils from the present site were recovered along the creek bed after heavy rains. Subsequently, they were traced to the source area where they were excavated. Dry screening allowed recovery of many of the small vertebrates. Since the state of fossil preservation was usually good, special collecting techniques were not necessary.

Systematic Discussion of Fauna

Class PISCES

Two specimens are indicative of this class in the La Mirada fauna, an abraded shark tooth and a distorted fish vertebra. Both are evidently the result of reworked marine deposits.

Class AMPHIBIA
Order ANURA
Family RANIDAE
cf. *Rana*

Two pelvis fragments and the proximal ends of four humeri attest to the presence of a moderate sized frog in the fauna.

Class REPTILIA
Order CHELONIA
Family TESTUDINIDAE
Clemmys

The western pond turtle is well represented at La Mirada as shown by numerous shell fragments and a few incomplete limb elements. Seventy-eight pieces of shell are present.

Order SQUAMATA

Five isolated vertebrae of two unidentified snakes have been collected; four specimens are small, about the size of a garter snake, and one is moderately large, about the size of a rattlesnake.

Class AVES
Order ANSERIFORMES
Family ANATIDAE

One cervical vertebra and a proximal fragment of a carpometacarpus represent an undetermined genus of duck. Its size, as based on the two elements, slightly exceeds that of the teal.

Order GALLIFORMES
Family PHASIANIDAE
Lophortyx

The presence of quail at La Mirada is based on the distal end of a humerus.

Parapavo californicus

A complete radius and the superior end of a coracoid of this extinct turkey are components of the La Mirada fauna. They were indistinguishable from the many corresponding elements in the Rancho La Brea collection.

Class MAMMALIA
Order EDENTATA
Family MEGALONYCHIDAE
Megalonyx Harlan

Abundance: Two individuals, based on a radius (juvenile) and a median phalanx of the manus (adult).

Discussion: Both epiphyses are absent on the radius; nevertheless, its generic characters are evident. This specimen resembles the radius of *Megalonyx* and differs from that of *Nothrotherium* in its greater distal width, more pronounced medial sulcus, which extends to the proximal end, and shape of the bicipital tubercle. The radius is much less massive but longer than that of *Paramylodon*.

Although the phalanx is waterworn, it too most closely resembles *Megalonyx*.

Order LAGOMORPHA
Family LEPORIDAE
Sylvilagus Gray

Abundance: Two individuals, based on tibiae. 15 specimens, including a palate, three jaw fragments, a humerus, three tibiae, three pelves, two femora and two phalanges.

Discussion: As no teeth are present in the fauna it is doubtful that a positive determination to species can be made. However, since only two species of *Sylvilagus, S. audubonii* and *S. bachmani,* have been recognized in the Pleistocene and Recent of southwestern California, it is almost certain the fossils can be ascribed to one or both of these species. Upon comparison, all but one element was found compatible in size with *S. bachmani.* The exceptional specimen, the distal part of a tibia, is comparable in size to a large individual of *S. audubonii.*

Order RODENTIA
Family GEOMYIDAE
Thomomys bottae (Eydoux and Gervais)

Abundance: Six individuals, based on left jaws. 16 specimens, including jaws and isolated teeth.

Discussion: Of the eight jaws represented in the fauna, seven are edentulous. The few teeth present, however, do show features indicative of *Thomomys bottae.* This is best demonstrated by P/4, the characters of which have already been discussed. The size of the specimens from La Mirada is also in agreement with the only species of gopher recognized in the vicinity of the Los Angeles basin.

Family CRICETIDAE
Peromyscus Gloger

Abundance: One individual, based on a right lower first molar.

Discussion: Six species of *Peromyscus* are presently known in southern California. Of these, *P. maniculatus, P. eremicus, P. boylei* and *P. truei* correspond to the La Mirada species in size. *P. crinitus* is smaller and *P. californicus* is larger. The fossil specimen does not exhibit a distinct anterointernal inflection on the anteroconid as is usually found in *P. maniculatus.* However, the present material is inadequate to eliminate this or any of the remaining species from consideration.

Microtus cf. *californicus* (Peale)

Abundance: Two individuals, based on an incomplete right jaw containing the first molar and an isolated right, first lower molar.

Discussion: Very limited material which excludes palatal specimens prohibits a definite species assignment to the La Mirada *Microtus.* It does, however, compare more closely to the larger specimens of *M. californicus* than to any other species.

Order CARNIVORA
Family CANIDAE
Canis cf. *latrans* Say

Abundance: One individual, based on a jaw fragment.

Discussion: The specimen contains only the roots of two teeth, probably P/4 and M/1. It is tentatively assigned to *Canis latrans* because its size and configuration are encompassed by jaws of that coyote in the Rancho La Brea collection.

A few coprolites contained in the fauna can probably be attributed to *C. latrans.* Elements of *Thomomys* are present in one.

Canis cf. *dirus* (Leidy)

Abundance: One individual, based on an upper second premolar.

Discussion: Even the roots are intact on this littleworn tooth. It was compared to the accordant tooth in several skulls of the recent gray wolf and found to differ from them by being noticeably more massive. The size as well as the configuration of this tooth is, however, indistinguishable from specimens of *Canis dirus* from the Rancho La Brea and McKittrick faunas (greatest anteroposterior length, 16.1 mm; greatest mediolateral width, 8.2 mm).

Urocyon cf. *cinereoargenteus* (Schreber)

Abundance: One individual. Five specimens, including a cervical and thoracic vertebra, a humerus, a femur and an astragalus.

Habitat: The gray fox is usually found where open woods or a chaparral cover prevail.

Discussion: With the exception of the thoracic vertebra, all the specimens are complete. They were compared with the Recent foxes found in the United States and Mexico. Since no cranial material exists in the present fauna, identification is based mostly on size. *Vulpes velox* (Say) and *V. macrotis* Merriam (according to Hall and Kelson, 1959: 860, the former species may be only subspecifically different from the latter), the kit fox and swift fox respectively, are much smaller than the species from La Mirada. *Vulpes fulva* (Desmarest), the red fox, is comparable in size but does not inhabit southern California. Also, this fox was possibly introduced from Europe. *Urocyon,* the only other genus of fox present today, is repre-

sented by two species, *U. cinereoargenteus* and *U. littoralis* (Baird). The last named species is distinctly smaller than the first and is known only from islands along the coast of southern California.

The La Mirada material compares favorably in size and morphology only with the remaining species of fox, *Urocyon cinereoargenteus*. This species, which is currently widespread throughout the United States and Mexico, is present in the Rancho La Brea fauna.

Family PHOCIDAE

Discussion: Three vertebrae, two cervicals and a thoracic, of a juvenile phocid were found associated with the terrestrial vertebrates at La Mirada. Although sufficient comparative material was not available for generic determination, is was adequate for familial identification. The fossil cervical vertebrae resemble phocids and differ from otariids in their anteroposteriorly compressed condition and tripartite centra.

At least three explanations are possible to account for the anomalous presence of seal in a nonmarine deposit. Since some marine animals have been deposited from reworked pre-existing sites, it could be assumed that this explains the occurrence of the phocid. However, the few reworked cetacean bones recovered from the deposit are much more abraded, highly permineralized and of a different color. Another possibility is that an extension of the sea was in close proximity to the La Mirada site during the Late Pleistocene. And as based on current observations, terrestrial carnivores could have dragged stranded seals some distance back from the beach. The third possibility is that Coyote Creek had sufficient water to allow seals to swim some distance upstream. According to Scheffer (1958: 88 and 91), some phocids are known to ascend rivers and have been observed regularly inhabiting freshwater lakes.

Family URSIDAE

Ursus americanus Pallas

Abundance: One individual, based on a skull with lower jaws, LACM 17161.

Habitat: The habitat of the black bear in the western United States is presently in forested areas. A more widespread range during prehistoric times probably included more sparsely wooded regions.

Discussion: An essentially complete bear skull in association with articulated lower jaws (Fig. 25) was found at the La Mirada site. Both specimens, which belong to one individual, were moderately fractured and misshapen when removed. They have subsequently been restored. The degree of tooth wear indicates a mature animal, probably a female

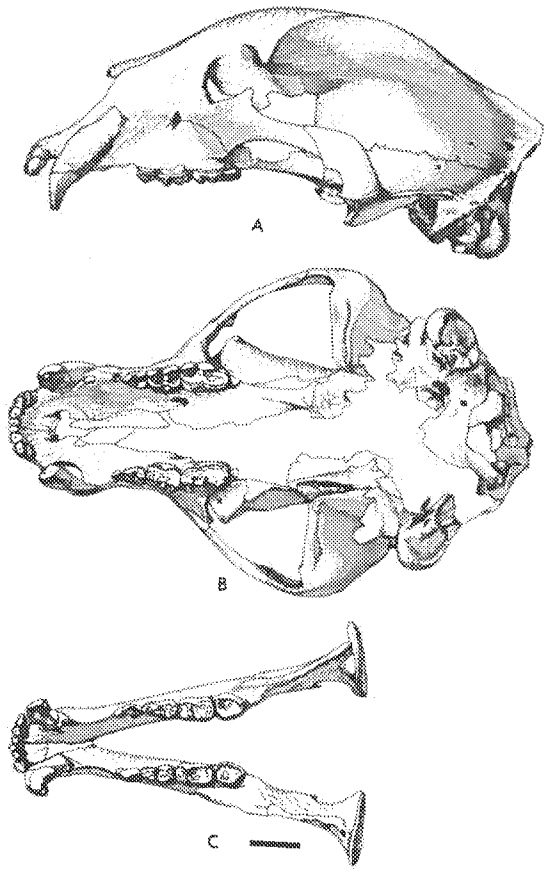


FIGURE 25. *Ursus americanus*, LACM 17161, La Mirada, Loc. 6689: A, left lateral view of skull; B, occlusal view of skull; C, occlusal view of mandibles. Line beneath figure represents 30 mm.

by the relatively small size of the canines. Except for three reduced upper premolars, the entire dentition is intact in skull and jaws.

The La Mirada bear can be distinguished from *Tremarctos* and *Arctodus*, tremarctine bears, by its relatively longer and more slender skull, lack of premasseteric fossa and a mandibular condyle which is on a plane with the cheek teeth rather than above it. There is close agreement, however, between the present material and specimens of *Ursus* which represent another major group of North American Pleistocene bears (see Merriam and Stock, 1925, for a diagnosis of tremarctine and ursine bears).

In his identification of the adult ursine skull from Rancho La Brea, Kurtén (1960) compared characteristics of grizzly and black bears. He noted that in living representatives the former noticeably exceeded the latter in size. However, it was em-

phasized that the Pleistocene black bear was distinctly larger than its living counterpart and was similar to both fossil and Recent grizzlies in this respect. Although the La Mirada black bear skull is as large as the fossil grizzlies listed by Kurtén, its cheek teeth are markedly smaller. Also, the width between orbits and between postorbital processes is greater in the present skull than in the grizzly. Using Kurtén's measurements (1960: 5), the La Mirada specimens very closely resemble the fossil black bear, *Ursus americanus.*

Many of the following points of measurement on the La Mirada skull relate to those used by Kurtén (1960: 5) on fossil and Recent *Ursus:* greatest length of skull, 315 mm; basal length of skull, 272 mm; greatest width (across zygomatic arches), 196 mm; width of postorbital constriction, 78 mm; width across postorbital processes, 110 mm; interorbital width, 75 mm; muzzle width (across M2/), 79 mm; rostral width (across C1/), 74 mm; C1/ (length), 12.7 mm; m1/ (length), 20.0 mm; M1/ (width), 15.1 mm; M2/ (length), 28.6 mm; M2/ (width), 17.2 mm; greatest length of jaw, 214 mm; least depth of jaw at diastem, 39 mm; depth of jaw at anterior border of M/3, 47 mm; greatest length of tooth row (P/4 - M/3), 76 mm; M/1 (length), 21.8 mm; M/1 (width), 11.2 mm; M/2 (length), 22.0 mm; M/2 (width), 13.9 mm; M/3 (length), 17.5 mm and M/3 (width), 14.9 mm.

Fossil *Ursus* specimens are rare in the deposits of southern California but a few have been recovered from the brea deposits at McKittrick and Rancho La Brea. Schultz (1938) identified a new black bear from the former locality, *Ursus optimus,* and referred the one from the latter locality to the same species. However, Kurtén (1960: 3) placed *U. optimus* in synonymy with *U. americanus.*

Family FELIDAE
Lynx cf. *rufus* (Schreber)

Abundance: One individual. Two specimens, including a calcaneum and a proximal phalanx.

Habitat: Rocky, brushy country is the preferred habitat of the bobcat.

Discussion: Both specimens are representative of a small mature cat. They were closely compared with numerous corresponding elements of fossil and Recent bobcat from the southwestern United States and found to agree well with the smallest ones seen. The Canadian Lynx, *Lynx canadensis* Kerr, is usually a little larger than the bobcat and has distinctly larger feet (Ingles, 1965: 392-393). Also, this cat is restricted to the colder regions of North America, whereas *Lynx rufus* ranges from Canada to Mexico (greatest length of phalanx, 19.3 mm; greatest length of calcaneum, 37.5 mm; greatest width of calcaneum, 15.2 mm).

Order PROBOSCIDEA
Family MAMMUTIDAE
Mammut americanum (Kerr)

Abundance: Two individuals, based on size of elements. Five specimens, including a premolar, two molar fragments and two jaw fragments.

Habitat: The American Mastodon probably inhabited wooded areas throughout North America.

Discussion: Osborn (1936: 137) has listed numerous species of the genus *Mammut* in his extensive work on the proboscideans. However, only one species in the family Mammutidae is now generally acknowledged from the Pleistocene of North America, *Mammut americanum,* as shown by current usage.

M. americanum is recognized in the La Mirada fauna on the basis of brachyodont teeth which lack appreciable cement and exhibit open valleys between lophs. In addition to the elements previously listed, several others may possibly relate to this form. These include a tusk fragment, an incomplete rib and several limb fragments. It is possible, though, that these specimens represent a mammoth rather than a mastodon.

Order PERISSODACTYLA
Family EQUIDAE
Equus Linnaeus

Abundance: Two individuals, based on cheek teeth. 31 specimens, including 20 teeth, a maxillary fragment, a jaw, four vertebrae, a complete pelvis, a metacarpal, a splint bone, a calcaneum and a magnum.

Discussion: All elements were compared with cognate ones from Rancho La Brea and Costeau Pit. Based on the close similarity between the present specimens and those from the two localities just mentioned, especially regarding dentition, a common species is indicated. As previously discussed, the specific name is not yet resolved. The size of the La Mirada horse approximates the average Rancho La Brea equid.

Order ARTIODACTYLA
Family CAMELIDAE
Camelops cf. *hesternus* (Leidy)

Abundance: One individual. Ten specimens, including an incomplete jaw, two cheek teeth, five vertebrae and the proximal portions of a scapula and metacarpal.

Discussion: A comparison was made between each specimen and its corresponding element on

Camelops hesternus from the Rancho La Brea and McKittrick faunas; no significant differences were observed. Despite the close correspondence, though, the identification should remain tentative in the absence of adequate dental material.

Family CERVIDAE
Odocoileus cf. *hemionus* (Caton)

Abundance: One individual. Three specimens, including two antler fragments and a proximal portion of a scapula.

Discussion: All three elements show pronounced abrasion, especially the antler fragments. One of these displays numerous markings which suggest rodent gnawing. This was evidently done before the presumed stream transport. The three specimens compare closely to a small individual of the species currently found in southern California, *Odocoileus hemionus.*

Family BOVIDAE
Bison Smith

Abundance: Two individuals, based on size. Seven specimens, including two teeth, an incomplete vertebra, scapula, tibia and a complete astragalus and calcaneum.

Discussion: The cheek teeth, vertebra, scapula and tibia represent an adult animal; the astragalus and calcaneum, which evidently belong to the same individual, are indicative of a juvenile. None of the specimens are sufficiently diagnostic for a positive species identification but the adult elements appear to represent a large individual or individuals.

Age and Correlation of the La Mirada Fauna

Age: Radiometric dating (Geochron Laboratories, Cambridge, Mass.) of wood samples found in association with the fauna indicates an age of 10,690 ± 360 years B.P. The relative age suggested by the faunal assemblage is Rancholabrean, as each taxon present in it is represented by a similar constituent in the Rancho La Brea collection.

Correlation: As indicated above, the La Mirada fauna is in close agreement with the one from Rancho La Brea. Indeed, it would be difficult to establish a closer taxonomic harmony between two assemblages. Relative abundances of the different species may not be in complete mutual accord, but the sample from La Mirada is numerically too small to allow a meaningful comparison in this respect. The present fauna also is similar to the one from Costeau Pit and to terrestrial aspects of those from San Pedro and Newport Bay Mesa (LACM Loc. 1066). Its greater dissimilarity to the Costeau assemblage could be a reflection of environmental differences.

Late Pleistocene Climate and Environment at La Mirada

Climate: None of the animals recognized in the La Mirada fauna appear to be good indicators of climate. However, *Sylvilagus bachmani* and *S. audubonii,* one or both of which are present in the fauna, are very commonly found in semiarid regions, as is *Lophortyx,* the quail. Since the faunal assemblage from La Mirada is so similar to the others discussed in this paper which manifest semiarid conditions, there is a distinct probability that it does also. The abundance of pond turtle probably indicates that Coyote Creek, a major tributary of the San Gabriel River, was perennial. Although I saw no historic records that indicated early hydrologic conditions of Coyote Creek, it might have been ever-flowing during early settlement of the area as was the San Gabriel River. Climatic conditions prevailing at the time of deposition of the La Mirada fauna were presumably very similar to the climate today.

Environment: The composition of the fauna is such as to reflect both wooded and grassland conditions during the period of fossil depositions. The former is suggested by horse, camel and bison, and the latter by turkey, bear, lynx and deer. Present day topography suggests that the site bordered both habitats. Hills located immediately to the north and east were likely wooded in part and the Los Angeles plain, extending south and west, was evidently grass-covered.

MISCELLANEOUS PLEISTOCENE LOCALITIES IN THE LOS ANGELES BASIN AND VICINITY

LACM 1215. (Pleistocene) Oso Creek. Site near center of SW ¼ Sec. 13, T 7S, R 8W, San Juan Capistrano 7.5′ quadrangle, 1949 ed., about 800 ft north of BM 255. Tooth from 10 ft thick gravel bed which includes shell fragments and carbonaceous matter. Fauna—*Equus* (tooth).

LACM 1115. (Pleistocene) San Joaquin Hills. Stie at boundary of Secs. 3 & 4, T 8S, R 8W, San Juan Capistrano 7.5′ quadrangle, 1949 ed. Specimens found in stream terrace deposits that rest on the Miocene Capistrano Fm. Fauna—*Mammuthus* cf. *columbi* (incomplete skull including tusk fragments and two teeth).

LACM 1068. (Late Pleistocene) Bonita Creek. Site at base of irrigation ditch 100 yds east of Bonita Creek and about one-third mile northeast of locality 1067; lithology unrecorded. Fauna—*Sylvilagus* (pelvis fragment), *Tapirus* (jaw), *Equus* (femur, tibia and phalanx), *Camelops* (calcaneum and astragalus), *Odocoileus* cf. *hemionus* (antler fragments and phalanx), *Bison* (phalanx).

LACM 1100. (Late Pleistocene) Newport Bay Mesa. Specimen in ?Palos Verdes Sand one-half mile south of emergency air field (no longer in existence), 87 ft above sea level and 15 ft below level of runway. Fauna—*Bison* cf. *antiquus* (axis).

LACM 65113. (Late Pleistocene) Huntington Beach. Mammoth specimens collected at 5092 Wintersburg Rd about 6-8 ft below soil level, just above diatomaceous clay; coarse sand beneath this unit. Bison jaw recovered in diatomaceous sandstone 14-20 ft below soil. Site now covered by building. Fauna—*Mammuthus* (tooth and tusk fragments), *Bison* (jaw fragment).

LACM 6472. (Pleistocene) Fullerton. Site between Sections 23 and 24, T 3S, R 10W (La Habra 15′ quadrangle, 1952 ed.), on a hill about 1200 ft southwest of the western end of Fullerton dam; lithology unrecorded. Fauna—*Equus* (phalanx).

LACM 1052. (?Late Pleistocene) Imperial Highway. This site is discussed by Howard (1936), and is about one and one-half miles northwest of the La Mirada locality described in this paper. Both localities may occur in correlative deposits. Fauna—*Parapavo californicus* (distal portion of a radius), *Paramylodon* cf. *harlani* (incomplete jaw and vertebra), *Mammut* cf. *americanum* (tooth), proboscidean (femur and scapula fragments), *Equus* (teeth and limb elements), *Odocoileus* (scapula and phalanx).

LACM 1285. (Pleistocene) Artesia. Locality at Manville St. and P.C. railroad crossing at a depth of about 10 ft; lithology unrecorded. Fauna—*Equus* small sp. (femur).

LACM 1409. (Pleistocene) Seal Beach. Location just above shoreline on beach near 15th St. Museum notes (Aug. 1959) indicate specimen could have been uncovered by recent dredging in Los Alamitos channel and that it was found two or three days after a very heavy surf. Fauna—*Mammuthus* cf. *columbi* (tooth).

LACM 1121. (Pleistocene) Seal Beach. Specimens from small sandstone outcrop 15 ft beneath the sea (about 500 ft offshore) one-fourth mile north of gun club. Fauna—*Mammuthus* cf. *columbi* (skull fragments and teeth). A horn-core of *Bison* cf. *alleni* was reportedly found on the beach in the general area of this site.

LACM 2031. (Late Pleistocene) Long Beach. Site 100 yds north of Belmont pier; lithology unrecorded. Fauna—*Tapirus* (tooth), *Bison* cf. *antiquus* (femur, metatarsal and navicular-cuboid).

LACM 1144. (Late Pleistocene) Long Beach. Site in sewer excavation at 1211 Lomita Vista Dr. in sands and gravels; unrecorded depth. Fauna—*Bison* (incomplete jaw and femur fragments). Under this locality heading a site is mentioned at 12th and Pine Sts. in which a shark tooth, pinniped radius fragment and a distal fragment of a camelid femur were found at a depth of 48 ft.

LACM 1919. (Pleistocene) Wilmington Avenue. Specimens recovered 10 ft below street surface in an indurated sandy-silt, southwest of Dominguez Blvd., 400 ft northwest of Wilmington Ave. and 600 ft south of 223rd St. Fauna—cf. *Mammuthus* (humerus and ulna fragments).

LACM 1643. (Pleistocene) Dominguez Hills. Material uncovered in a new housing development excavation near Avalon and 190th Sts. at a depth of 8-10 ft in a sandy-silt. Fauna—*Mammuthus* (many postcranial elements of one individual).

LACM 1602. (?Late Pleistocene) San Pedro. Site at Wilmington and San Pedro Rds., 1,000 ft N 30° E of BM 11. Specimens recovered from ferruginous pebbly sand (?Palos Verdes Sand) containing many shells; 35-38 ft above sea level. Fauna—*Clemmys* (shell fragments), proboscidean (vertebra), *Equus* (jaw and pelvis fragment), cf. *Capomeryx* (metapodial fragment).

CIT 186. (Pleistocene) San Pedro. Site 100 ft northeast of corner of Pacific and Oliver Sts.; lithology unrecorded. Fauna *Clemmys* (shell fragments), *Canis* cf. *dirus* (tooth), Equus (teeth).

CIT 187. (?Late Pleistocene) San Pedro. Site at hill 48 on Wilmington quadrangle (1925 ed.), just west of Boschke Slough. This is probably equivalent to UCMP Loc. 2047, discussed in this paper. Fauna—*Megalonyx* (humerus).

LACM 1057. (Late Pleistocene) San Pedro Lumber Yard. This locality is evidently equivalent to UCMP Loc. 2047, discussed in this paper. Fauna—proboscidean (scapula fragments), *Equus* (vertebrae fragments).

LACM 1158. (Late Pleistocene) San Pedro. Location at Anaheim Ave. near Vermont Ave. in a pit excavation. Fossils recovered 135 ft below the street level in the ?Palos Verdes Sand. Fauna—*Equus* (teeth and phalanx), *Bison* (tibia fragment).

CIT 484. (Late Pleistocene) San Pedro. Site about 2 miles south of Highway 101 on Western Ave. Specimen from Palos Verdes Sand. Fauna—*Mirounga* cf. *angustirostris* (skull fragment).

LACM 1163. (Late Pleistocene) San Pedro. Specimens found 100 ft west of Henry Ford Blvd. near Anaheim Ave. at a depth of 5 ft; lithology unrecorded. Fauna—*Bison* (jaw fragments).

LACM 1056. (Late Pleistocene) San Pedro. Specimens taken from the Palos Verdes Sand 2 ft above the road level, one mile east of Hilltop Quarry. Fauna—*Bison* (fragments of a metapodial and horn-core).

LACM 1005. (Pleistocene) Bixby Park. Site on side of cliff near 17th Pl., 60 ft below the park sur-

face; lithology unrecorded. Fauna—*Mammuthus* cf. *columbi* (teeth).

UCLA 1063.12. (Late Pleistocene) San Pedro. Site at Second and Beacon Sts. Specimens recovered from the Palos Verdes Sand. Fauna—*Megalonyx* (incomplete skull and radius). Lyon (1938) based a new species on this skull, *M. milleri*. The only specific characters listed were the distinct slope of the supraoccipital region and narrow temporal region. Because the variability in sloths is great, including the first character listed (see Fig. 5), and the degree of difference between *M. milleri* and *M. jeffersoni* is slight, it is doubtful that this specimen represents a new species.

LACM 1228. (Pleistocene) Green Hills. Locality in Green Hills Memorial Park on Palos Verdes Dr. North and Western Ave. in the Palos Verdes Hills; lithology unrecorded. Fauna—cf. *Camelops* (teeth fragments).

LACM 1876. (Late Pleistocene) Palos Verdes. Site in the south wall of canyon just north of northernmost extension of Paseo del Mar St. and opposite school grounds. Skull located about 25 ft below ground surface in alluvium. Fauna—*Bison antiquus* (incomplete skull).

LACM 65107. (Late Pleistocene) Palos Verdes. Specimen recovered from Bent Spring Canyon, 200 ft west of Empty Saddle Club and 500 ft south of Empty Saddle Rd. in tan and white silty-sand (Palos Verdes Sand). Fauna—cf. *Camelops* (cuboid).

LACM 1087. (Late Pleistocene) Chandler's Sand Pit. Site just west of Narbonne St., about one-half mile south of Highway 101 in the northern portion of the Palos Verdes Hills. Fossils from sands and gravels (Palos Verdes Sand). Fauna—*Megalonyx* (phalanx), *Mammut americanum* (tooth), *Mammuthus* cf. *columbi* (teeth), *Tapirus* (maxilla), *Equus* (palate, teeth and radius), *Odocoileus* cf. *hemionus* (jaw fragment), *Bison* (vertebra).

LACM 1254. (Pleistocene) Redondo Beach (On the grounds of the Redondo Beach steam generating plant). Tooth collected at a depth of 27-30 ft; lithology unrecorded. Fauna—*Tanupolama* (tooth).

LACM 6705. (Pleistocene) Los Angeles Harbor. Specimen recovered in dredging operation at berth 128; water depth about 155 ft. Fauna—*Paramylodon* cf. *harlani* (incomplete jaw).

LACM 1839. (Pleistocene) Recharge Basin. Locality at Crenshaw Blvd. and 236th St. in Torrance. Specimen taken from marine deposit in stream channel about 35 ft below ground level. Fauna—*Equus* (tooth).

LACM 1165. (Late Pleistocene) Alameda and Sepulveda Boulevards. Site in excavation near intersection of above streets; lithology unrecorded. Fauna—*Bison* (atlas fragment).

LACM 2035. (Pleistocene) Hawthorne. Locality 75 ft west of Prairie Ave. on 139th St.; lithology unrecorded. Fauna—*Mammuthus* cf. *columbi*, incomplete skull (specimen not seen, Henry Wylde, 1968, personal communication).

LACM 1344. (Pleistocene) Harbor Freeway. Site in excavation for Los Angeles Harbor Freeway near Athens Blvd., about three-fourths of a mile south of locality 1295. Fossils taken from east side of freeway excavation in sands and silts; about 20 ft below street level. Fauna—*Citellus* cf. *beecheyi* (jaw), *Mammuthus* (tooth fragment), *Capromeryx* (jaw and metapodial fragment).

LACM 1295. (Late Pleistocene) Harbor Freeway. Specimens recovered from the Los Angeles Harbor Freeway excavation between 112th and 113th Sts. in a greenish gray argillaceous silt, 16-21 ft below the road level. Fauna—cf. *Clemmys* (shell fragment), *Paramylodon* cf. *harlani* (humerus), *Thomomys* cf. *bottae* (jaws and isolated teeth), *Canis* cf. *dirus* (humerus and radius fragments), *Canis* cf. *latrans* (maxillary fragment), *Equus* (skull and jaw fragments, isolated teeth and vertebrae), *Odocoileus* cf. *hemionus* (antler fragments), *Bison* cf. *antiquus* (vertebrae, tibia and phalanges).

LACM 1225. (Pleistocene) Harbor Freeway. Site in excavation for the Los Angeles Harbor Freeway near 99th St. Specimens taken 15-20 ft below the street level; lithology unrecorded. Fauna—cf. *Mammuthus* (radius and tibia fragments and a calcaneum).

LACM 1198. (Pleistocene) Los Angeles. Site at 801 S. Tremaine St. in a Los Angeles County Flood Control Project excavation. Material recovered 17 ft beneath the street surface in a sandy-clay. Fauna—proboscidean (jaw fragments).

LACM 1170. (Pleistocene) Centinella Park. Specimens found in excavation for pistol range just north of Florence Blvd. in Inglewood. Fauna—*Megalonyx* (astragalus), *Mustela* cf. *frenata* (jaw), *Felis* cf. *atrox* (tooth), *Platygonus* (tooth), *Capromeryx* (tooth).

LACM 1180. (Pleistocene) Manchester and Airport Boulevards. Site 13½ ft below surface in excavation for telephone building at northeast corner of intersection. Specimens recovered from a green to buff colored sand. Fauna—cf. *Mammut* (tusk fragments), *Equus* (metapodial fragments).

LACM 1783. (Late Pleistocene) La Brea Boulevard and San Vicente Street. Site in a sewer excavation 16 ft beneath the ground surface. Specimens from a brown sand unit just above a grayish green sandy clay. Fauna—*Paramylodon* cf. *harlani* (humerus), *Equus* (pelvis), *Bison* (femur fragment).

LACM 1272. (Pleistocene) La Brea and Venice Boulevards. Material recovered from a storm drain excavation 300 ft west of La Brea and 23 ft below the surface. Sediment consists of a coarse sand with included carbonaceous matter; clay lenses occur above and below the sand unit. Fauna—*Mammuthus* (tooth fragments).

LACM 1276. (Late Pleistocene) La Brea Boulevard. Location on 1300 block of above street in Los Angeles. Specimens from excavation 9-12 ft below the street surface in blue sandy-clay which underlies a gravel bed. Fauna—*Bison* (humerus fragment).

LACM 1238. (Pleistocene) Olympic Blvd. and Alvira St. Site in excavation for a Los Angeles County Flood Control Project. Top of fossil 13 ft beneath level of sidewalk in a sandy clay. Fauna—*Mammuthus* (specimen not seen, reported as skull and tusks).

LACM 2032. (Pleistocene) Los Angeles Brickyard. Locality at Mission Rd. and Daly St., 20-35 ft below the ground surface in a clay deposit. Fauna—*Clemmys marmorata* (carapaces), *Paramylodon harlani* (jaws, teeth, humerus, tibia and dermal ossicles), *Mammut americanum* (much of a single individual), *Mammuthus* cf. *columbi* (teeth and miscellaneous postcranial elements), *Equus* (teeth and tibiae), *Camelops* (tibia).

LACM 2033. (Late Pleistocene) Beverly Hills. Location at Melrose Ave. and La Cienega Blvd.; lithology unrecorded. Fauna—cf. *Gopherus* (carapace fragments), *Mammuthus* cf. *columbi* (tooth and miscellaneous fragments, cf. *Camelops* (teeth fragments), *Bison* (jaw and vertebrae fragments).

LACM 2034. (Pleistocene) Kilkea Dr. and Beverly Blvd. Site in north outfall sewer excavation. Stock (1924) gave information on a geographically related site in this sewer excavation where human remains were uncovered. Fauna—*Mammut* cf. *americanum* (teeth and tusk fragments), *Mammuthus* cf. *columbi* (jaw).

LACM 1157. (Pleistocene) Consolidated Rock Company. Site in gravel pit on Alameda St. near 26th St. in Los Angeles; lithology unrecorded. Fauna—*Mammut* cf. *americanum* (tooth).

LACM 2029. (Late Pleistocene) 16th and Alameda Sts. Locality in Blue Diamond Co. Gravel pit, Los Angeles; lithology unrecorded. Fauna—*Mammuthus* cf. *columbi* (incomplete jaw with tooth), *Bison* cf *antiquus* (atlas).

LACM 1268. (Pleistocene) 3rd and Edinburough Sts. Site at 8000 W. 3rd St. in Los Angeles, 20 ft beneath the ground surface in wet sandy mud. Fauna—proboscidean (miscellaneous fragments).

LACM 1604. (Late Pleistocene) Wilshire Blvd. and Orange Grove Dr. Locality at 600 Wilshire Blvd. in Los Angeles. Specimen found 15 ft below ground level in excavation for the Seibu Department Store in a grayish black clay lens, with included sands and silts. Fauna—*Bison* cf. *antiquus* (radius).

LACM 1023. (Pleistocene) Workman and Alameda Sts. Site in storm drain excavation. Fauna—cf. *Parapavo* (tibiotarsus fragment and phalanx; these specimens and the site were briefly mentioned by Howard, 1936), *Smilodon* cf. *californicus* (jaw), *Equus* (tooth fragments), *Odocoileus* cf. *hemionus* (teeth and astragalus).

LACM 1893. (Late Pleistocene) Santa Monica Freeway. Site in freeway excavation 75 yds east of Gramercy St. in Los Angeles. Specimens recovered from sands and gravels below recent fill; unrecorded depth. Fauna—*Bison* cf. *antiquus* (radius) cf. *Mammuthus* (humerus fragment).

LACM 1266. (Pleistocene) Hyde Park. Site in an excavation for outfall sewer at a depth of 80 ft; lithology unrecorded. Fauna—*Mammuthus* (tooth fragment).

LACM 2027. (Pleistocene) Pasadena. Locality on 1600 block of Bridgen Blvd.; lithology unrecorded. Fauna—*Mammuthus* (tooth fragment).

CONCLUSIONS

None of the Pleistocene terrestrial mammals listed by Hibbard (1958) and Hibbard et al. (1965) as being suggestive of Illinoian or an older age have been identified in or near the Los Angeles basin. Conversely, all the mammals given in this report are recognized in either Sangamon or later age deposits. This is indicative of the relative recentness of the nonmarine strata that have been investigated in the area and suggests that the Los Angeles basin may not have been available as a habitat for terrestrial vertebrates until after Late Pleistocene time had commenced. Just how much earlier the sea retreated from this basin is not definitely known. However, it is doubtful that much time would be required to develop a suitable plant cover which could support vertebrate life. Yerkes et al. (1965: A19) have indicated that much, if not all, of the Los Angeles basin was inundated until some time in the Late Pleistocene. The terrestrial vertebrates seem to confirm this. Although a relatively good sampling of the nonmarine vertebrates in the basin has yielded nothing earlier than a Rancholabrean age, earlier Pleistocene land animals may be uncovered after more extensive searchings of its upland borders or investigations of more deeply buried nonmarine basinal deposits

are made. Irvingtonian age vertebrates are known, though, in southern California from Riverside County, Bautista fauna, and San Diego County, Vallecito fauna.

All the fossils reported in this paper, which are from known stratigraphic levels, are contained in essentially flat-lying beds. However, the underlying strata, Pleistocene or older, are usually inclined. A similar condition prevails in the San Francisco Bay area; as Savage (1951; 289) has stated, "The beds of rock containing Rancholabrean faunas in the San Francisco Bay region may often be distinguished from earlier deposits by a relatively flat-lying attitude." It therefore seems possible that the structure of Late Cenozoic strata in the Los Angeles basin and vicinity can be used as an aid in recognizing Rancholabrean age deposits.

There are differing interpretations of the climate for the Los Angeles basin and vicinity during the Late Pleistocene (Axelrod, 1966; Stock, 1963; Mason, 1944; Miller, 1929; Frost, 1927 and others). Axelrod[1] (1966: 42–44) has stated that two floras are present in the deposits at Rancho La Brea. The older is said to be typified by closed-cone pines and represents a temperate, humid climate of later Wisconsin age and the younger by juniper and hackberry which evinces a semiarid climate of the Xerothermic period. He suggested that the former flora was present no more than 14,000 years ago and possibly as late as 8,500 years B. P. Dates compiled by Berger and Libby (1966) and ones as yet unpublished thus far indicate that the major fossil assemblage at Rancho La Brea is older than 14,000 years B. P. Since the pine flora is very limited (only a few incomplete cones exist) and the juniper-hackberry flora is abundant (it is apparently present throughout the pits at all depths), there is not sufficient evidence presently to indicate two distinct floras. Mason (1944), in opposition to Axelrod's interpretation, regarded the flora at Rancho La Brea as a single unit that reflects interior (semiarid) conditions. Axelrod (1966: 44) also pointed out that the desert shrew *(Notiosorex crawfordi)* from the Rancho La Brea deposits is associated with the Xerothermic flora. However, this species has been found at Costeau Pit and Newport Bay Mesa in faunas that either predate the La Brea accumulation, or correlate with early stages of deposition there.

The Late Pleistocene terrestrial vertebrates of the Los Angeles basin, as presently identified, do not appear to reflect climatic fluctuations. As previously discussed, each one appears compatible with semiarid conditions. Probably some climatic variation, synchronous with major changes elsewhere, did transpire during the Late Pleistocene in the Los Angeles basin. And since plants in general are more delicate indicators of climate than animals, they may show these changes. However, it will necessitate a very careful investigation of the fossil floras to show these possible fluctuations. It is conceivable that the climatic changes which affected most areas during the Late Pleistocene, possibly including the mountains of southwestern California (Axelrod, 1966: 53), had no profound effect on the climate in areas such as the Los Angeles basin, where lowlands in lower latitudes are in close proximity to the climate-regulating sea. An examination of the Life-Zones map of California by Grinnell (1935, plate 3) reveals the ocean's ameliorating effect on climate.

The greater thermal diversity of the ocean in the San Pedro and Newport areas during the Late Pleistocene, suggested by Valentine and Meade (1961) and Kanakoff and Emerson (1959), respectively, could have been the result of colder currents than presently exist at these localities, coming in close proximity to water in the bays which were heated under local conditions. Fitch (1966: 15) stated that the fish fauna of Playa Del Rey (located at the present Santa Monica Bay) suggested warmer near-shore waters for the Late Pleistocene than now exist. Colder waters might have resulted from upwelling currents or in response to cooler conditions nearer their source. As mentioned before, the land vertebrates in the mixed marine-nonmarine faunal assemblages of Newport and San Pedro do not reflect a climate colder than the existing one.

Stock (1963: 16) expressed the opinion that the two different environmental assemblages of mammals at Rancho La Brea (mastodon, *Megalonyx*, peccary, deer and others in one group, and mammoth, *Paramylodon*, camel, bison, horse and many more in the other group) might have been an indication of changing climatic conditions during fossil accumulation. He suggested that the former group could represent the terminal phase of the last glacial and the latter one might indicate a post-glacial stage. I believe that these two groups were probably contemporaneous. Mixed assemblages

[1]He (1966: 44) stated that evidence of closed-cone pine in floras from Wilmington and Santa Monica support the thesis for a pronounced temperate, humid climate in the Los Angeles basin during the Late Pleistocene. However, these floras, which contain only a few pine specimens, are both from locations adjacent to uplands; the Palos Verdes Hills border the former and the latter is in the foothills of the Santa Monica Mountains. Also, juniper and hackberry are common constituents of these floras.

very similar to this are known at La Mirada, San Pedro, Newport Bay Mesa and elsewhere in the Los Angeles basin in deposits that are much more temporally restricted, as inferred from sediment type and thickness. The more temperate aspect of the Rancho La Brea fauna was evidently derived from adjacent wooded uplands, while the major faunal component occupied the existing grasslands.

TABLE 1

Pleistocene Mammalian Faunas from Sites in the Los Angeles Basin and Vicinity

(x = presence of taxon; — = absence of taxon; cf. = compares with taxon)

Taxon	Rancho La Brea	Costeau Pit	Newport Bay 1066	Mesa 1067	San Pedro	La Mirada
Order Insectivora						
Family Soricidae						
Sorex ornatus	cf.	—	—	x	—	—
Notiosorex crawfordi	x	x	—	x	—	—
Family Talpidae						
Scapanus latimanus	—	—	—	x	—	—
Order Chiroptera						
Family Vespertilionidae						
Antrozous pallidus	—	—	—	x	—	—
Order Edentata						
Family Megalonychidae						
+*Nothrotherium shastense*	x	—	x	—	cf.	—
+*Megalonyx jeffersoni*	x	—	cf.	—	cf.	cf.
Family Mylodontidae						
+*Paramylodon harlani*	x	cf.	—	—	—	—
Order Lagomorpha						
Family Leporidae						
Lepus californicus	x	cf.	—	—	cf.	—
Sylvilagus bachmani	x	x	—	x	cf.	cf.
Sylvilagus audubonii	x	x	cf.	—	—	cf.
Order Rodentia						
Family Sciuridae						
Citellus beecheyi	x	x	cf.	—	x	—
Family Geomyidae						
Thomomys bottae	x	x	cf.	x	x	x
Family Heteromyidae						
Perognathus californicus	x	cf.	—	cf.	—	—
Perognathus	—	—	x	—	—	—
Dipodomys agilis	x	—	—	cf.	—	—
Dipodomys	—	x	—	—	—	—
Family Cricetidae						
Peromyscus crinitus	—	—	—	cf.	—	—
Peromyscus maniculatus	x	x	—	x	—	—
Peromyscus	—	—	—	—	—	x
Reithrodontomys humulis	—	cf.	—	—	—	—
Reithrodontomys megalotis	x	—	—	x	—	—
Onychomys torridus	x	—	—	—	—	—
Neotoma fuscipes	—	—	—	x	cf.	—
Neotoma	x	x	x	—	—	—
Microtus californicus	x	x	—	x	cf.	cf.
Ondatra	—	x	—	—	—	—
Order Carnivora						
Family Canidae						
Canis latrans	x	x	—	—	—	cf.
**Canis dirus*	x	cf.	cf.	—	cf.	cf.
Urocyon cinereoargenteus	x	—	—	—	—	cf.
Family Ursidae						
+*Arctodus simus*	x	—	—	—	—	—
Ursus horribilis	x	—	—	—	—	—
Ursus americanus	x	—	—	—	—	x

TABLE 1 (continued)

Taxon	Rancho La Brea	Costeau Pit	Newport Bay 1066	Mesa 1067	San Pedro	La Mirada
Family Mustelidae						
Mustela frenata	x	x	—	—	—	—
Taxidea taxus	x	—	—	—	—	—
Mephitis mephitis	x	—	—	—	—	—
Spilogale gracilis	x	—	—	—	—	—
Spilogale	—	—	—	cf.	—	—
Enhydra lutris	—	—	x	—	x	—
Family Felidae						
+*Smilodon californicus*	x	cf.	—	—	cf.	—
**Felis atrox*	x	—	—	—	cf.	—
Felis concolor	x	cf.	—	—	cf.	—
Lynx rufus	x	—	—	—	—	cf.
Family Otariidae						
gen. indet.	—	—	x	—	—	—
Family Phocidae						
Mirounga angustirostris	—	—	cf.	—	—	—
gen. indet.	—	—	—	—	—	x
Order Proboscidea						
Family Mammutidae						
+*Mammut americanum*	x	—	—	—	—	x
Family Elephantidae						
+*Mammuthus columbi*	x	x	—	—	—	—
Family indet.	—	—	x	x	—	—
Order Perissodactyla						
Family Equidae						
Equus large sp.	x	x	x	x	x	x
Equus small sp.	—	cf.	x	—	—	—
Family Tapiridae						
Tapirus	x	—	x	—	—	—
Order Artiodactyla						
Family Tayassuidae						
+*Platygonus*	x	—	—	—	—	—
Family Camelidae						
+*Camelops hesternus*	x	cf.	—	—	cf.	cf.
+*Camelops*	—	—	x	—	—	—
+*Tanupolama*	x	x	x	x	—	—
Family Cervidae						
Odocoileus hemionus	x	—	cf.	—	cf.	cf.
gen. indet.	—	cf.	—	—	—	—
Family Antilocapridae						
+*Capromeryx minor*	x	—	—	—	—	—
+*Capromeryx*	—	x	—	—	x	—
Antilocapra americana	cf.	—	—	—	—	—
Family Bovidae						
**Bison latifrons*	x	x	cf.	—	cf.	—
**Bison antiquus*	x	x	—	—	—	—
Bison	—	—	—	—	—	x
+*Euceratherium*	cf.	—	—	—	—	—

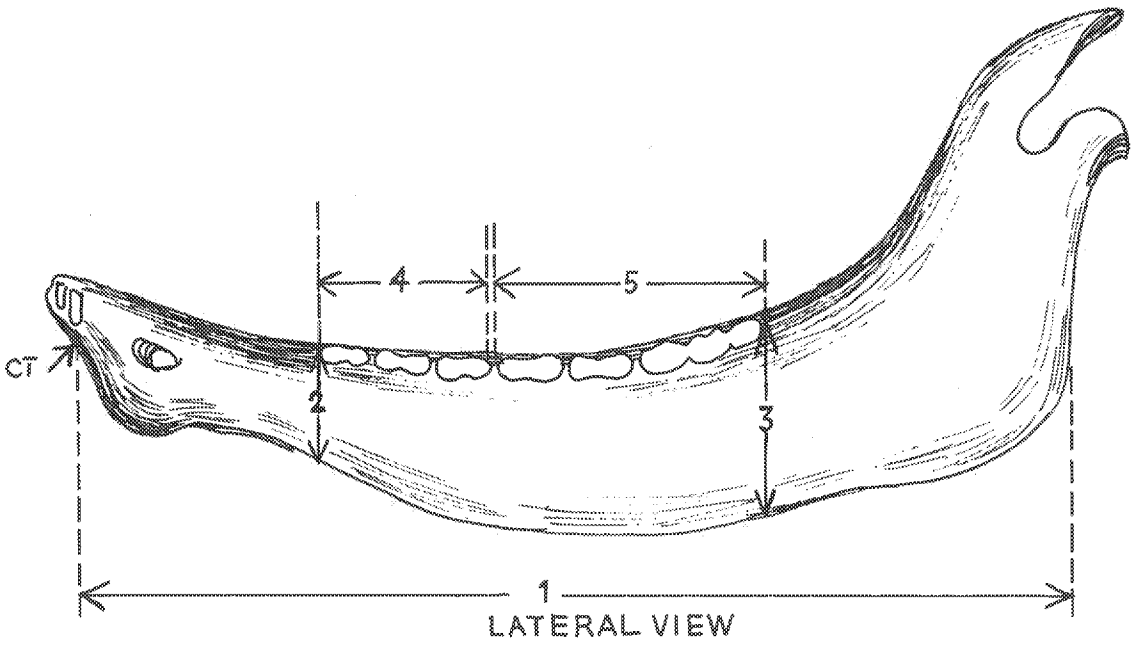


FIGURE 26. *Bison* mandible (not to scale). Numbers on drawing correspond to measurements on table 2. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

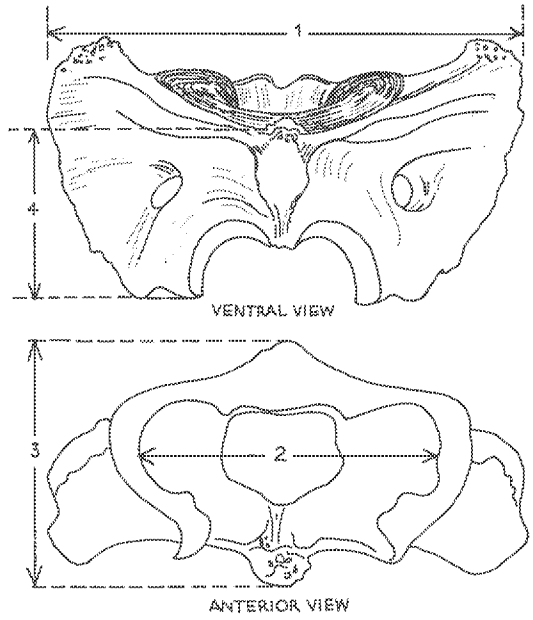


FIGURE 27. *Bison* atlas (not to scale). Numbers on drawing correspond to measurements on table 3. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

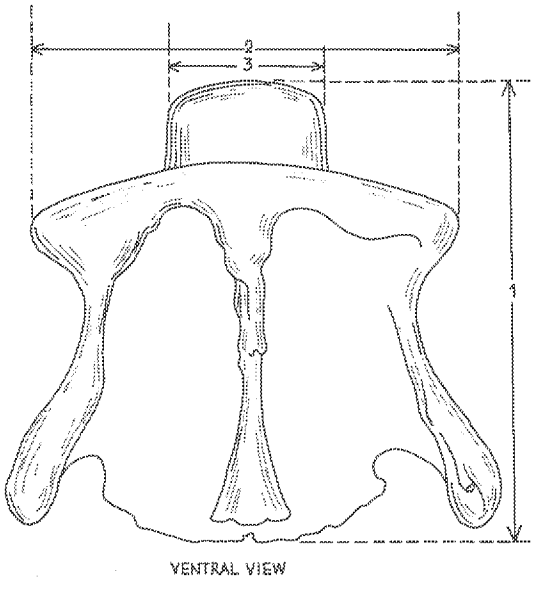


FIGURE 28. *Bison* axis (not to scale). Numbers on drawing correspond to measurements on table 4. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 2

Measurements of *Bison* mandibles from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18807	18811	18808	18809	18810	—	—	Y-6710	Y-6711
Bison latifrons	x	x	x	x	x	x	x	x	—
Bison antiquus	—	—	—	—	—	—	—	—	x
1. Length of jaw, lateral border of C/1 alveolus to angle	(458)	—	—	—	—	(460)	—	468	401
2. Depth of jaw at antero-internal border of P/2 alveolus	—	—	—	56	—	54	60	60	43
3. Depth of jaw at postero-internal border of M/3 alveolus	—	95	(87)	—	—	85	—	95	80
4. Distance between anterior border of P/2 alveolus to posterior border of P/4 alveolus	(65)	—	—	67	70	73	67	68	61
5. Distance between anterior border of M/1 alveolus to posterior border of M/3 alveolus	110	125	122	—	—	117	(125)	115	108

Specimen number	Y-6718	Y-6712	Y-6717	Y-6714	Y-6722	Y-6719	Y-6709	Y-6721	Y-6725
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	423	406	434	(436)	413	405	430	418	425
2.	48	46	51	47	48	46	47	46	47
3.	83	85	92	88	81	84	83	82	85
4.	62	61	63	62	—	58	60	63	62
5.	110	108	113	112	110	112	111	113	113

Specimen number	Y-6730	Y-6724	Y-6731	Y-6713	Y-6720	Y-6728	Y-6726	Y-6723	Y-6733
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	422	(425)	(420)	406	—	—	—	—	—
2.	45	48	49	46	49	45	49	46	50
3.	81	85	87	82	88	79	87	86	87
4.	62	58	58	57	63	62	62	58	62
5.	113	112	113	110	113	113	113	111	114

Specimen number	Y-6715	Y-6716	Y-6732	Y-6727
Bison latifrons	—	—	—	—
Bison antiquus	x	x	x	x
1.	—	—	—	—
2.	48	—	52	52
3.	90	85	—	—
4.	62	—	57	60
5.	113	111	110	—

TABLE 3

Measurements of *Bison* atlases from Costeau Pit and Rancho La Brea (in mm)

Specimen number	15218	18284	18333	Y-6737	Y-5439	Y-5432	Y-5385	Y-5386
Bison latifrons	x	x	x	x	—	—	—	—
Bison antiquus	—	—	—	—	x	x	x	x
1. Greatest transverse distance of atlas	261	—	—	260	180	169	190	199
2. Greatest transverse distance between articular facets for occipital condyles	153	148	—	150	126	124	128	138
3. Greatest dorso-ventral width	123	118	—	130	100	100	109	106
4. Distance between anterior and posterior articulating surfaces	125	122	123	121	102	102	105	109

Specimen number	Y-5388	Y-5393	Y-5396	Y-5398	Y-5387	Y-5395	Y-5399	Y-5394	Y-5390
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	195	186	183	190	194	184	—	180	175
2.	137	131	117	126	128	135	126	129	(120)
3.	108	109	104	107	105	108	(100)	103	102
4.	109	098	106	106	107	105	106	093	103

Specimen number	Y-5428	Y-5418	Y-5429	Y-5430	Y-5427	Y-5424	Y-5414	Y-5406	Y-5413
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	—	181	(160)	190	157	—	165	186	167
2.	130	123	129	132	120	122	126	133	120
3.	105	103	094	106	095	097	096	108	099
4.	100	100	096	102	092	098	100	103	092

Specimen number	Y-5405	Y-5403	Y-5404	Y-5412	Y-5402	Y-5401	Y-5409	Y-5410	Y-5408
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	—	—	175	191	172	193	177	182	—
2.	121	125	126	132	127	121	131	128	138
3.	104	110	106	100	107	100	104	107	110
4.	094	100	096	105	104	100	098	097	104

Specimen number	Y-5389	Y-5417	Y-5425	Y-5438	Y-5420	Y-5415	Y-5422	Y-5419	Y-5421
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	180	—	—	192	—	184	—	169	183
2.	122	(130)	124	137	136	132	130	126	131
3.	100	100	103	109	107	—	(101)	100	109
4.	101	(103)	101	104	102	104	104	099	106

TABLE 4
Measurements of *Bison* axes from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18334	18335	Y-6734	Y-5664	Y-5661	Y-5667	Y-5671	Y-5675
Bison latifrons	x	x	x	—	—	—	—	—
Bison antiquus	—	—	—	x	x	x	x	x
1. Greatest antero-posterior length	146	—	148	130	126	126	124	126
2. Greatest width across anterior articulation surface	137	140	138	114	113	114	121	121
3. Greatest width of odontoid process	60	64	59	55	52	55	54	55

Specimen number	Y-5674	Y-5663	Y-5668	Y-5660	Y-5669	Y-5659	Y-5665	Y-5670	Y-5678
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	130	129	115	126	130	129	128	128	127
2.	118	118	110	120	117	113	117	124	119
3.	55	56	53	52	57	55	55	55	56

Specimen number	Y5677	Y-5676	Y-5672	Y-5680	Y-5679	Y-5653	Y-5652	Y-5658	Y-5648
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	122	130	124	128	128	127	(118)	136	125
2.	118	113	112	119	121	117	117	123	117
3.	55	55	55	55	56	55	54	56	54

Specimen number	Y-5649	Y-5656	Y-5651	Y-5657	Y-5647	Y-5646	Y-5645	Y-5654	Y-5650
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	129	131	130	126	130	119	126	130	127
2.	121	116	122	120	119	119	124	120	114
3.	55	55	52	57	55	55	56	56	54

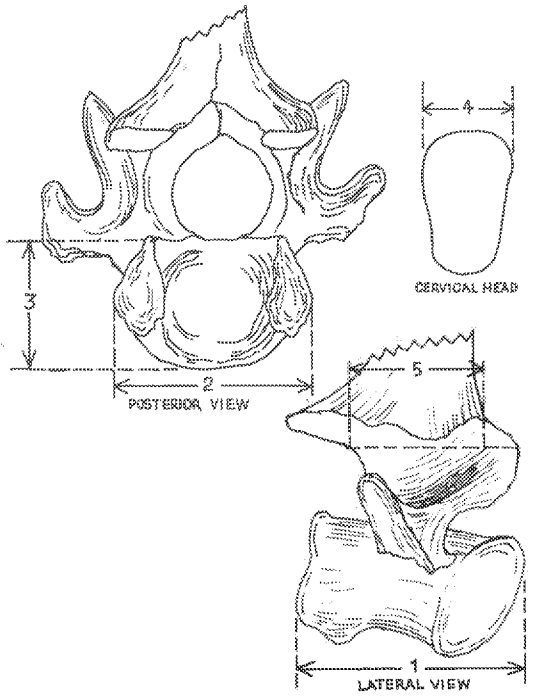


FIGURE 29. *Bison* 7th cervical vertebra (not to scale). Numbers on drawing correspond to measurements on table 5. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 5

Measurements of *Bison* 7th cervical vertebrae from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18375	18376	18377	18378	—	Y-6513	Y-6509	Y-6597	Y-6510
Bison latifrons	x	x	x	x	x	—	—	—	—
Bison antiquus	—	—	—	—	—	x	x	x	x
1. Greatest antero-posterior length of centrum	86	82	(87)	(82)	86	75	71	70	75
2. Greatest width of centrum	88	98	—	—	96	73	73	71	73
3. Greatest height of centrum	68	69	—	—	69	54	52	53	54
4. Greatest width of head	52	50	53	51	50	39	49	35	37
5. Anteroposterior diameter at base of spine	58	59	67	—	61	53	48	45	55

Specimen number	Y-6505	Y-6485	Y-6484	Y-6489	Y-6473	Y-6495	Y-6518	Y-6496	Y-6501
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	76	73	75	73	70	74	69	76	72
2.	79	76	74	77	71	77	72	77	72
3.	55	53	53	54	49	53	52	54	55
4.	40	39	38	39	37	39	37	39	41
5.	54	53	53	50	55	50	53	49	53

TABLE 5 (continued)

Specimen number	Y-6492	Y-6499	Y-6517	Y-6494	Y-6507	Y-6500	Y-6481	Y-6488	Y-6516
Bison Latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	74	70	75	71	75	74	74	74	(73)
2.	76	69	74	(70)	77	73	78	77	79
3.	54	54	53	54	52	55	56	54	—
4.	38	37	39	38	37	40	37	39	38
5.	52	48	52	48	54	54	—	—	54

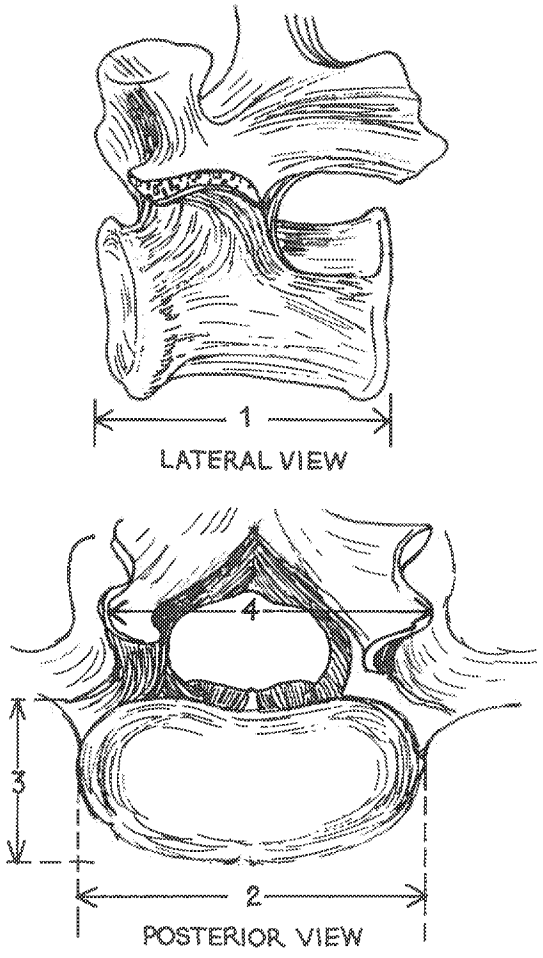


FIGURE 30. *Bison* 5th lumbar vertebra (not to scale). Numbers on drawing correspond to measurements on table 6. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

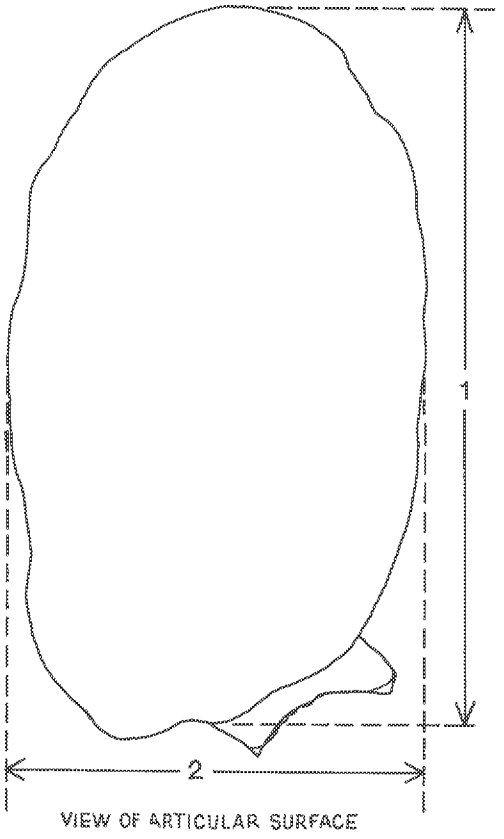


FIGURE 31. *Bison* scapula (not to scale). Numbers on drawing correspond to measurements on table 7. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 6

Measurements of *Bison* 5th lumbar vertebrae from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18580	18581	Y-6749	Y-6750	Y-6786	Y-6746	Y-6748	Y-6739	Y-6747
Bison latifrons	?	?	?	?	?	—	—	—	—
Bison antiquus	—	—	—	—	—	x	x	x	x
1. Greatest length of centrum	82	84	84	80	78	73	71	74	68
2. Greatest width of centrum	91	86	91	84	92	74	71	71	71
3. Greatest height of centrum	49	48	53	46	48	41	42	41	43
4. Width across center of posterior zygapophyses	82	76	76	85	79	73	72	77	76

Specimen number	Y-6744	Y-6743	Y-6753	Y-6740	Y-6752	Y-6741	Y-6745	Y-6751	Y-6742
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	?	?	?	?	x	x
1.	74	70	72	78	73	73	74	74	70
2.	75	73	80	83	83	84	83	74	77
3.	44	43	42	47	44	46	—	44	45
4.	72	75	71	78	82	82	74	—	—

TABLE 7

Measurements of *Bison* scapulae from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18582	18583	—	—	Y-6738	Y-6785	Y-6767	Y-6773	Y-6764
Bison latifrons	x	—	x	x	x	—	—	—	—
Bison antiquus	—	x	—	—	—	x	x	x	x
1. Anteroposterior diameter across center of glenoid cavity	96	73	93	92	90	80	76	73	81
2. Transverse diameter across center of glenoid cavity	72	57	73	72	75	61	57	56	64

Specimen number	Y-6762	Y-6765	Y-6772	Y-6763	Y-6757	Y-6771	Y-6760	Y-6769	Y-6755
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	?	x	x	x	x	x	x	x	x
1.	84	74	74	80	81	70	81	77	77
2.	66	56	52	60	62	50	64	59	57

Specimen number	Y-6768	Y-6766	Y-6761	Y-6754	Y-6759	Y-6770	Y-6758	Y-6756
Bison latifrons	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x
1.	73	70	72	83	82	73	80	79
2.	53	50	54	64	54	55	64	61

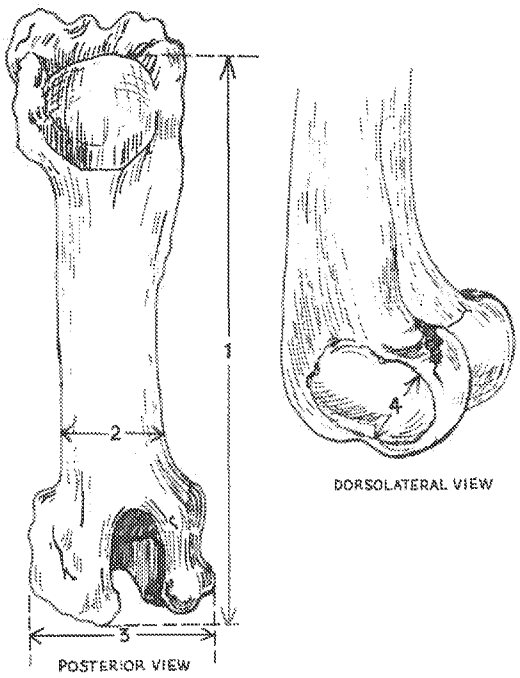


FIGURE 32. *Bison* humerus (not to scale). Numbers on drawing correspond to measurements on table 8. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 8

Measurements of *Bison* humeri from Costeau Pit and Rancho La Brea (in mm)

Specimen number	15217	Y-6657	Y-6658	Y-6661	Y-6656	Y-6655	Y-6662	Y-6660	
Bison latifrons	x	x	—	—	—	—	—	—	
Bison antiquus	—	—	?	x	x	x	x	x	
1. Length	375	367	358	334	333	342	343	338	
2. Least diameter of shaft	62	65	54	50	50	50	49	53	
3. Greatest distal transverse diameter	123	119	103	102	101	098	098	102	
4. Greatest diameter of lateral condyle	53	49	46	45	45	47	47	42	
Specimen number	Y-6659	Y-6664	Y-6663	Y-6665	Y-6671	Y-6679	Y-6670	Y-6669	Y-6667
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	346	330	349	344	346	342	—	—	—
2.	53	47	55	52	54	51	53	52	(52)
3.	102	097	104	102	106	099	100	103	100
4.	43	41	46	47	47	44	46	45	46
Specimen number	Y-6675	Y-6674	Y-6666	Y-6678	Y-6672	Y-6680	Y-6673	Y-6677	
Bison latifrons	—	—	—	—	—	—	—	—	
Bison antiquus	x	x	x	x	x	x	x	x	
1.	—	—	—	—	—	—	—	—	
2.	51	45	50	49	51	41	—	—	
3.	098	097	103	102	104	101	104	099	
4.	43	50	46	44	45	41	45	43	

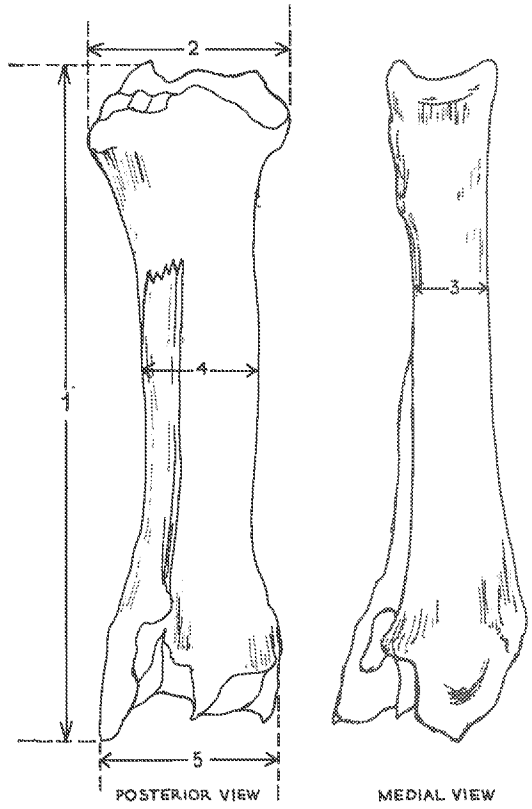


FIGURE 33. *Bison* radius (not to scale). Numbers on drawing correspond to measurements on table 9. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

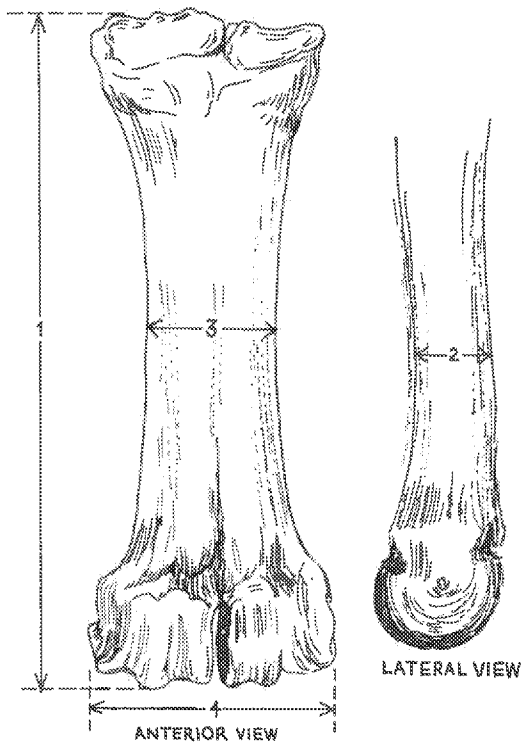


FIGURE 34. *Bison* metacarpal (not to scale). Numbers on drawing correspond to measurements on table 10. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 9

Measurements of *Bison* radii from Costeau Pit and Rancho La Brea (in mm)

Specimen number	15221	18638	18639	18640	Y-6690	Y-6686	Y-6697	Y-6692	Y-6694
Bison latifrons	x	x	x	x	?	?	—	—	—
Bison antiquus	—	—	—	—	—	—	x	x	x
1. Greatest length	385	391	—	—	376	—	367	351	355
2. Greatest proximal transverse diameter	124	125	(120)	—	117	122	104	107	108
3. Least anteroposterior width of shaft	40	41	41	—	41	41	40	38	35
4. Least transverse width of shaft	67	67	73	—	64	—	56	58	52
5. Greatest distal transverse diameter	110	110	—	114	109	—	100	095	095

TABLE 9 (continued)

Specimen number	Y-6696	Y-6681	Y-6684	Y-6682	Y-6683	Y-6698	Y-6685	Y-6703	Y-6704
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	357	372	360	373	364	357	353	—	—
2.	102	108	105	107	107	—	—	106	108
3.	39	37	36	36	36	(38)	(39)	—	—
4.	56	55	57	57	55	56	(56)	—	—
5.	092	098	095	097	098	096	098	—	—

Specimen number	Y-6702	Y-6707	Y-6705	Y-6687	Y-6793	Y-6700
Bison latifrons	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x
1.	—	—	—	—	—	—
2.	100	—	—	—	—	—
3.	—	—	—	—	—	—
4.	—	—	—	—	—	—
5.	—	092	094	103	098	097

TABLE 10
Measurements of *Bison* metacarpals from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18579	—	—	Y-2420	Y-2443	Y-2445	Y-2404	Y-2457	Y-2442
Bison latifrons	x	x	x	—	—	—	—	—	—
Bison antiquus	—	—	—	?	x	x	x	x	x
1. Greatest length	—	233	232	219	226	227	232	214	225
2. Least anteroposterior width of shaft	34	35	38	32	31	29	30	33	29
3. Least transverse width of shaft	—	61	61	55	46	49	50	52	43
4. Greatest distal transverse diameter	106	098	96	088	079	079	78	082	074

Specimen number	Y-2434	Y-2414	Y-2418	Y-2444	Y-2424	Y-2429	Y-2412	Y-2433	Y-2416
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	217	212	218	225	224	227	220	213	214
2.	30	27	28	31	30	30	30	27	31
3.	48	42	46	46	47	50	48	41	50
4.	081	070	075	083	077	080	079	070	077

TABLE 10 (continued)

Specimen number	Y-2438	Y-2413	Y-2579	Y-2425	Y-2447	Y-2435	Y-2406	Y-2436	Y-2419
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	219	220	218	220	218	221	216	216	232
2.	30	29	32	31	31	30	31	29	29
3.	51	46	47	48	48	49	50	47	44
4.	081	075	080	077	080	079	080	075	076

Specimen number	Y-2447	Y-2420	Y-2430	Y-2431	Y-2449
Bison latifrons	—	—	—	—	—
Bison antiquus	x	x	x	x	x
1.	217	219	224	225	207
2.	30	32	31	29	29
3.	45	55	49	46	45
4.	080	088	077	076	074

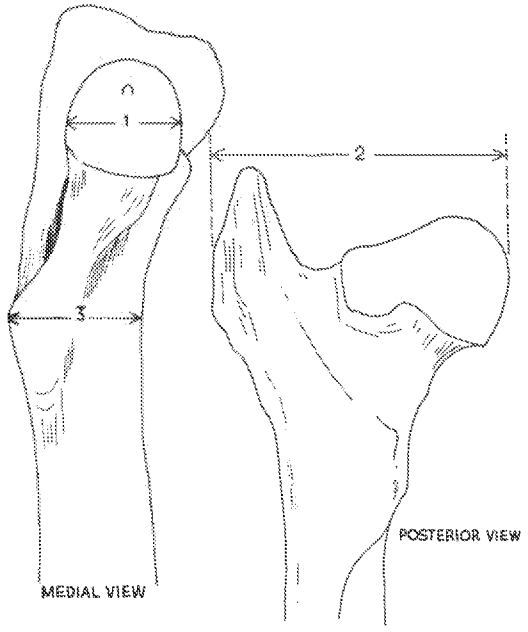


FIGURE 35. *Bison* femur (not to scale). Numbers on drawing correspond to measurements on table 11. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

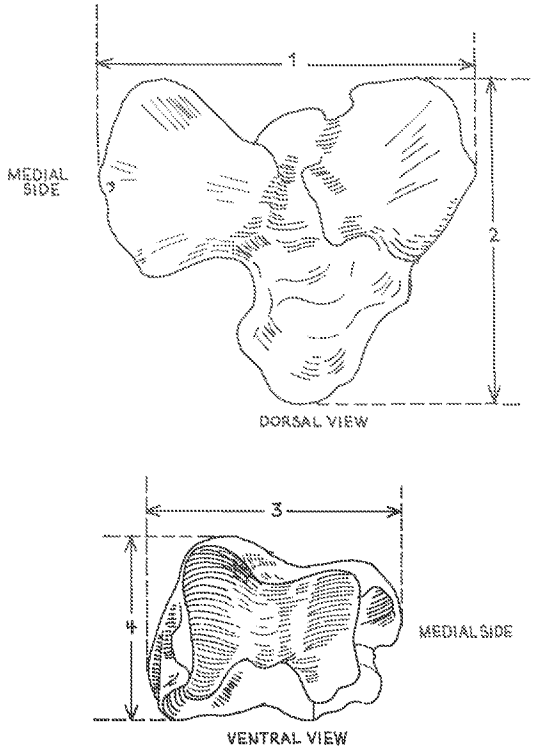


FIGURE 36. *Bison* tibia (not to scale). Numbers on drawing correspond to measurements on table 12. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 11
Measurements of *Bison* femora from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18417	18418	18416	—	Y-6783	Y-6780	Y-6775	Y-6777	Y-6778
Bison latifrons	x	x	?	?	?	?	—	—	—
Bison antiquus	—	—	—	—	—	—	x	x	x
1. Anteroposterior diameter of head	69	(67)	66	68	69	68	63	62	64
2. Greatest proximal transverse diameter	172	(175)	—	—	184	170	160	160	162
3. Greatest proximal anteroposterior diameter of diaphysis	84	—	—	—	78	77	63	69	75

Specimen number	Y-6779	Y-6774	Y-6778	Y-6781	Y-6776	Y-6782	Y-6784
Bison latifrons	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x
1.	62	63	62	62	61	63	63
2.	157	167	166	155	156	—	(156)
3.	70	68	76	62	60	75	75

TABLE 12
Measurements of *Bison* tibiae from Costeau Pit and La Brea (in mm)

Specimen number	15216	18423	18422	Y-6793	Y-6808	Y-6788	Y-6790	Y-6807	Y-6803
Bison latifrons	x	x	?	x	x	—	—	—	—
Bison antiquus	—	—	—	—	—	x	x	x	x
1. Greatest proximal transverse diameter	152	—	—	151	148	133	134	133	136
2. Greatest proximal anteroposterior diameter	145	—	—	143	—	130	127	127	130
3. Greatest distal transverse diameter	—	94	(86)	93	91	84	81	82	82
4. Greatest distal anteroposterior diameter	—	—	66	69	66	63	64	60	64

Specimen number	Y-6802	Y-6806	Y-6804	Y-6805	Y-6801	Y-6791	Y-6792	Y-6800	Y-6798
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	123	133	(129)	121	130	134	130	(122)	130
2.	117	132	122	118	124	132	126	117	125
3.	80	83	79	76	77	84	82	77	83
4.	62	59	60	59	60	61	62	60	61

Specimen number	Y-6794	Y-6799	Y-6796	Y-6797	Y-6795	Y-6789
Bison latifrons	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x
1.	127	134	134	133	132	—
2.	127	123	134	122	131	123
3.	81	82	86	82	84	79
4.	61	60	64	63	63	60

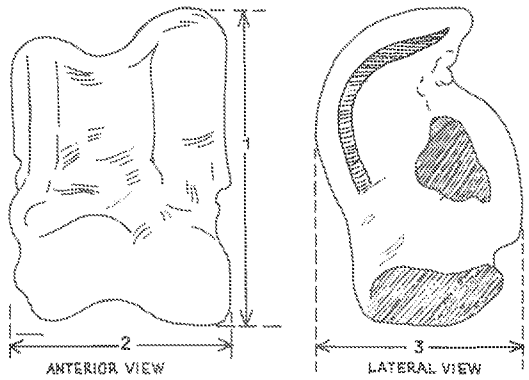


FIGURE 37. *Bison* astragali (not to scale). Numbers on drawing correspond to measurements on table 13. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

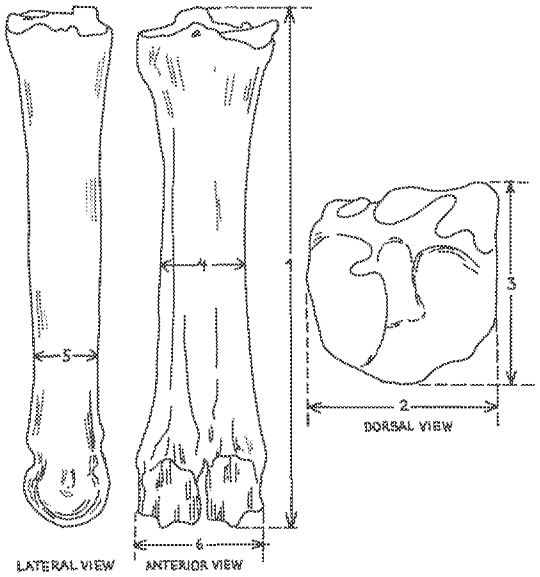


FIGURE 38. *Bison* metatarsal (not to scale). Numbers on drawing correspond to measurements on table 14. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 13
Measurements of *Bison* astragali from Costeau Pit and Rancho La Brea (in mm)

Specimen number	—	18488	Y-0816	Y-0882	Y-0923	Y-0977	Y-0834	Y-0813
Bison latifrons	x	—	x	x	—	—	—	—
Bison antiquus	—	?	—	—	?	?	x	x
1. Greatest length	97	88	94	95	91	90	85	84
2. Greatest transverse width	65	58	63	63	60	60	59	54
3. Greatest antero-posterior width	59	54	55	53	52	52	50	49

Specimen number	Y-0815	Y-0817	Y-0842	Y-0818	Y-0848	Y-0850	Y-0853	Y-0921	Y-0983
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	87	88	84	85	87	88	85	80	89
2.	59	59	55	56	55	56	57	53	59
3.	50	49	48	48	49	50	51	47	52

TABLE 13 (continued)

Specimen number	Y-0947	Y-0934	Y-0913	Y-0979	Y-0930	Y-0952	Y-0961	Y-0863	Y-0973
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	80	84	87	81	81	80	89	87	90
2.	51	54	59	53	50	51	58	57	56
3.	46	50	50	49	46	49	52	51	52
Specimen number	Y-0942	Y-0927	Y-0970	Y-0980	Y-0948	Y-0984	Y-0965	Y-0981	Y-0953
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	81	85	88	89	85	83	80	86	88
2.	54	57	57	57	53	54	51	57	57
3.	48	51	51	51	50	49	45	50	51
Specimen number	Y-0881	Y-0920	Y-0922	Y-0978					
Bison latifrons	—	—	—	—					
Bison antiquus	x	x	x	x					
1.	90	86	90	82					
2.	58	58	60	52					
3.	52	52	53	46					

TABLE 14
Measurements of *Bison* metatarsals from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18424	—	—	Y-2306	Y-2393	Y-2312	Y-2319	Y-2390	Y-2283
Bison latifrons	—	x	?	x	—	—	—	—	—
Bison antiquus	?	—	—	—	—	—	?	?	?
1. Greatest length of shaft	—	275	—	275	274	275	276	277	275
2. Greatest proximal transverse diameter	72	73	72	72	74	69	63	62	63
3. Greatest proximal anteroposterior diameter	53	65	63	69	68	65	61	64	63
4. Least transverse width of shaft	47	(50)	50	50	48	46	37	41	40
5. Least anteroposterior width of shaft	34	44	—	41	38	37	36	37	37
6. Greatest transverse width of condyles	—	(87)	—	83	80	80	74	74	78

TABLE 14 (continued)

Specimen number	Y-2298	Y-2295	Y-2280	Y-2309	Y-2317	Y-2315	Y-2303	Y-2297	Y-2279
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	?	?	?	x	x	x	x	x	x
1.	266	277	275	278	282	267	281	266	258
2.	67	63	66	60	64	56	63	61	63
3.	64	62	63	59	61	57	61	63	60
4.	44	41	40	42	43	34	40	39	40
5.	40	40	37	35	39	33	37	35	35
6.	75	75	71	71	78	67	74	74	75

Specimen number	Y-2397	Y-2278	Y-2277	Y-2319	Y-2322	Y-2313	Y-2321	Y-2291	Y-2311
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	269	272	265	275	281	272	269	282	269
2.	57	62	58	63	61	60	61	62	61
3.	58	59	58	60	60	61	61	60	59
4.	41	40	36	37	39	36	37	40	41
5.	37	37	34	35	37	34	35	37	39
6.	71	72	68	74	73	71	73	73	74

Specimen number	Y-2294	Y-2275	Y-2382	Y-2288	Y-2274	Y-2396	Y-2281	Y-2289	Y-2300
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	272	262	266	265	270	262	263	278	268
2.	61	59	60	61	60	59	60	62	61
3.	62	58	58	58	59	58	57	59	58
4.	39	37	40	41	37	35	37	39	40
5.	35	35	36	37	35	34	34	34	36
6.	72	68	71	71	70	69	69	73	71

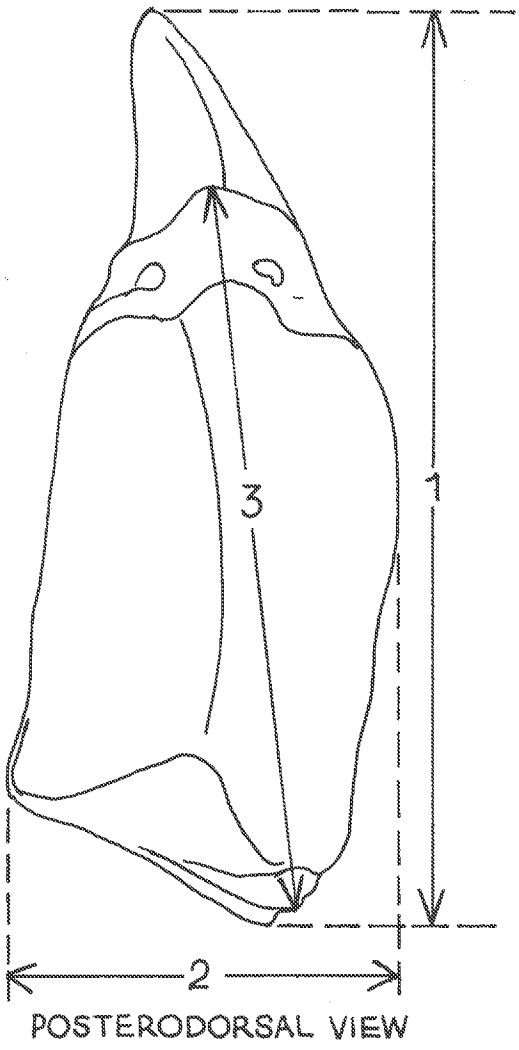


FIGURE 39. *Bison* ungual phalanx (not to scale). Numbers on drawing correspond to measurements on table 15. Rancho La Brea specimen numbers prefixed with "Y", all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 15

Measurements of *Bison* ungual phalanges from Costeau Pit and Rancho La Brea (in mm)

Specimen number	15222	Y-3384	Y-3368	Y-3341	Y-3331	Y-3458	Y-3336	Y-3398
Bison latifrons	x	—	—	—	—	—	—	—
Bison antiquus	—	?	?	x	x	x	x	x
1. Greatest antero-posterior length	104	099	097	078	090	090	086	074
2. Greatest proximal transverse diameter	44	37	36	30	34	39	34	28
3. Greatest proximal anteroposterior diameter	76	66	63	54	61	67	60	50

TABLE 15 (continued)

Specimen number	Y-3363	Y-3385	Y-3397	Y-3395	Y-3394	Y-3371	Y-3320	Y-3321	Y-3391
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	082	082	090	084	087	093	084	090	082
2.	34	35	38	33	33	36	31	38	33
3.	60	59	69	60	60	66	58	63	61
Specimen number	Y-3271	Y-3369	Y-3370	Y-3372	Y-3335	Y-3386	Y-3484	Y-3366	Y-3388
Bison latifrons	—	—	—	—	—	—	—	—	—
Bison antiquus	x	x	x	x	x	x	x	x	x
1.	092	090	083	091	080	083	086	085	086
2.	35	35	34	34	32	32	33	34	31
3.	61	59	60	59	59	59	61	59	57
Specimen number	Y-3258	Y-3338	Y-3293						
Bison latifrons	—	—	—						
Bison antiquus	x	x	x						
1.	086	080	095						
2.	32	30	38						
3.	56	56	62						

TABLE 16

Measurements of *Paramylodon harlani* skulls from Costeau Pit and Rancho La Brea (in mm)

Specimen number	15460	1717-2	1717-19	1717-4	1717-26	1717-0	1717-17	1717-24
1. Greatest external width of occipital condyles	135	130	130	126	128	130	129	132
2. Least internal distance between occipital condyles	64	58	52	54	57	63	62	56
3. Dorsoventral diameter of foramen magnum	39	44	41	43	43	45	43	44
4. Greatest height of occiput	155	130	142	136	128	147	146	146
5. Greatest width of occiput	190	188	184	175	155	188	176	186
6. Distance between centers of stylohyal depressions	142	139	135	129	128	139	137	140
Specimen number	1717-22	1717-21	1717-20	1717-1	1717-3	1717-25	1717-6	1717-8
1.	133	134	136	128	132	135	126	125
2.	57	63	54	56	—	62	50	—
3.	48	46	41	42	47	47	44	43
4.	153	141	150	130	156	155	147	130
5.	186	189	(187)	175	185	—	—	(176)
6.	143	137	134	133	134	142	141	131

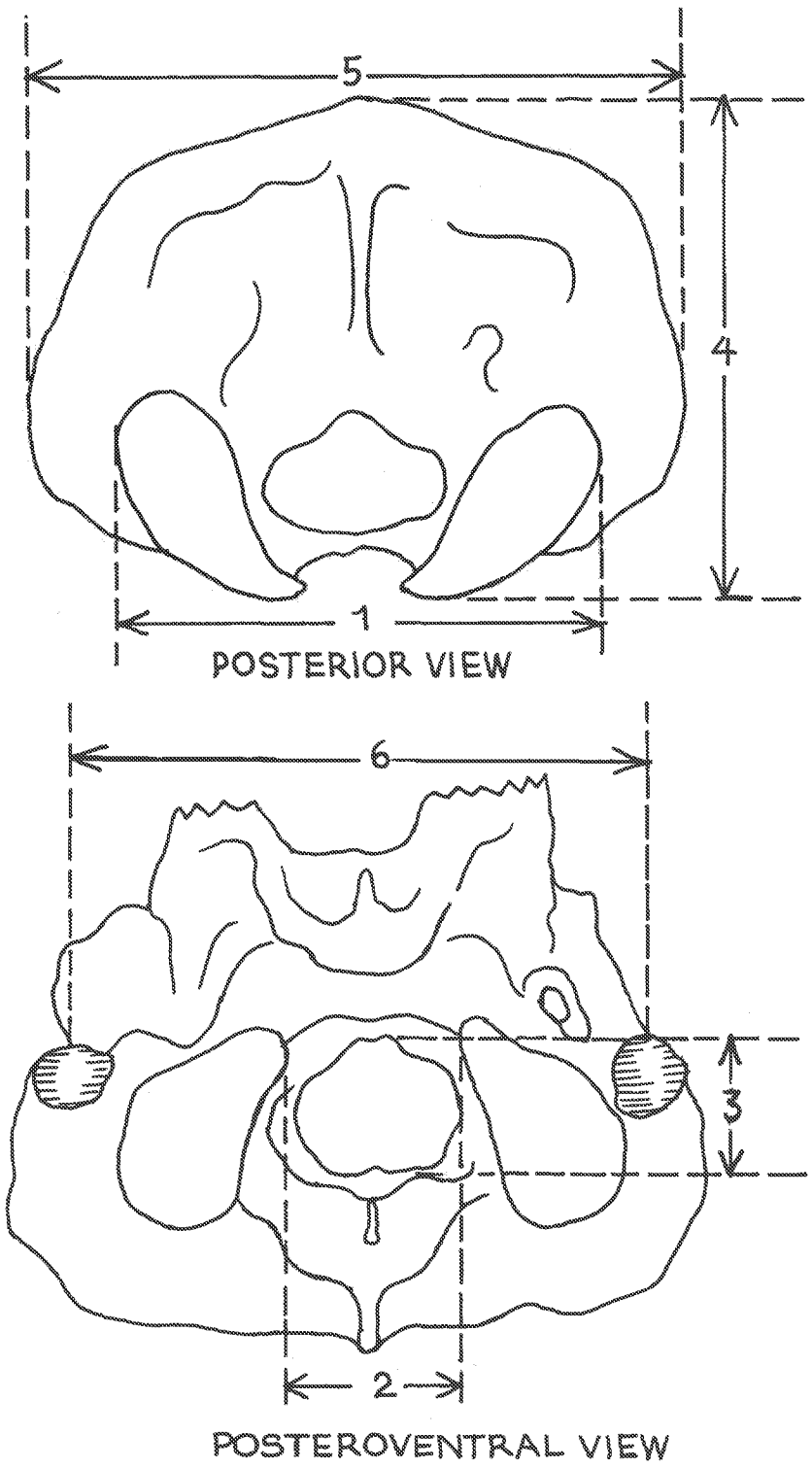


FIGURE 40. Posterior one-third of a *Paramylodon harlani* skull (not to scale). Numbers on drawing correspond to measurements on table 16. Rancho La Brea specimen numbers begin with 1717, all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

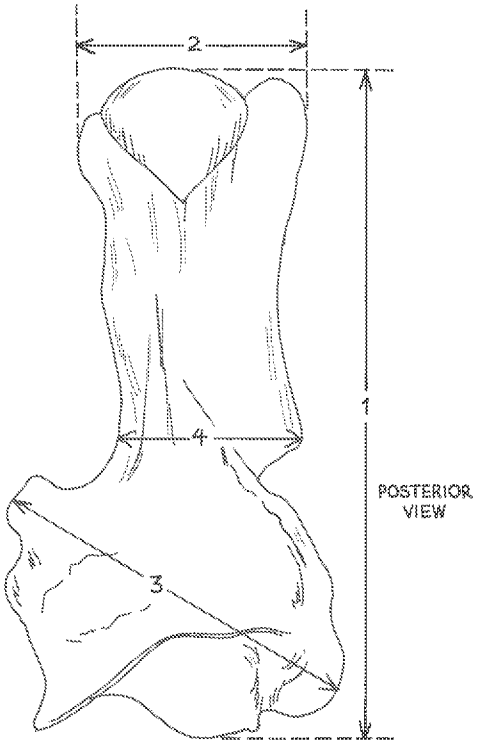


FIGURE 41. *Paramylodon harlani* humerus (not to scale). Numbers on drawing correspond to measurements on table 17. Rancho La Brea specimen numbers begin with 1712, all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

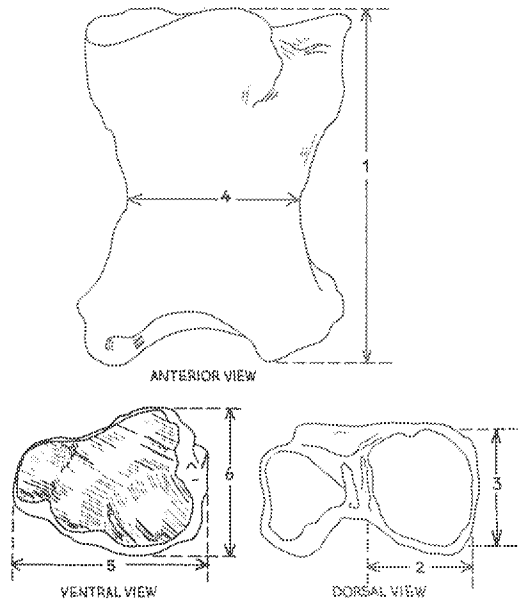


FIGURE 42. *Paramylodon harlani* tibia (not to scale). Numbers on drawing correspond to measurements on table 18. Rancho La Brea specimen numbers begin with 1702, all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 17

Measurements of *Paramylodon harlani* humeri from Costeau Pit and Rancho La Brea (in mm)

Specimen number	18181	18180	18179	1712-R-4	1712-R-1	1712-L-1	1712-L-9
1. Length of shaft	425	438	—	452	457	457	(440)
2. Greatest proximal transverse diameter	155	—	—	163	174	156	157
3. Greatest distal transverse diameter	243	239	—	269	262	258	254
4. Greatest transverse width of diaphysis	108	105	106	129	132	121	115

Specimen number	1712-R-2	1712-R-3	1712-L-11	1712-R-6	1712-R-11	1712-R-5	1712-L-17
1.	451	445	452	—	448	460	—
2.	170	168	163	—	168	170	—
3.	258	—	—	264	—	—	269
4.	118	—	—	125	122	130	133

Specimen number	1712-L-19	1712-L-34
1.	—	—
2.	—	173
3.	266	—
4.	124	—

TABLE 18

Measurements of *Paramylodon harlani* tibiae from Costeau Pit and Rancho La Brea (in mm)

Specimen number	—	—	1702-L-4	1702-R-30	1702-L-25	1702-R-24	1702-L-19
1. Greatest length	243	—	276	260	273	272	270
2. Transverse diameter of medial condyle	110	—	096	109	110	102	119
3. Anteroposterior diameter of medial condyle	101	—	126	105	127	125	111
4. Least width of diaphysis	093	(087)	097	096	097	103	097
5. Greatest distal transverse diameter	147	134	149	144	147	156	152
6. Greatest distal anteroposterior diameter	105	097	110	101	104	119	104

Specimen number	1702-L-12	1702-R-1	1702-R-32	1702-L-15	1702-L-7	1702-L-5	1702-L-24
1.	264	262	249	257	257	267	252
2.	087	093	090	080	088	091	087
3.	114	117	128	114	115	128	104
4.	093	087	101	091	091	096	090
5.	143	145	146	142	140	149	135
6.	101	107	110	099	100	101	094

Specimen number	1702-R-14	1702-R-34	1702-L-13	1702-R-19	1702-L-28	1702-L-30
1.	251	255	260	276	254	256
2.	082	094	100	101	092	101
3.	112	106	130	123	113	113
4.	084	097	098	099	082	089
5.	138	133	141	156	133	133
6.	096	102	106	110	098	088

Specimen number	1702-L-31	1702-R-12	1702-L-18	1702-L-14	1702-R-8	1702-R-5
1.	248	272	266	255	264	267
2.	080	094	(088)	091	094	088
3.	092	110	098	118	114	111
4.	090	100	095	092	089	103
5.	130	148	148	149	139	150
6.	091	101	102	106	103	100

Specimen number	1702-R-25	1702-R-4	1702-R-13	1702-L-11	1702-R-11	1702-R-18
1.	250	270	265	247	256	260
2.	084	091	091	099	089	—
3.	109	118	107	112	106	115
4.	090	094	093	091	094	095
5.	133	150	142	139	140	140
6.	094	105	102	103	100	100

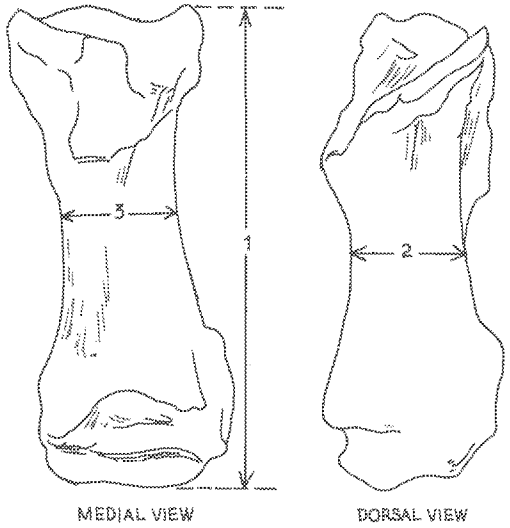


FIGURE 43. *Paramylodon harlani* 4th metacarpal (not to scale). Numbers on drawing correspond to measurements on table 19. Rancho La Brea specimen numbers begin with 1478, all others represent Costeau Pit specimens; unnumbered specimens are from private collections. Approximate measurements are given in parentheses. Only adult specimens used.

TABLE 19

Measurements of *Paramylodon harlani* 4th metacarpals from Costeau Pit and Rancho La Brea (in mm)

Specimen number	—	1478-R-28	1478-L-13	1478-L-17	1478-L-25	1478-R-16
1. Greatest length	115	120	113	127	124	116
2. Least transverse width of diaphysis	26	30	28	33	24	28
3. Least anteroposterior width of diaphysis	28	34	34	34	38	30

Specimen number	1478-L-12	1478-R-23	1478-L-31	1478-R-14	1478-L-29	1478-L-28
1.	125	124	122	128	118	123
2.	29	30	27	29	30	32
3.	36	32	32	37	37	37

Specimen number	1478-L-15	1478-R-32	1478-R-15	1478-L-18	1478-R-21	1478-R-7	1478-L-7
1.	120	127	119	128	125	121	124
2.	30	32	29	34	33	33	29
3.	36	40	36	36	40	35	31

Specimen number	1478-L-22	1478-L-29	1478-R-2	1478-L-16	1478-L-9	1478-R-30	1478-L-5
1.	124	120	123	122	118	123	122
2.	30	33	33	28	28	32	32
3.	37	34	38	31	29	37	38

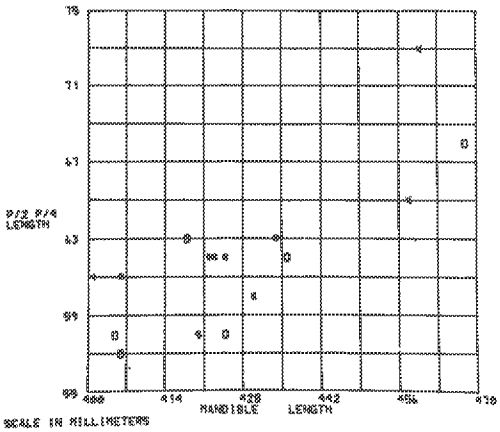
TABLE 20

Taxonomic References of Mammalian Genera Appearing in Faunal Lists
(Numbers opposite taxon relate to bibliographic reference in which genus is discussed)

Genus	Bibliographic Number
Antilocapra	13, 15, 16, 19, 39, 40, 52, 55, 68, 70, 86, 104, 109, 133, 145, 147, 156, 169, 170, 171, 188, 190, 197, 205
Antrozous	13, 52, 70, 86, 133, 136, 145, 156, 194, 197
Arctodus	53, 59, 60, 68, 103, 117, 119, 124, 145, 156, 157, 187, 188, 205
Bison	6, 13, 14, 17, 21, 22, 23, 24, 32, 41, 44, 45, 52, 53, 59, 60, 61, 63, 67, 68, 73, 86, 98, 100, 103, 104, 113, 128, 133, 138, 139, 143, 144, 145, 146, 147, 148, 152, 153, 154, 156, 157, 163, 164, 165, 169, 188, 193, 197, 205
Camelops	24, 25, 53, 54, 59, 64, 65, 66, 68, 100, 103, 104, 121, 128, 145, 147, 150, 155, 156, 157, 164, 169, 183, 185, 188, 198, 205
Canis	13, 24, 25, 28, 43, 52, 53, 59, 65, 66, 70, 86, 96, 103, 104, 107, 111, 113, 115, 116, 118, 133, 145, 147, 156, 157, 188, 197
Capromeryx	15, 16, 19, 25, 28, 39, 40, 53, 64, 65, 66, 68, 103, 104, 145, 154, 156, 165, 169, 171, 188, 190, 205
Citellus	13, 24, 25, 27, 52, 54, 55, 57, 60, 63, 66, 68, 70, 86, 89, 104, 109, 133, 145, 147, 155, 156, 165, 169, 188, 197
Dipodomys	13, 24, 25, 27, 52, 60, 66, 70, 86, 133, 145, 155, 156, 188, 197, 202
Enhydra	13, 52, 86, 129, 133, 145, 197
Equus	4, 14, 19, 24, 25, 26, 28, 42, 53, 55, 58, 59, 61, 65, 66, 68, 71, 86, 96, 97, 103, 104, 113, 122, 140, 145, 147, 148, 154, 155, 156, 157, 161, 164, 165, 169, 172, 173, 188, 197, 205
Euceratherium	53, 59, 65, 104, 145, 147, 156, 161
Felis	13, 52, 53, 56, 65, 66, 70, 86, 94, 96, 100, 112, 114, 117, 119, 123, 124, 125, 126, 133, 141, 145, 154, 156, 157, 158, 164, 188, 197, 205
Lepus	13, 52, 70, 86, 89, 96, 115, 119, 125, 133, 145, 156, 157, 164, 188, 197
Lynx	13, 52, 70, 86, 89, 96, 115, 119, 125, 133, 145, 156, 157, 164, 188, 197
Mammut	32, 53, 56, 61, 62, 95, 103, 104, 131, 132, 134, 145, 154, 156, 157, 162, 188, 199, 205
Mammuthus	14, 24, 25, 32, 33, 53, 59, 60, 61, 65, 66, 68, 95, 104, 113, 131, 132, 134, 141, 145, 147, 148, 154, 156, 157, 161, 162, 165, 188, 199, 205
Megalonyx	53, 58, 65, 66, 101, 104, 110, 145, 147, 156, 157, 161, 164, 175, 177, 178, 180, 184, 188, 205
Mephitis	13, 24, 48, 52, 70, 86, 133, 141, 145, 156, 157, 188, 197
Microtus	13, 24, 27, 47, 51, 52, 55, 56, 60, 61, 62, 63, 66, 68, 86, 89, 104, 109, 133, 145, 147, 155, 156, 165, 169, 188, 197
Mirounga	13, 52, 86, 133, 145, 149, 197
Mustela	13, 24, 48, 49, 52, 54, 55, 57, 63, 86, 108, 133, 145, 156, 157, 188, 197
Neotoma	13, 24, 25, 27, 28, 52, 60, 63, 66, 68, 70, 86, 89, 109, 133, 145, 156, 157, 164, 165, 188, 197
Nothrotherium	53, 65, 93, 103, 104, 105, 110, 145, 156, 175, 178, 180, 184, 188, 205
Notiosorex	13, 20, 36, 52, 56, 57, 66, 70, 86, 133, 142, 145, 156, 188, 196, 197
Odocoileus	13, 14, 24, 25, 52, 64, 65, 70, 86, 104, 109, 133, 145, 147, 156, 157, 164, 188, 190, 197
Ondatra	13, 24, 51, 52, 55, 60, 61, 62, 63, 65, 68, 72, 86, 109, 130, 133, 145, 157, 169, 197
Onychomys	13, 24, 25, 27, 52, 54, 57, 60, 66, 70, 86, 109, 133, 145, 155, 156, 169, 188, 197
Paramylodon	55, 60, 65, 66, 92, 104, 107, 110, 113, 145, 154, 155, 156, 157, 161, 175, 176, 177, 179, 180, 181, 184, 188, 205
Perognathus	13, 24, 25, 27, 28, 52, 54, 57, 60, 66, 70, 86, 133, 145, 147, 155, 156, 188, 197, 202
Peromyscus	13, 14, 24, 25, 27, 52, 55, 60, 63, 66, 68, 70, 75, 86, 89, 109, 133, 145, 147, 148, 156, 165, 169, 188, 197
Platygonus	14, 19, 25, 53, 64, 65, 66, 104, 145, 147, 148, 156, 157, 164, 182, 188
Reithrodontomys	13, 24, 25, 27, 52, 54, 55, 60, 63, 66, 70, 74, 86, 109, 133, 145, 156, 157, 188, 197
Scapanus	13, 52, 86, 133, 145, 197
Smilodon	32, 68, 107, 112, 113, 116, 124, 125, 126, 145, 147, 156, 157, 158, 188, 205
Sorex	13, 20, 24, 25, 36, 52, 54, 55, 60, 63, 68, 70, 86, 104, 133, 142, 145, 155, 156, 157, 169, 188, 196, 197
Spilogale	13, 48, 52, 54, 60, 66, 70, 86, 133, 145, 156, 157, 188, 197
Sylvilagus	13, 24, 25, 27, 52, 63, 65, 66, 68, 70, 86, 89, 133, 145, 155, 156, 157, 164, 188, 197
Tanupolama	24, 25, 28, 64, 65, 66, 92, 104, 128, 145, 147, 148, 156, 157, 164, 185, 198
Tapirus	52, 53, 65, 68, 92, 120, 133, 145, 157, 160, 164, 174, 186, 188, 197
Taxidea	13, 19, 25, 28, 48, 52, 68, 70, 86, 133, 145, 147, 156, 188, 197
Thomomys	13, 24, 27, 52, 59, 70, 86, 89, 133, 145, 156, 169, 188, 197
Urocyon	13, 24, 28, 52, 70, 86, 111, 118, 133, 145, 156, 157, 188, 195
Ursus	13, 52, 68, 70, 86, 91, 117, 119, 124, 133, 145, 156, 157, 164, 187, 188, 197, 205

44

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT

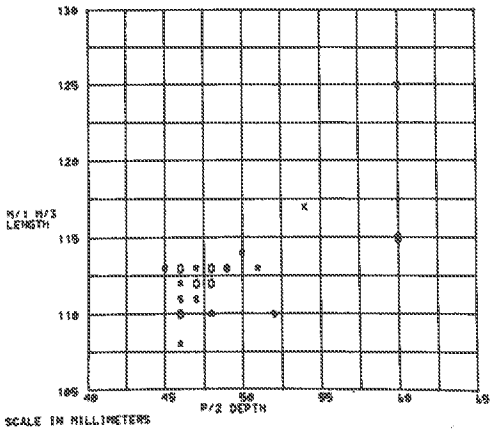


SCALE IN MILLIMETERS

x = COSTEAU PIT. & = PIT 3. 0 = PIT 4. ' = PIT 13. % = PIT 68. @ = PIT 61. # = PIT 67. < = PIT 71. * = PIT 8.

45

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT



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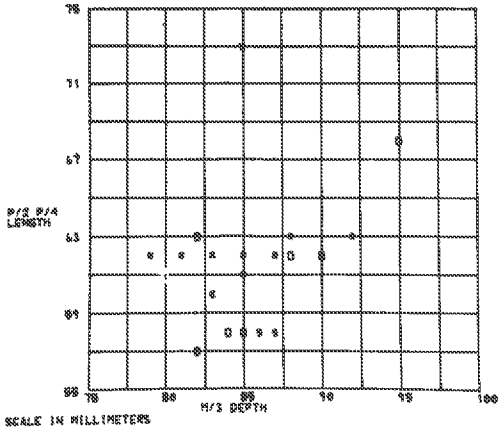
46

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT



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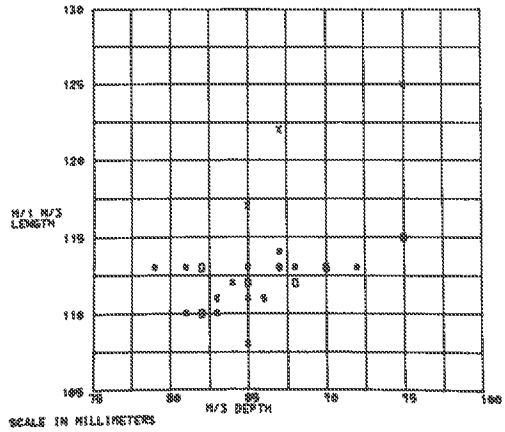
47

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

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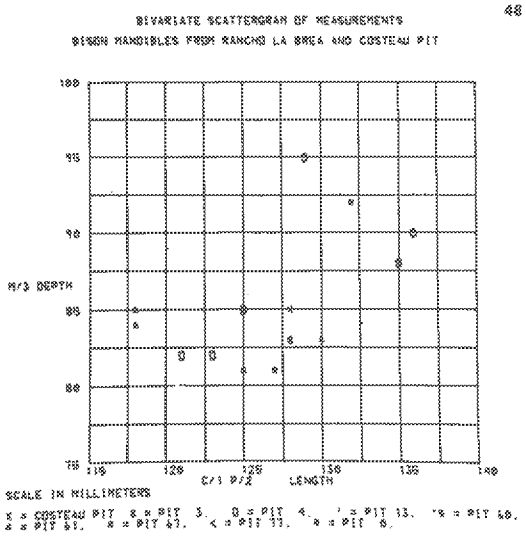
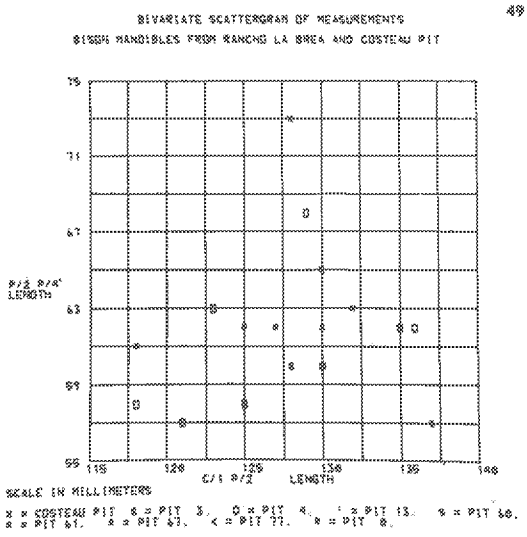
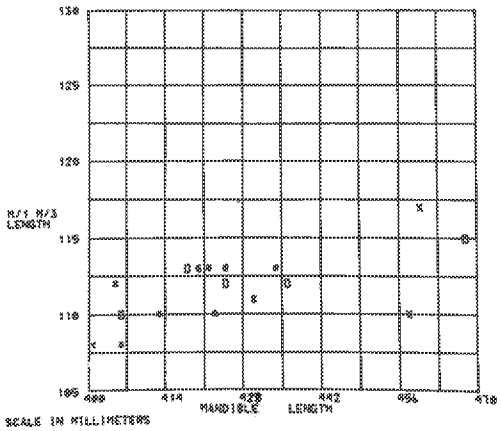




FIGURES 44-49. Comparison of mandibles of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit ◊ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Points of measurement are shown in figure 26.

50

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

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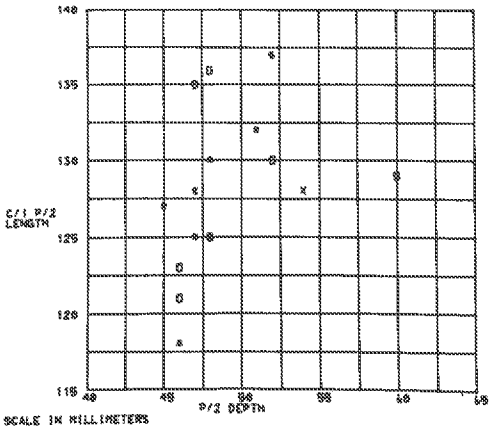
# = PIT 61. ^ = PIT 63. < = PIT 77. @ = PIT 0.

51

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT

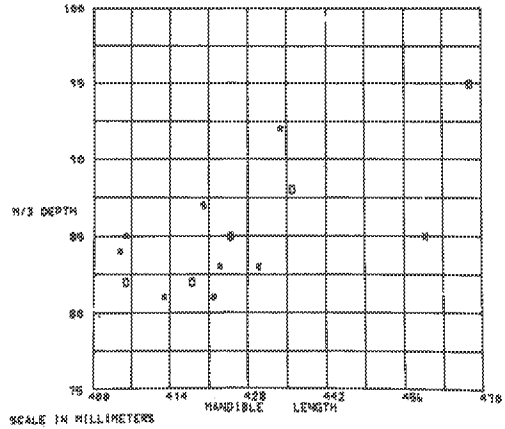


SCALE IN MILLIMETERS

X = COSTEAU PIT 4 = PIT 3. B = PIT 4. ' = PIT 13. % = PIT 60.
# = PIT 61. ^ = PIT 63. < = PIT 77. @ = PIT 0.

52

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT

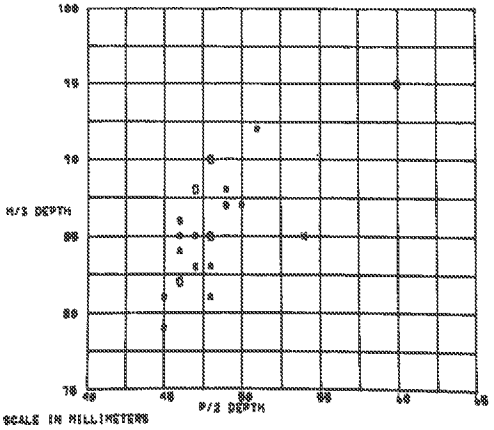


SCALE IN MILLIMETERS

X = COSTEAU PIT 4 = PIT 3. B = PIT 4. ' = PIT 13. % = PIT 60.
# = PIT 61. ^ = PIT 63. < = PIT 77. @ = PIT 0.

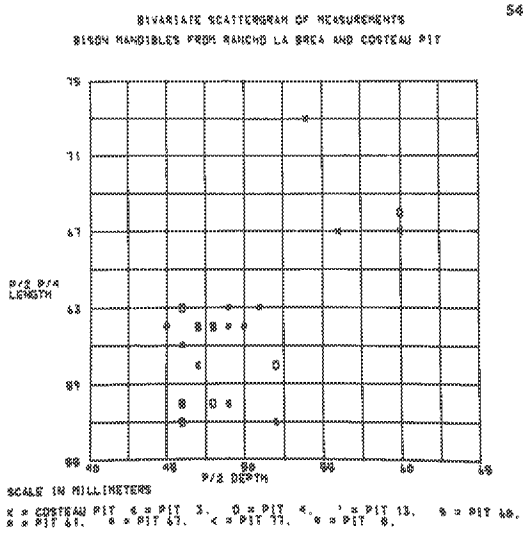
53

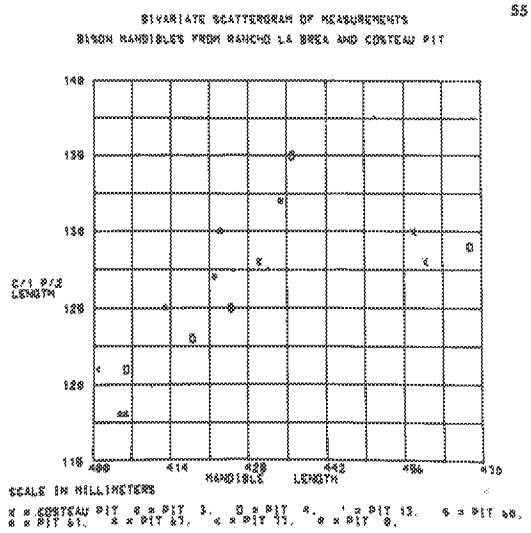
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON MANDIBLES FROM RANCHO LA BREA AND COSTEAU PIT



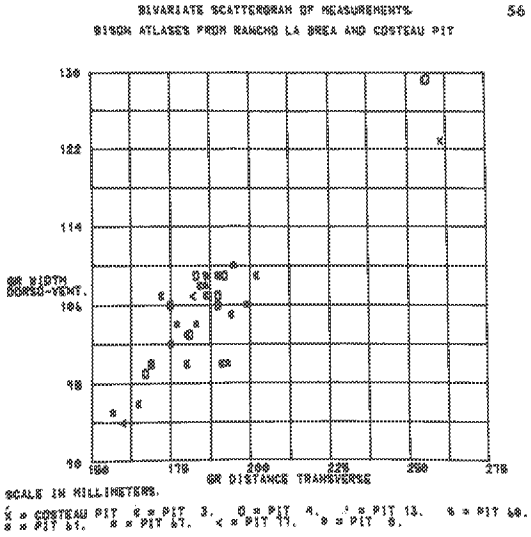
SCALE IN MILLIMETERS

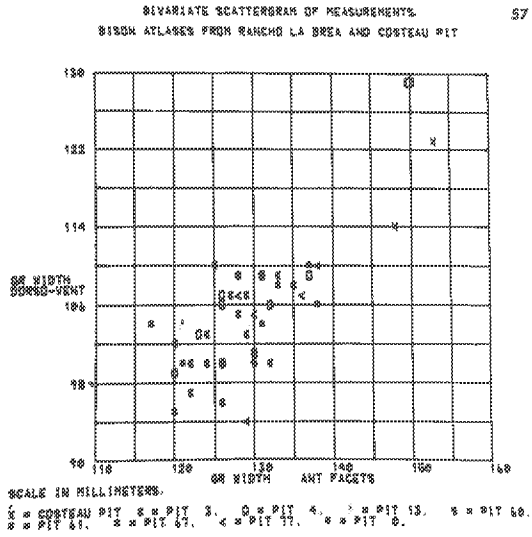
X = COSTEAU PIT 4 = PIT 3. B = PIT 4. ' = PIT 13. % = PIT 60.
# = PIT 61. ^ = PIT 63. < = PIT 77. @ = PIT 0.

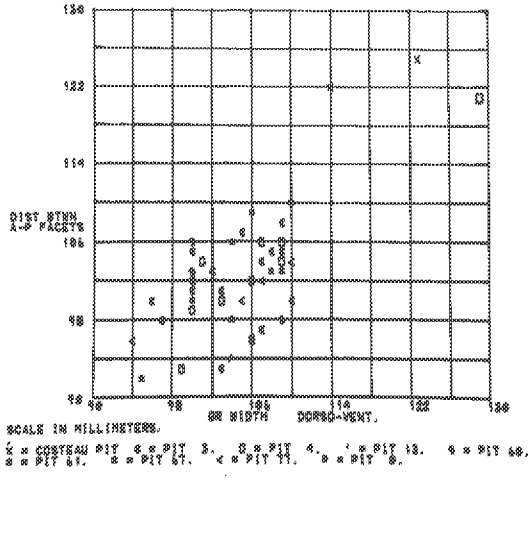


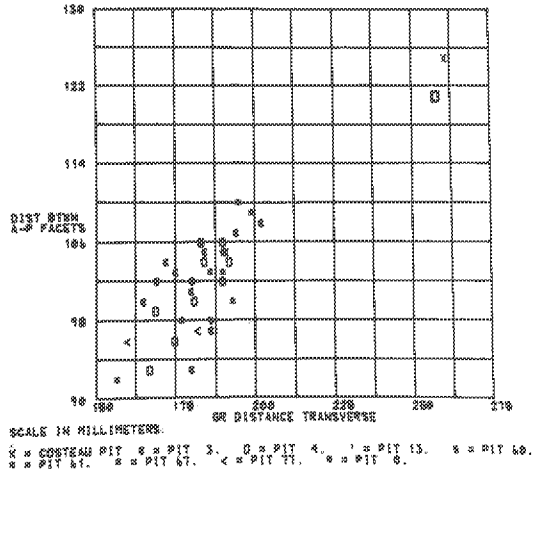


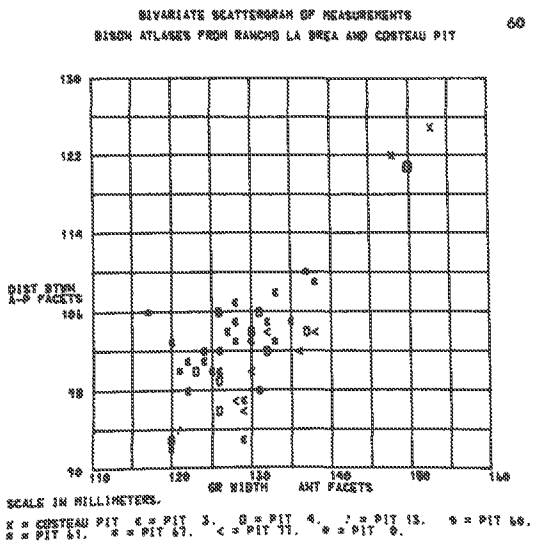
FIGURES 50-55. Comparison of mandibles of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Points of measurement are shown in figure 26.

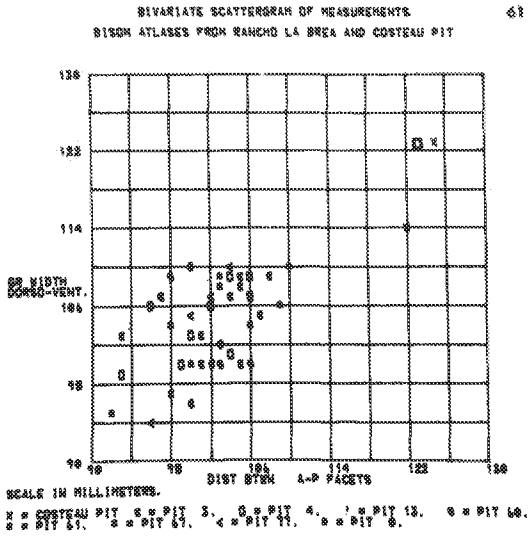

BIVARIATE SCATTERGRAM OF MEASUREMENTS. 56
BISON ATLASES FROM RANCHO LA BREA AND COSTEAU PIT
130
122
114
106
98
90
160
170
200
220
250
270
GR WIDTH DORSO-VENT.
GR DISTANCE TRANSVERSE
SCALE IN MILLIMETERS.
X = COSTEAU PIT 4 = PIT 3. O = PIT 4. ' = PIT 13. % = PIT 60.
# = PIT 61. @ = PIT 67. < = PIT 77. * = PIT 8.


BIVARIATE SCATTERGRAM OF MEASUREMENTS. 57
BISON ATLASES FROM RANCHO LA BREA AND COSTEAU PIT
130
122
114
106
98
90
110
120
130
140
150
160
GR WIDTH DORSO-VENT
GR WIDTH ANT FACETS
SCALE IN MILLIMETERS.
X = COSTEAU PIT 4 = PIT 3. O = PIT 4. ' = PIT 13. % = PIT 60.
# = PIT 61. @ = PIT 67. < = PIT 77. * = PIT 8.


BIVARIATE SCATTERGRAM OF MEASUREMENTS. 58
BISON ATLASES FROM RANCHO LA BREA AND COSTEAU PIT
130
122
114
106
98
90
90
98
106
114
122
130
DIST BTWN A-P FACETS
GR WIDTH DORSO-VENT.
SCALE IN MILLIMETERS.
X = COSTEAU PIT 4 = PIT 3. O = PIT 4. ' = PIT 13. % = PIT 60.
# = PIT 61. @ = PIT 67. < = PIT 77. * = PIT 8.

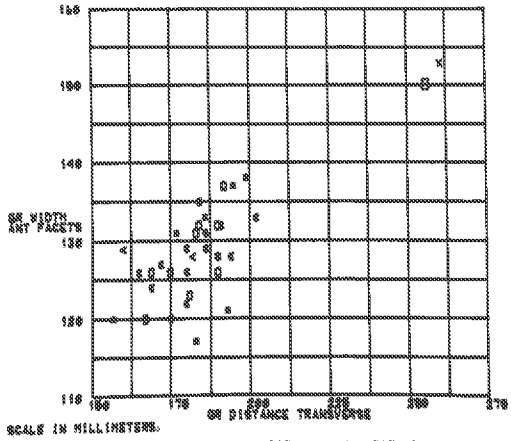

BIVARIATE SCATTERGRAM OF MEASUREMENTS. 59
BISON ATLASES FROM RANCHO LA BREA AND COSTEAU PIT
130
122
114
106
98
90
160
170
200
220
250
270
DIST BTWN A-P FACETS
GR DISTANCE TRANSVERSE
SCALE IN MILLIMETERS.
X = COSTEAU PIT 4 = PIT 3. O = PIT 4. ' = PIT 13. % = PIT 60.
# = PIT 61. @ = PIT 67. < = PIT 77. * = PIT 8.





FIGURES 56-61. Comparison of atlases of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; dorso-vent = dorso-ventral; dist = distance; btwn = between; a-p = anteroposterior; ant = anterior. Points of measurement are shown in figure 27.

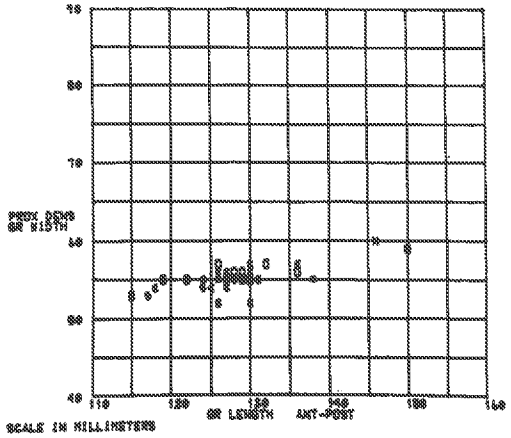
BIVARIATE SCATTERGRAM OF MEASUREMENTS 62
BISON ATLASES FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS.

X = COSTEAU PIT 6 = PIT 3. O = PIT 4. / = PIT 13. 9 = PIT 60.
8 = PIT 61. 7 = PIT 67. < = PIT 11. 0 = PIT 8.

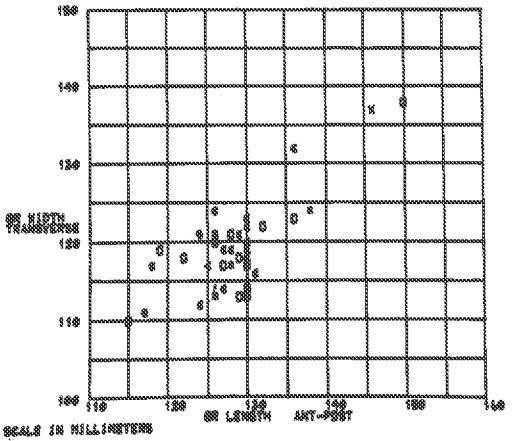
BIVARIATE SCATTERGRAM OF MEASUREMENTS 63
BISON AXES FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. O = PIT 4. / = PIT 13. 9 = PIT 60.
8 = PIT 61. 7 = PIT 67. < = PIT 11. 0 = PIT 8.

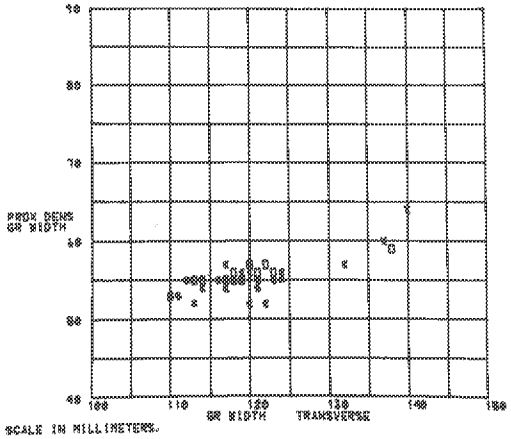
BIVARIATE SCATTERGRAM OF MEASUREMENTS 64
BISON AXES FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

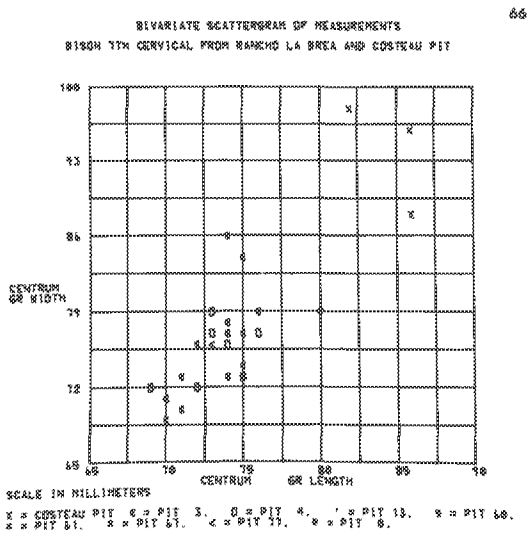
X = COSTEAU PIT 6 = PIT 3. O = PIT 4. / = PIT 13. 9 = PIT 60.
8 = PIT 61. 7 = PIT 67. < = PIT 11. 0 = PIT 8.

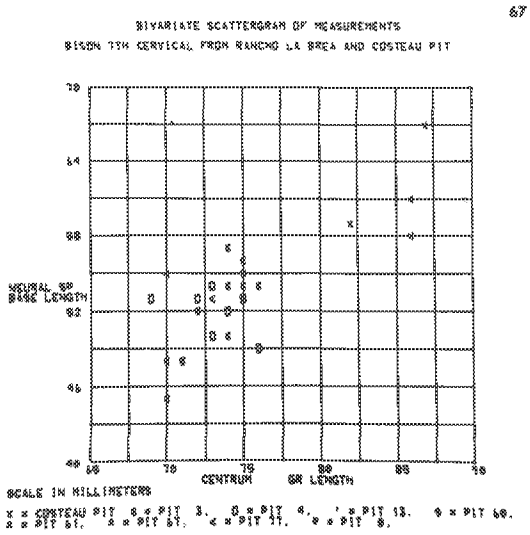
BIVARIATE SCATTERGRAM OF MEASUREMENTS 65
BISON AXES FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS.

X = COSTEAU PIT 6 = PIT 3. O = PIT 4. / = PIT 13. 9 = PIT 60.
8 = PIT 61. 7 = PIT 67. < = PIT 11. 0 = PIT 8.

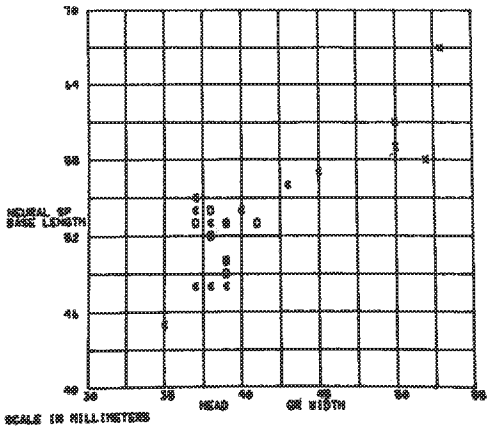




FIGURES 62-67. Comparison of atlases, axes and 7th cervical vertebrae of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is distinct. Pit ⊙ shown in diagram represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; ant = anterior; prox = proximal; sp = spine. Points of measurement are shown in figures 27-29.

68

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 7TH CERVICAL FROM RANCHO LA BREA AND COSTEAU PIT

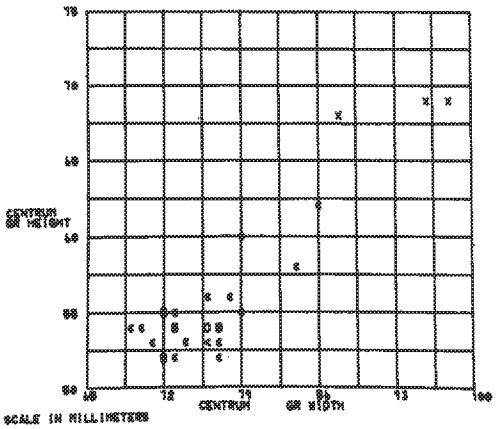


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 11. @ = PIT 8.

69

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 7TH CERVICAL FROM RANCHO LA BREA AND COSTEAU PIT

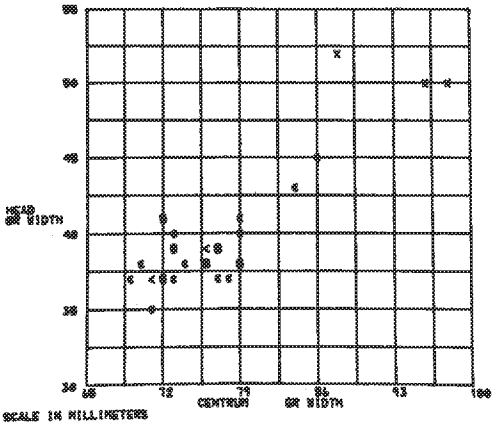


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 11. @ = PIT 8.

70

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 7TH CERVICAL FROM RANCHO LA BREA AND COSTEAU PIT

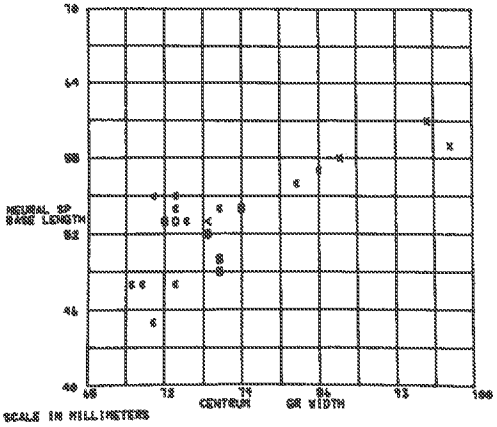


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 11. @ = PIT 8.

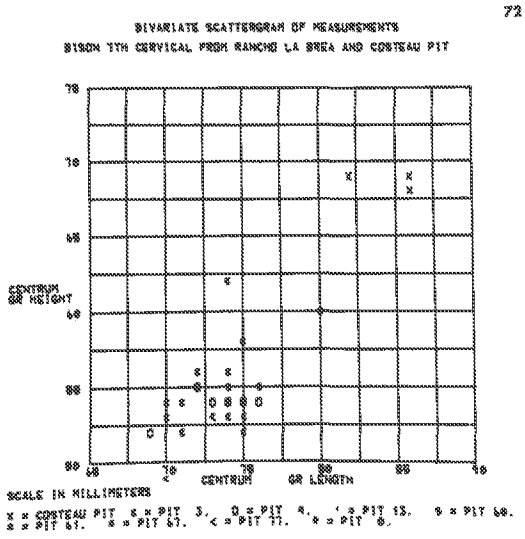
71

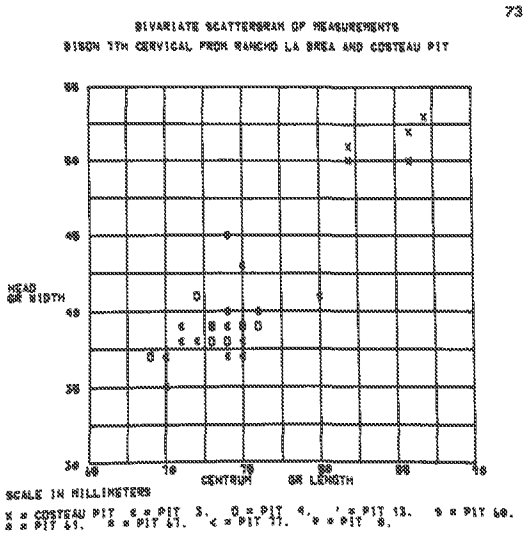
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 7TH CERVICAL FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 11. @ = PIT 8.

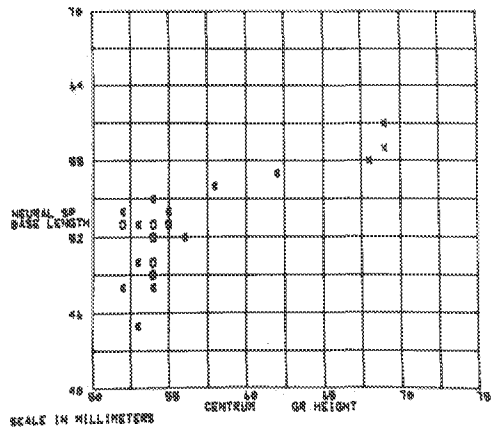




FIGURES 68-73. Comparison of 7th cervical vertebrae of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: sp = spine; gr = greatest. Points of measurement are shown in figure 29.

74

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 7TH CERVICAL FROM RANCHO LA BREA AND COSTEAU PIT

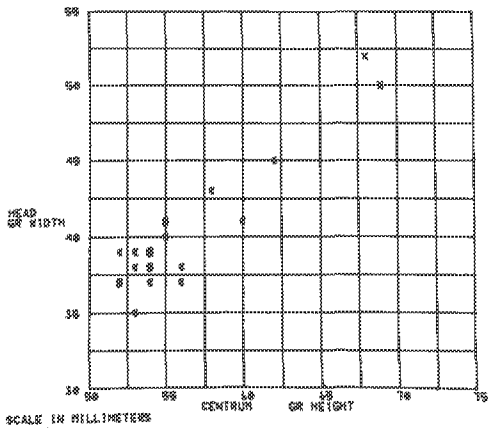


SCALE IN MILLIMETERS

K = COSTEAU PIT, 6 = PIT 3, 8 = PIT 4, ' = PIT 13, % = PIT 60, S = PIT 61, B = PIT 63, < = PIT 77, @ = PIT 8.

75

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 7TH CERVICAL FROM RANCHO LA BREA AND COSTEAU PIT

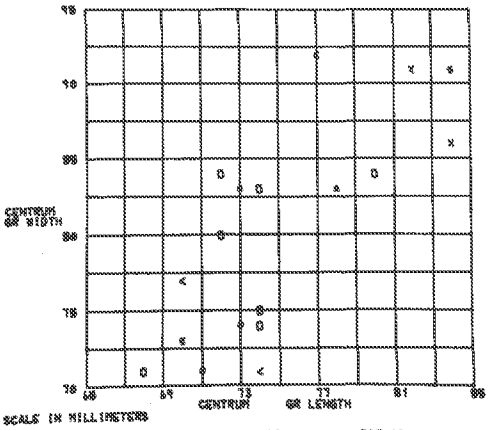


SCALE IN MILLIMETERS

K = COSTEAU PIT, 6 = PIT 3, 8 = PIT 4, ' = PIT 13, % = PIT 60, S = PIT 61, B = PIT 63, < = PIT 77, @ = PIT 8.

76

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 8TH LUMBARS FROM RANCHO LA BREA AND COSTEAU PIT

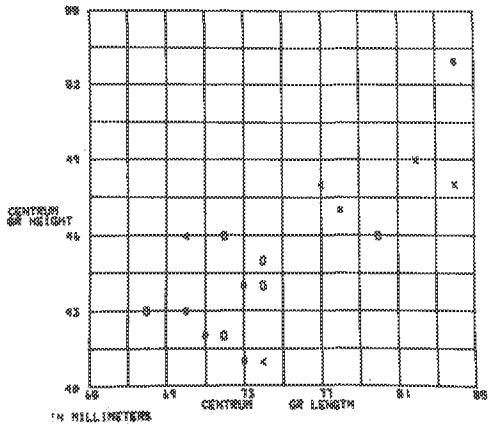


SCALE IN MILLIMETERS

K = COSTEAU PIT, 6 = PIT 3, 8 = PIT 4, ' = PIT 13, % = PIT 60, S = PIT 61, B = PIT 63, < = PIT 77, @ = PIT 8.

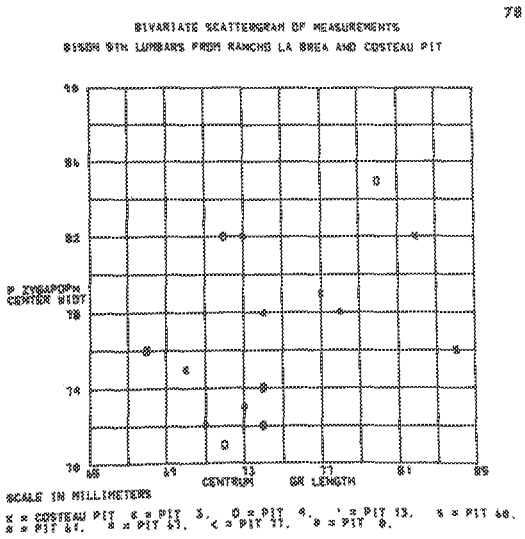
77

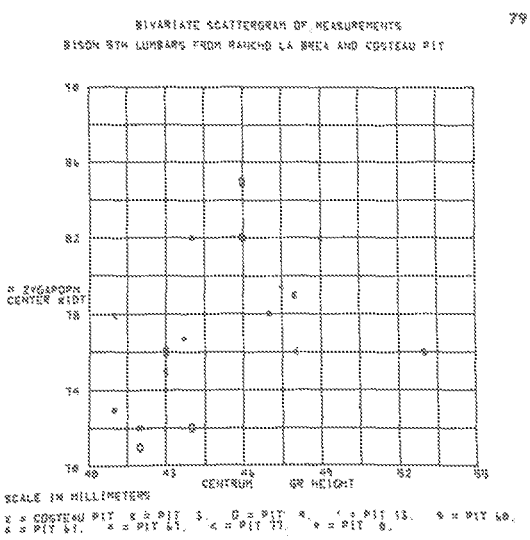
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 8TH LUMBARS FROM RANCHO LA BREA AND COSTEAU PIT



IN MILLIMETERS

AU PIT, 6 = PIT 3, 8 = PIT 4, ' = PIT 13, % = PIT 60, S = PIT 61, B = PIT 63, < = PIT 77, @ = PIT 8.



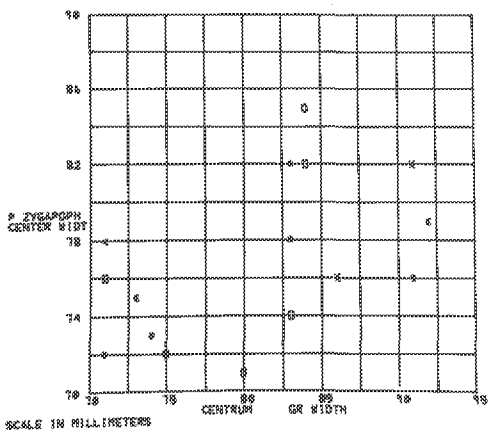


FIGURES 74-79. Comparison of 7th cervical and 5th lumbar vertebrae of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit ⬡ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: sp = spine; gr = greatest; p zygapoph = posterior zygapophyses: Points of measurement are shown in figures 29-30.

80

BIVARIATE SCATTERGRAM OF MEASUREMENTS

BISON 5TH LUMBARS FROM RANCHO LA BREA AND COSTEAU PIT



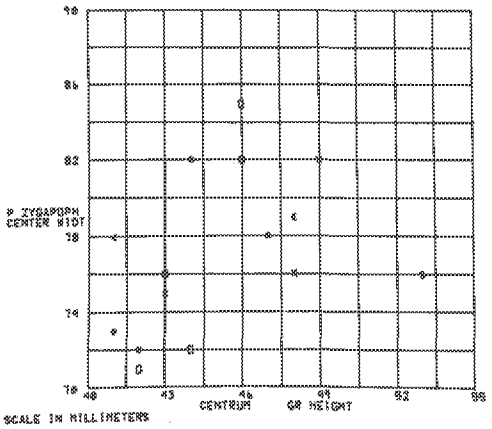
SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. Q = PIT 4. ' = PIT 13. % = PIT 60. # = PIT 61. @ = PIT 67. < = PIT 77. 8 = PIT 8.

81

BIVARIATE SCATTERGRAM OF MEASUREMENTS

BISON 5TH LUMBARS FROM RANCHO LA BREA AND COSTEAU PIT



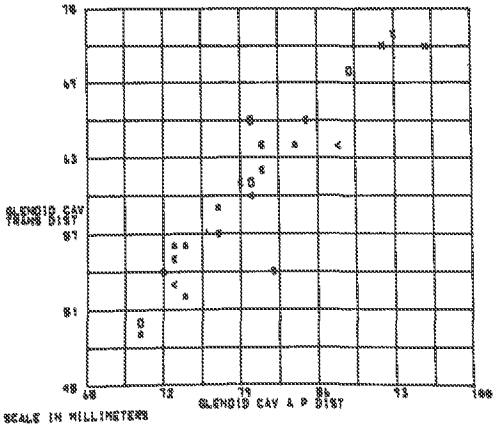
SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. Q = PIT 4. ' = PIT 13. % = PIT 60. # = PIT 61. @ = PIT 67. < = PIT 77. 8 = PIT 8.

82

BIVARIATE SCATTERGRAM OF MEASUREMENTS

BISON SCAPULAE FROM RANCHO LA BREA AND COSTEAU PIT



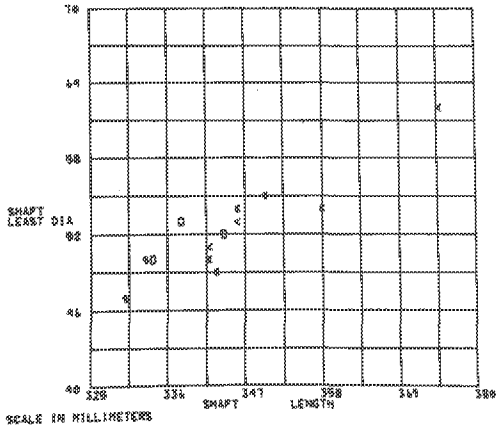
SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. Q = PIT 4. ' = PIT 13. % = PIT 60. # = PIT 61. @ = PIT 67. < = PIT 77. 8 = PIT 8.

83

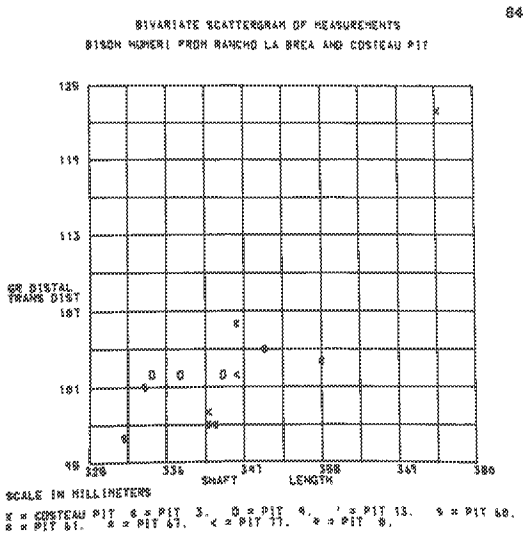
BIVARIATE SCATTERGRAM OF MEASUREMENTS

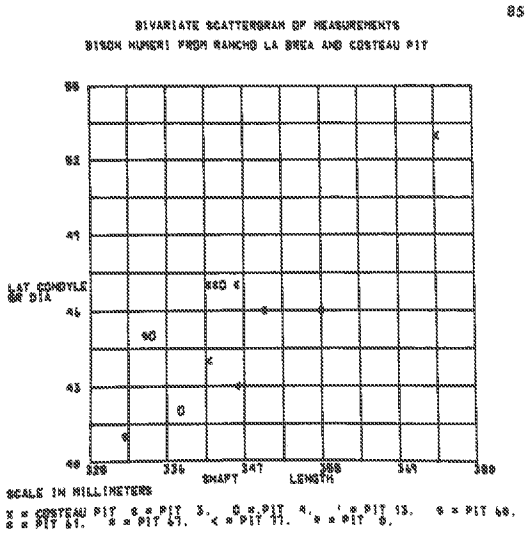
BISON HUMERI FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. Q = PIT 4. ' = PIT 13. % = PIT 60. # = PIT 61. @ = PIT 67. < = PIT 77. 8 = PIT 8.

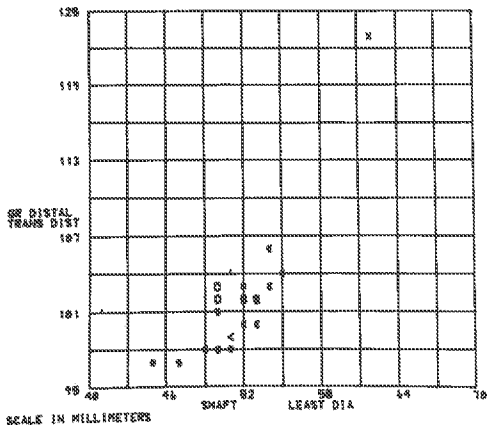




FIGURES 80-85. Comparisons of 5th lumber vertebrae, scapulae and humeri of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit 0 shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: p zygapoph = posterior zygapophyses; gr = greatest; cav = cavity; trans = transverse; dist = distance; a-p = anteroposterior; dia = diameter; lat = lateral. Points of measurement are shown in figures 30-32.

86

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON NUMERI FROM RANCHO LA BREA AND COSTEAU PIT

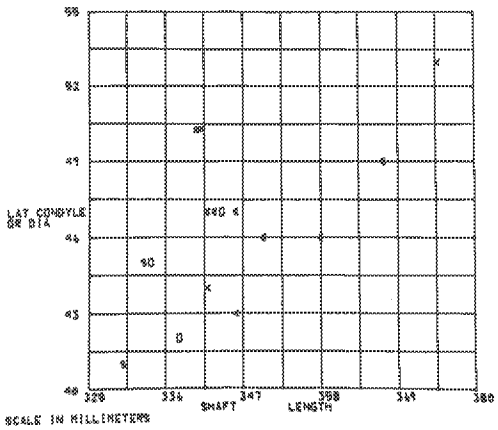


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. # = PIT 67. < = PIT 77. * = PIT 8.

87

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON NUMERI FROM RANCHO LA BREA AND COSTEAU PIT

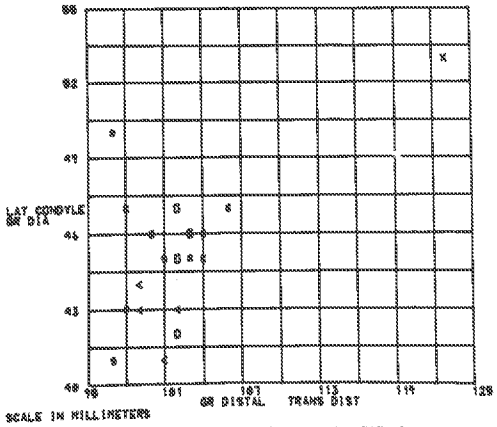


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. # = PIT 67. < = PIT 77. * = PIT 8.

88

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON NUMERI FROM RANCHO LA BREA AND COSTEAU PIT

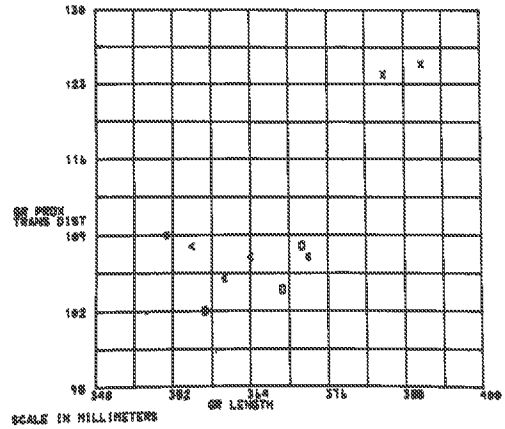


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. # = PIT 67. < = PIT 77. * = PIT 8.

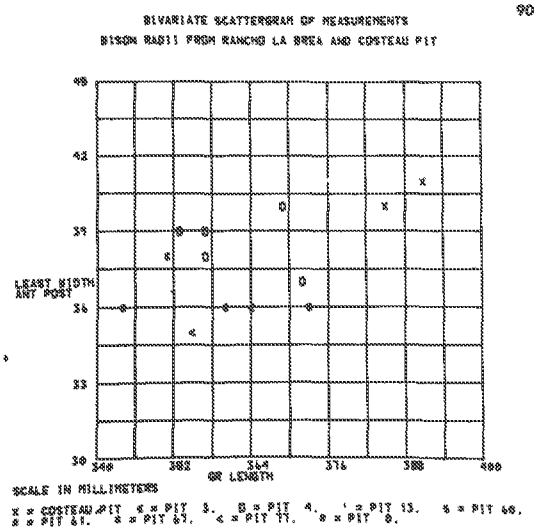
89

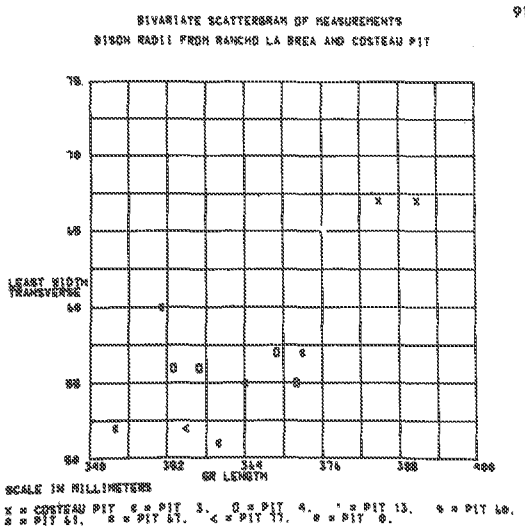
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON RADII FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. # = PIT 67. < = PIT 77. * = PIT 8.

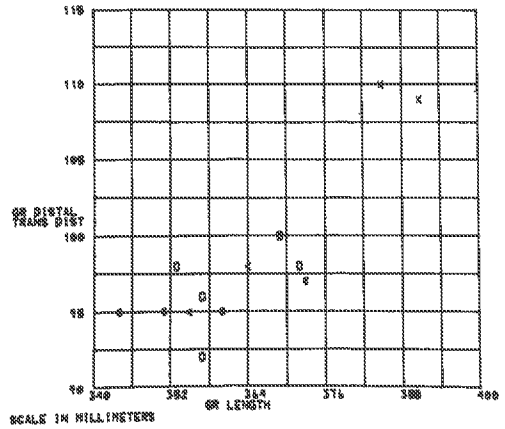




FIGURES 86-91. Comparison of humeri and radii of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is distinct. Pit ◊ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; trans = transverse; dist = distance; dia = diameter; lat = lateral; prox = proximal; ant = anterior; post = posterior. Points of measurement are shown in figures 32-33.

92

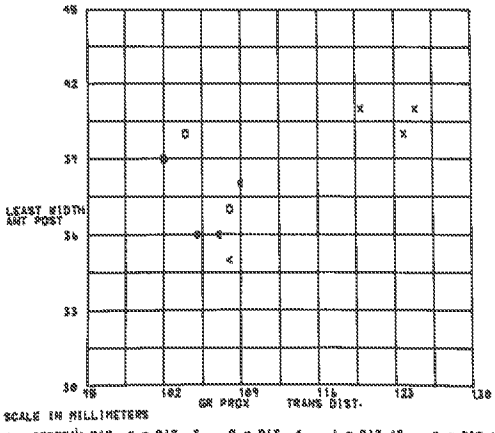
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON RADII FROM RANCHO LA BREA AND COSTEAU PIT



X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, 8 = PIT 48, 8 = PIT 61, 8 = PIT 67, < = PIT 77, 9 = PIT 0.

93

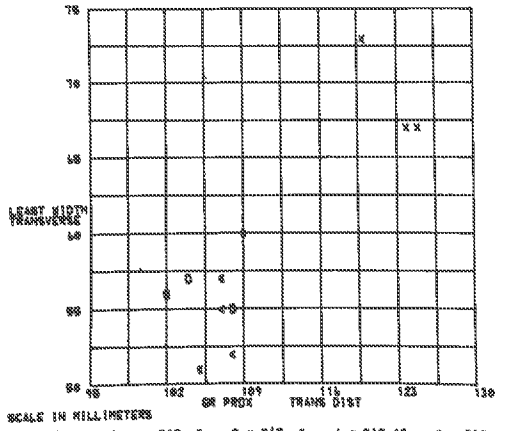
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON RADII FROM RANCHO LA BREA AND COSTEAU PIT



X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, 8 = PIT 48, 8 = PIT 61, 8 = PIT 67, < = PIT 77, 9 = PIT 0.

94

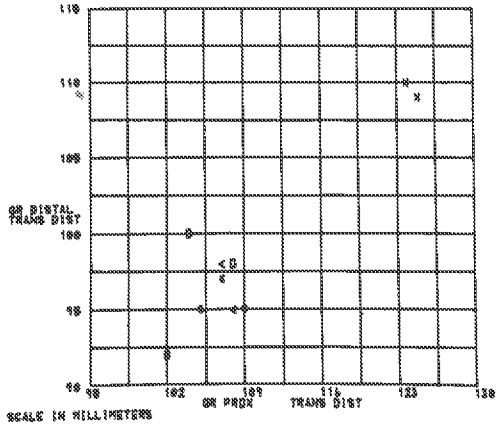
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON RADII FROM RANCHO LA BREA AND COSTEAU PIT



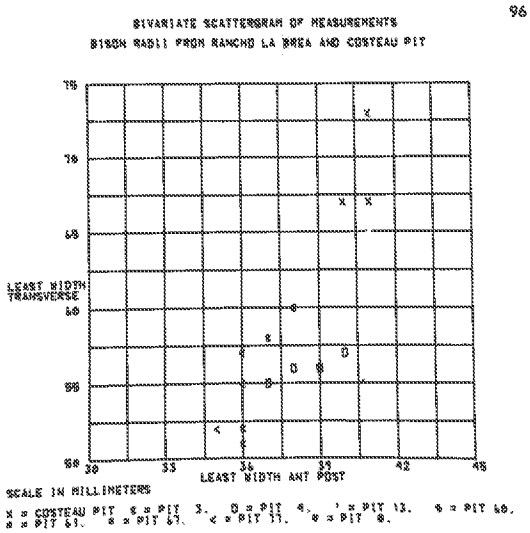
X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, 8 = PIT 48, 8 = PIT 61, 8 = PIT 67, < = PIT 77, 9 = PIT 0.

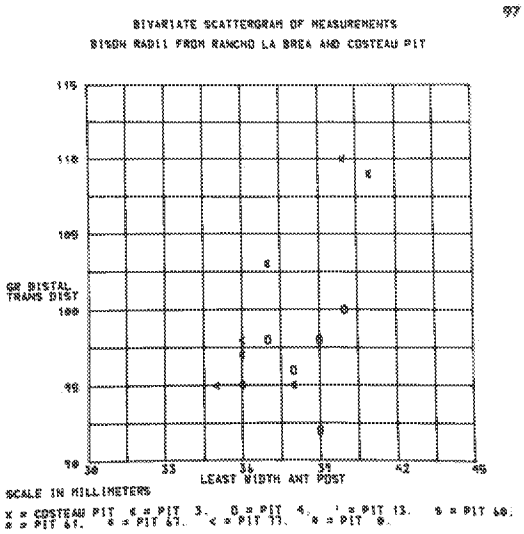
95

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON RADII FROM RANCHO LA BREA AND COSTEAU PIT



X = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, 8 = PIT 48, 8 = PIT 61, 8 = PIT 67, < = PIT 77, 9 = PIT 0.

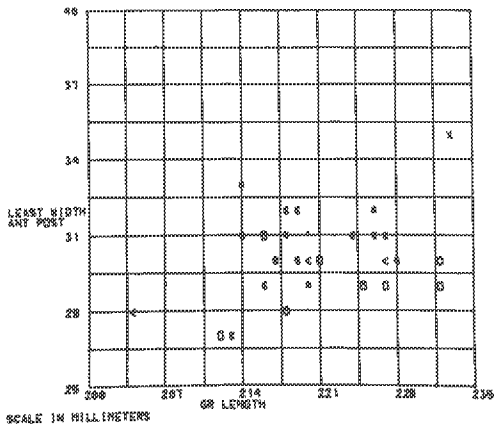




FIGURES 92-97. Comparison of radii of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; trans = transverse; dist = distance; ant = anterior; post = posterior; prox = proximal. Points of measurement are shown in figure 33.

98

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METACARPALS FROM RANCHO LA BREA AND COSTEAU PIT

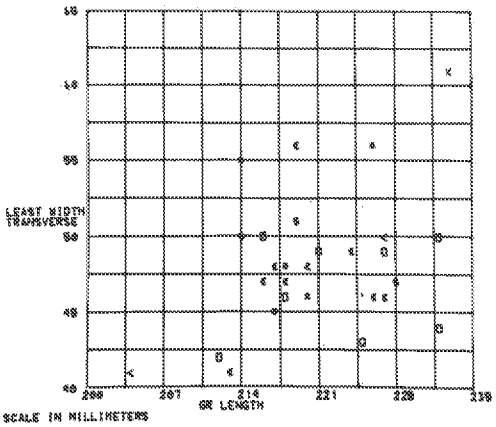


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, 0 = PIT 4, ' = PIT 13, % = PIT 68, # = PIT 61, & = PIT 67, < = PIT 11, @ = PIT 8.

99

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METACARPALS FROM RANCHO LA BREA AND COSTEAU PIT

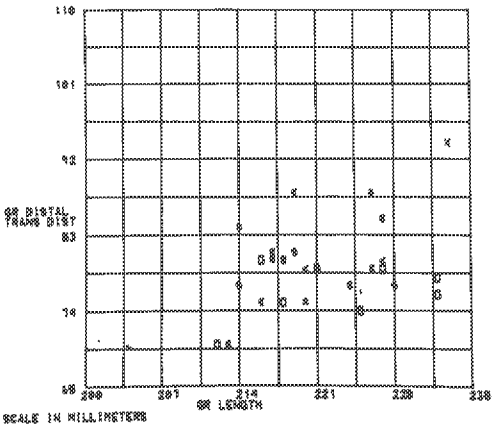


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, 0 = PIT 4, ' = PIT 13, % = PIT 68, # = PIT 61, & = PIT 67, < = PIT 11, @ = PIT 8.

100

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METACARPALS FROM RANCHO LA BREA AND COSTEAU PIT

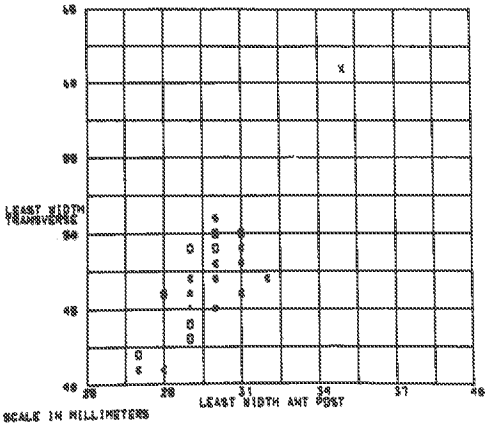


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, 0 = PIT 4, ' = PIT 13, % = PIT 68, # = PIT 61, & = PIT 67, < = PIT 11, @ = PIT 8.

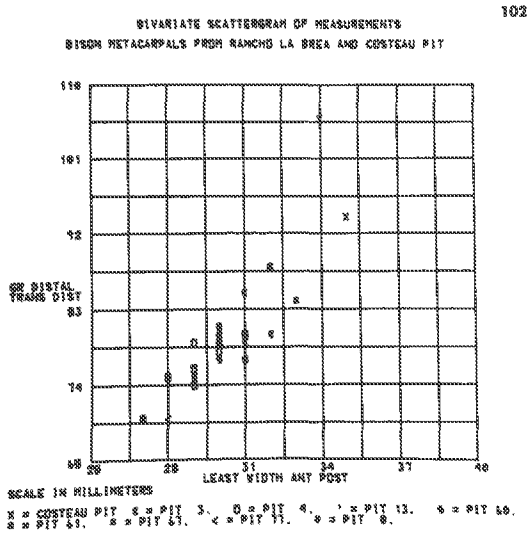
101

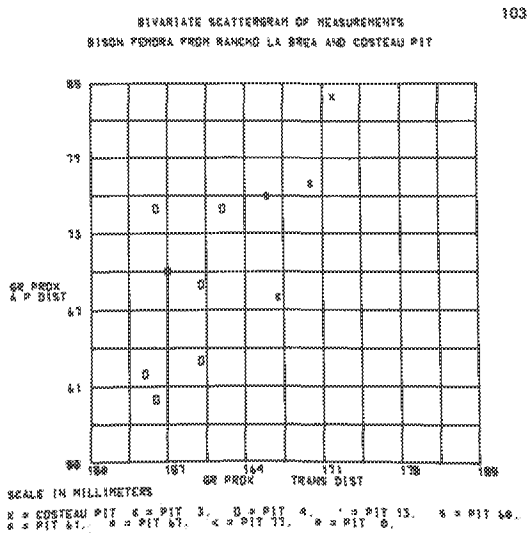
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METACARPALS FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3, 0 = PIT 4, ' = PIT 13, % = PIT 68, # = PIT 61, & = PIT 67, < = PIT 11, @ = PIT 8.

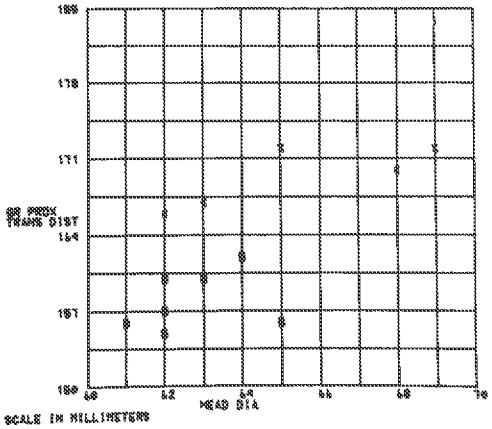




FIGURES 98-103. Comparison of metacarpals and femora of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit ⬡ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: ant = anterior; post = posterior; gr = greatest; trans = transverse; dist = distance; prox = proximal; a-p = anteroposterior. Points of measurement are shown in figures 34-35.

104

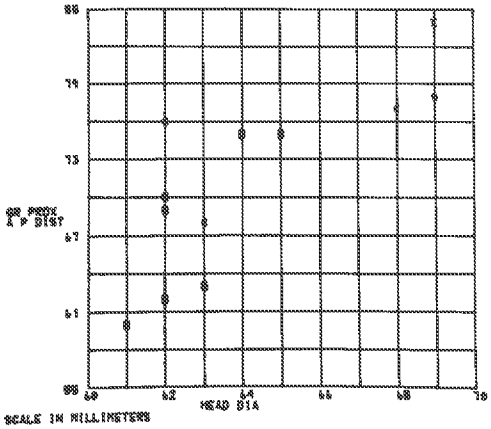
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON FEMORA FROM RANCHO LA BREA AND COSTEAU PIT



X = COSTEAU PIT, 6 = PIT 3, 0 = PIT 4, ' = PIT 13, 9 = PIT 60, 8 = PIT 61, 8 = PIT 67, < = PIT 11, 9 = PIT 8.

105

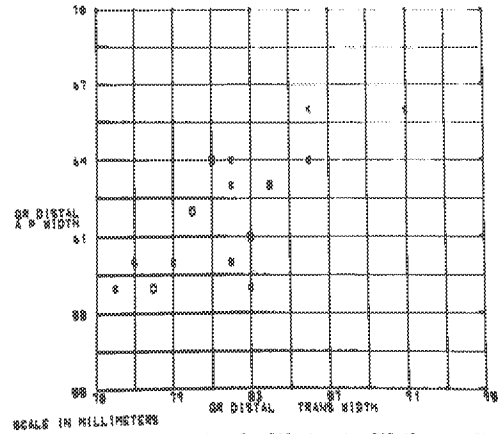
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON FEMORA FROM RANCHO LA BREA AND COSTEAU PIT



X = COSTEAU PIT, 6 = PIT 3, 0 = PIT 4, ' = PIT 13, 9 = PIT 60, 8 = PIT 61, 8 = PIT 67, < = PIT 11, 9 = PIT 8.

106

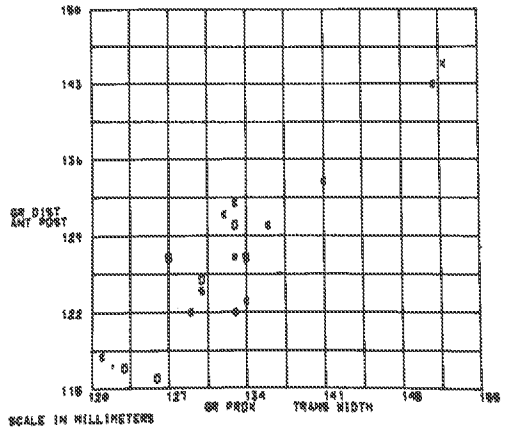
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT



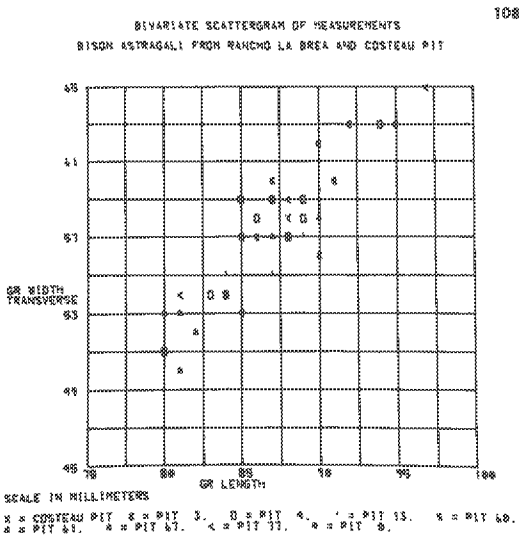
X = COSTEAU PIT, 6 = PIT 3, 0 = PIT 4, ' = PIT 13, 9 = PIT 60, 8 = PIT 61, 8 = PIT 67, < = PIT 11, 9 = PIT 8.

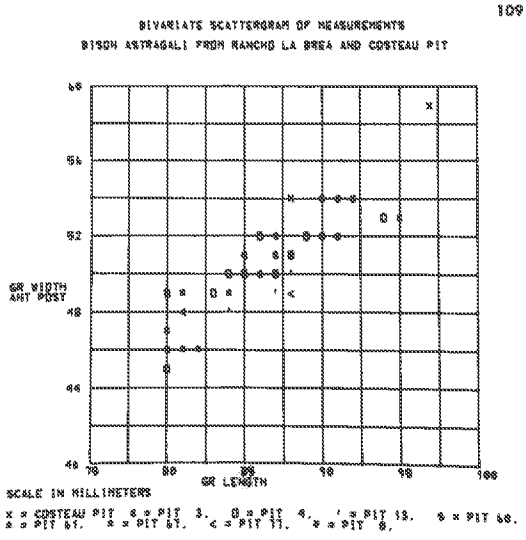
107

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT



X = COSTEAU PIT, 6 = PIT 3, 0 = PIT 4, ' = PIT 13, 9 = PIT 60, 8 = PIT 61, 8 = PIT 67, < = PIT 11, 9 = PIT 8.

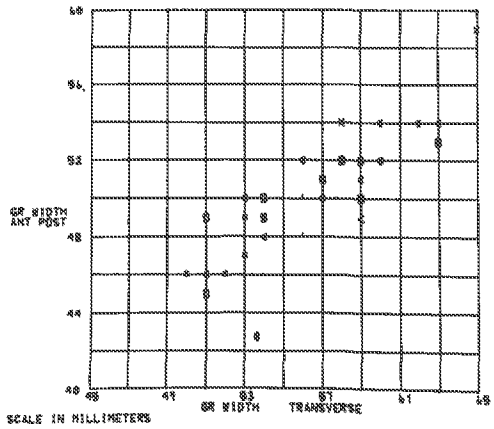




FIGURES 104-109. Comparison of femora, tibiae and astragali of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; prox = proximal; trans = transverse; dist = distance; dia = diameter; a-p = anteroposterior; ant = anterior; post = posterior. Points of measurement are shown in figures 35-37.

110

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON ASTRAGALI FROM RANCHO LA BREA AND COSTEAU PIT

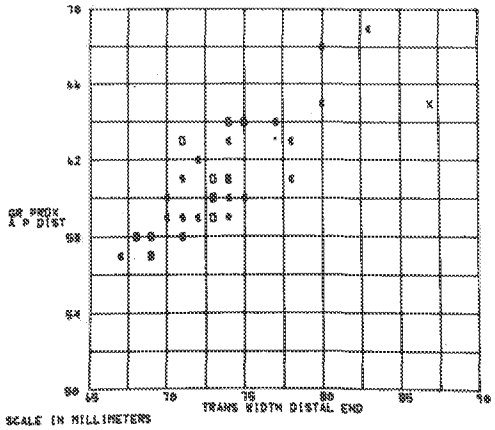


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 60.
8 = PIT 61. 5 = PIT 67. < = PIT 11. 8 = PIT 8.

111

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

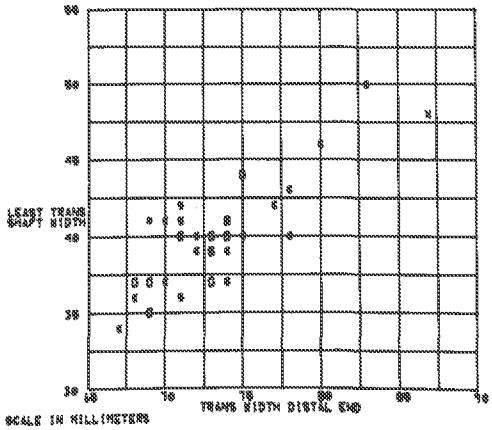


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 60.
8 = PIT 61. 5 = PIT 67. < = PIT 11. 8 = PIT 8.

112

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

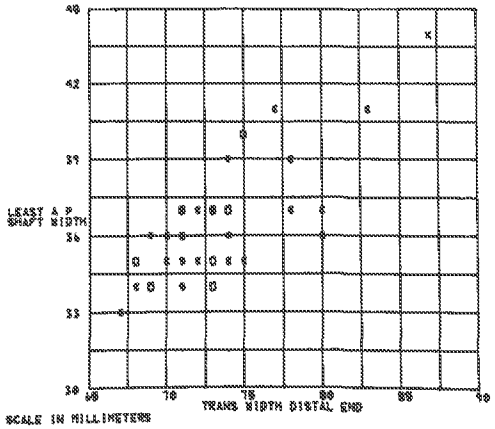


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 60.
8 = PIT 61. 5 = PIT 67. < = PIT 11. 8 = PIT 8.

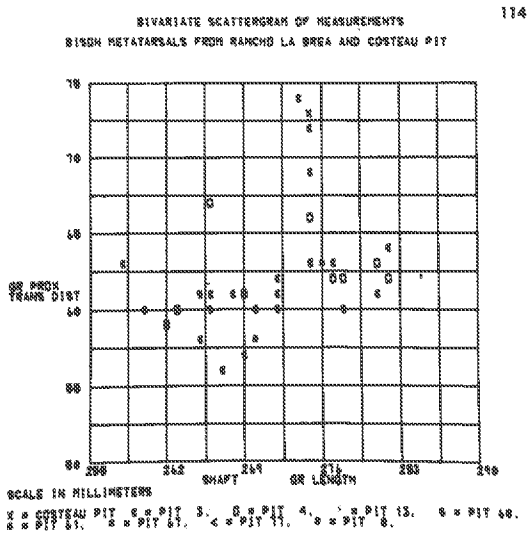
113

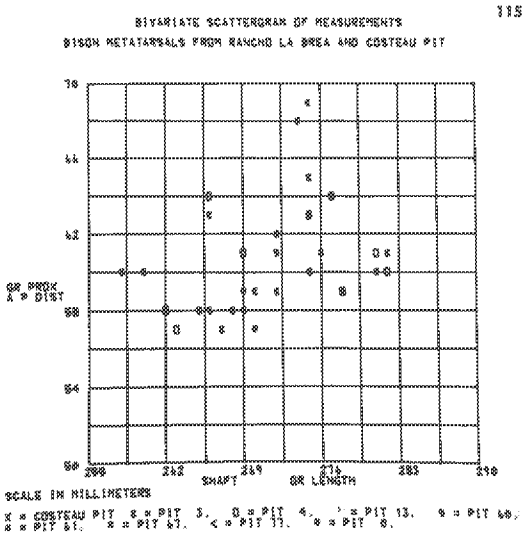
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 60.
8 = PIT 61. 5 = PIT 67. < = PIT 11. 8 = PIT 8.

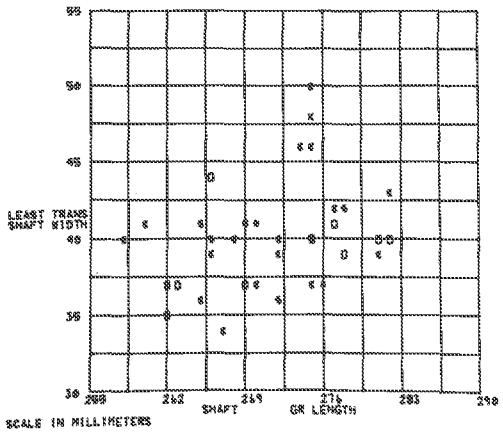




FIGURES 110-115. Comparison of astragali and metatarsals of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; ant = anterior; post = posterior; prox = proximal; a-p = anteroposterior; dist = distance; trans = transverse. Points of measurement are shown in figures 37-38.

116

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

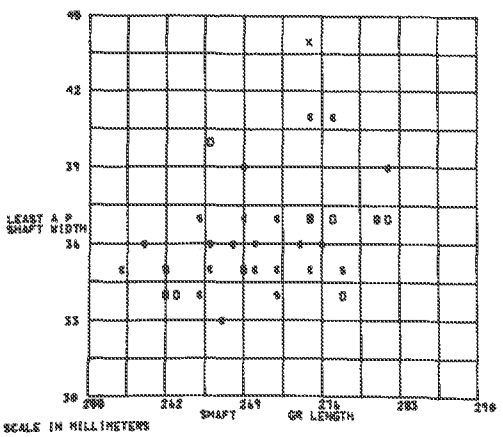


SCALE IN MILLIMETERS

X = COSTEAU PIT, 4 = PIT 3, D = PIT 9, ' = PIT 13, % = PIT 48, 8 = PIT 61, B = PIT 67, < = PIT 77, @ = PIT 8.

117

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

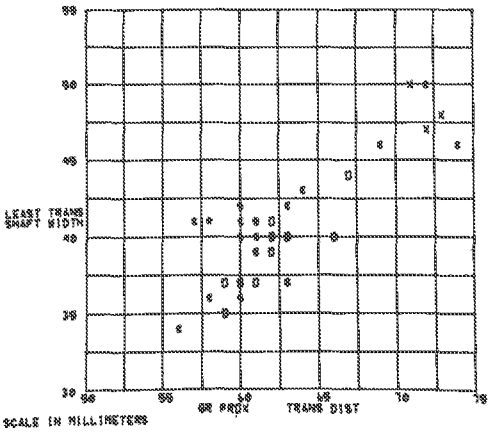


SCALE IN MILLIMETERS

X = COSTEAU PIT, 4 = PIT 3, D = PIT 9, ' = PIT 13, % = PIT 48, 8 = PIT 61, B = PIT 67, < = PIT 77, @ = PIT 8.

118

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

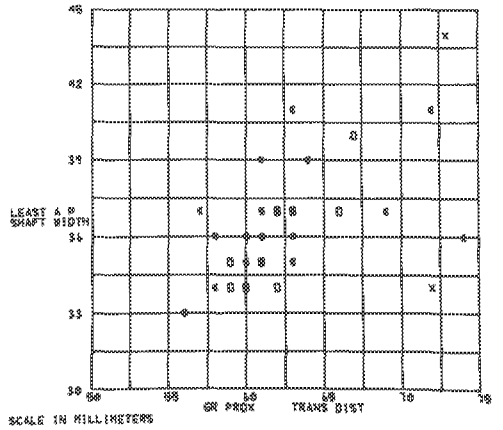


SCALE IN MILLIMETERS

X = COSTEAU PIT, 4 = PIT 3, D = PIT 9, ' = PIT 13, % = PIT 48, 8 = PIT 61, B = PIT 67, < = PIT 77, @ = PIT 8.

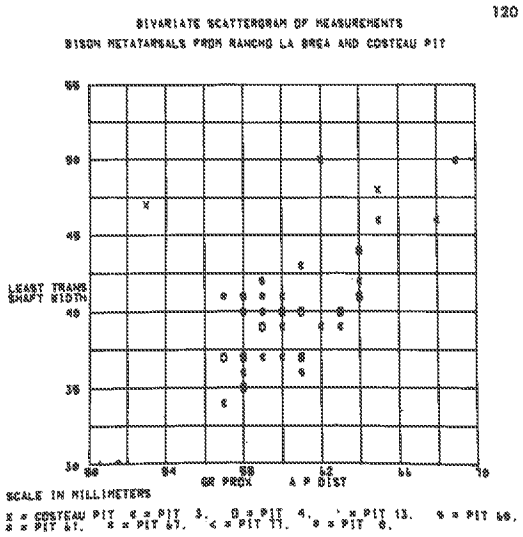
119

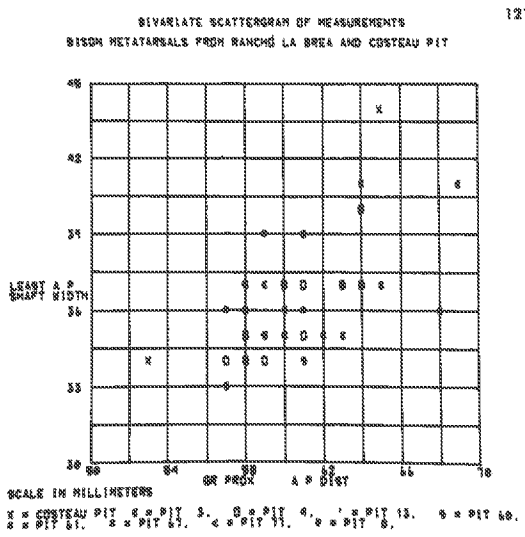
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT, 4 = PIT 3, D = PIT 9, ' = PIT 13, % = PIT 48, 8 = PIT 61, B = PIT 67, < = PIT 77, @ = PIT 8.

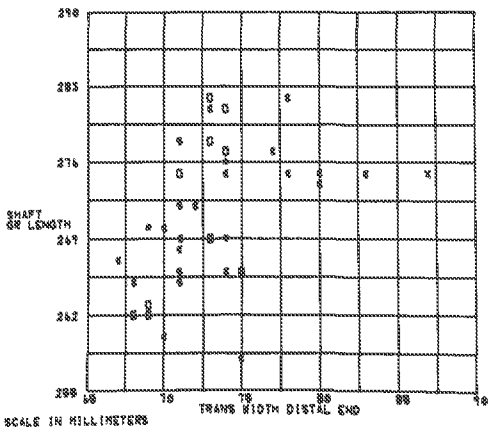




FIGURES 116-121. Comparison of metatarsals of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: trans = transverse; gr = greatest; a-p = anteroposterior; prox = proximal; dist = distance. Points of measurement are shown in figure 38.

122

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

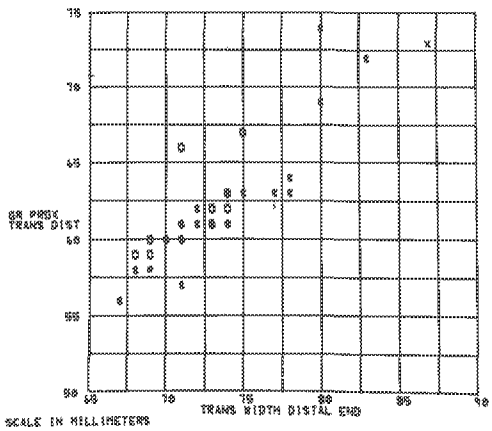


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 77. 9 = PIT 8.

123

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

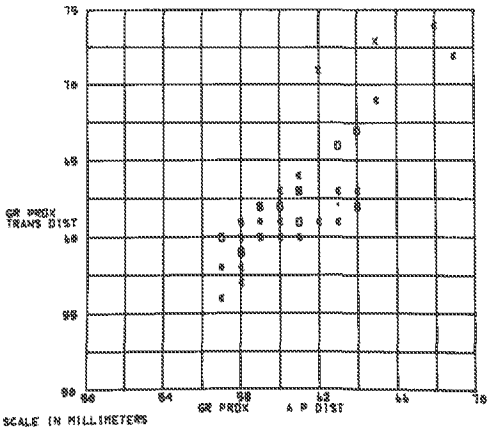


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 77. 9 = PIT 8.

124

BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON METATARSALS FROM RANCHO LA BREA AND COSTEAU PIT

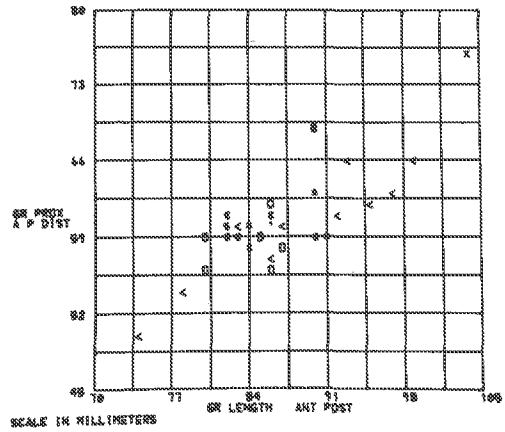


SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 77. 9 = PIT 8.

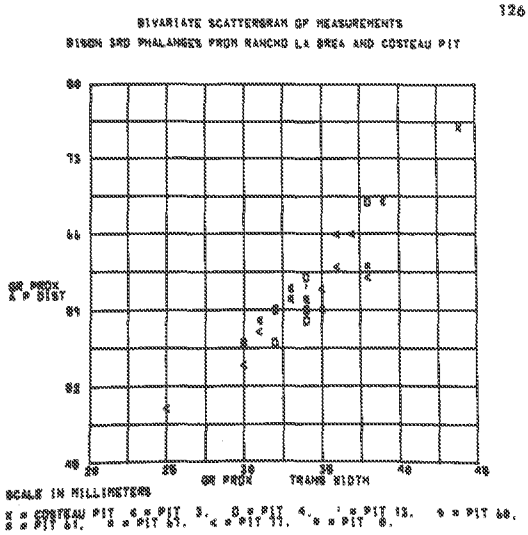
125

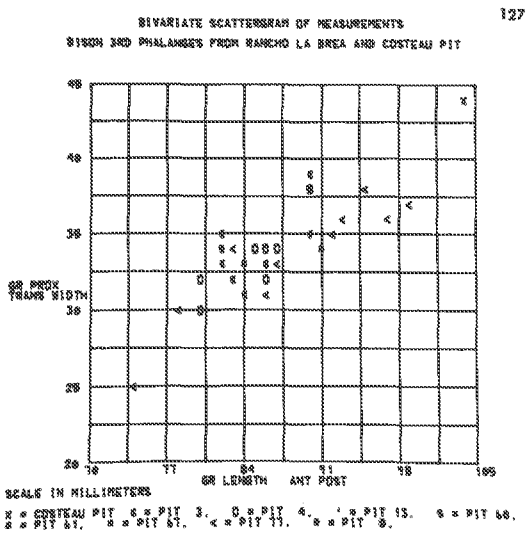
BIVARIATE SCATTERGRAM OF MEASUREMENTS
BISON 3RD PHALANGES FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT 6 = PIT 3. D = PIT 4. ' = PIT 13. 9 = PIT 68.
8 = PIT 61. 8 = PIT 67. < = PIT 77. 9 = PIT 8.

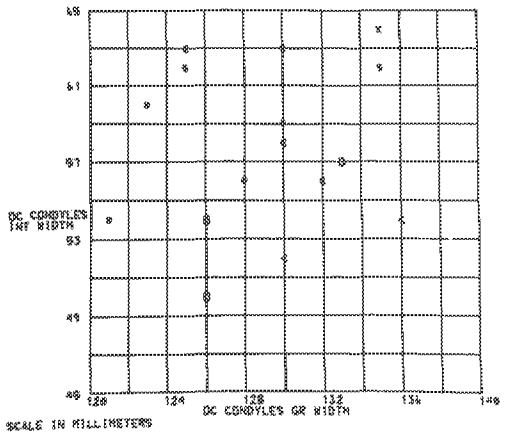




FIGURES 122-127. Comparison of metatarsals and 3rd phalanges of *Bison latifrons* and *Bison antiquus* from Rancho La Brea and Costeau Pit. Separation of the larger species, *B. latifrons*, is not always distinct. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; trans = transverse; prox = proximal; dist = distance; ant = anterior; post = posterior; a-p = anteroposterior. Points of measurement are shown in figures 38-39.

128

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT

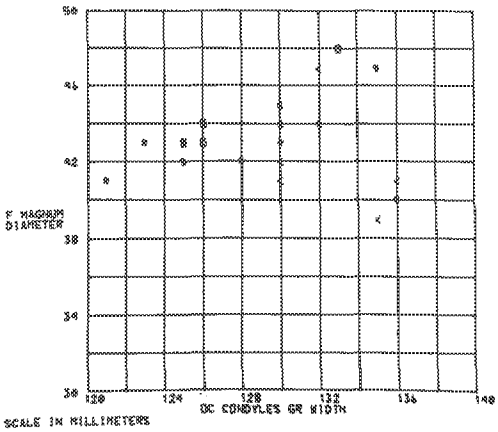


SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. @ = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. & = PIT 63. < = PIT 77. @ = PIT 8.

129

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT

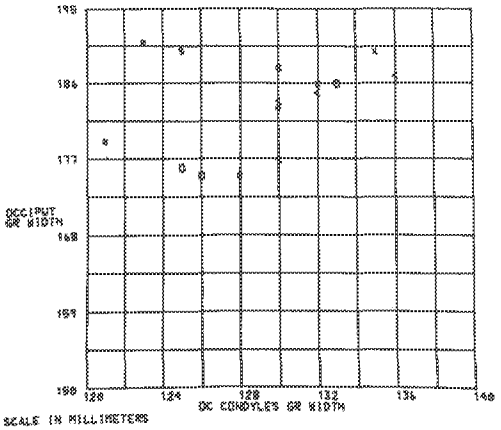


SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. @ = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. & = PIT 63. < = PIT 77. @ = PIT 8.

130

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT

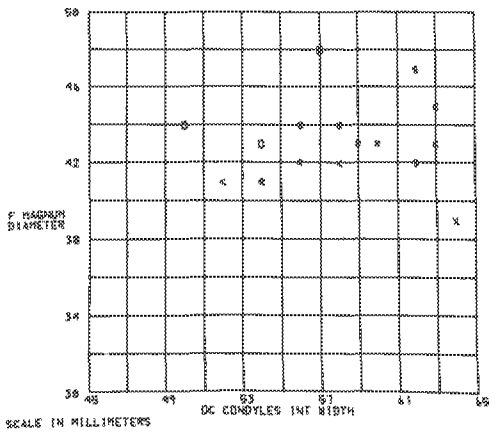


SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. @ = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. & = PIT 63. < = PIT 77. @ = PIT 8.

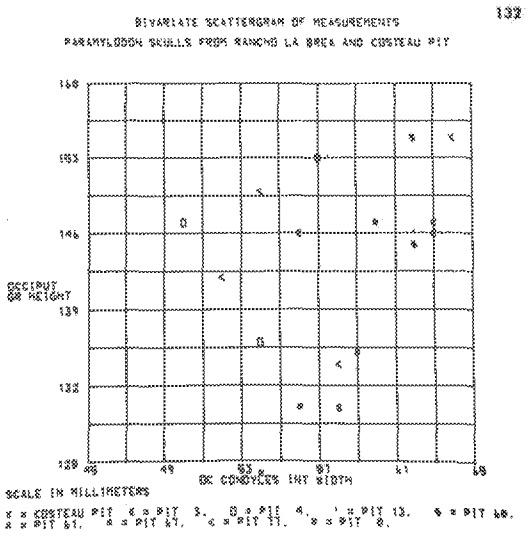
131

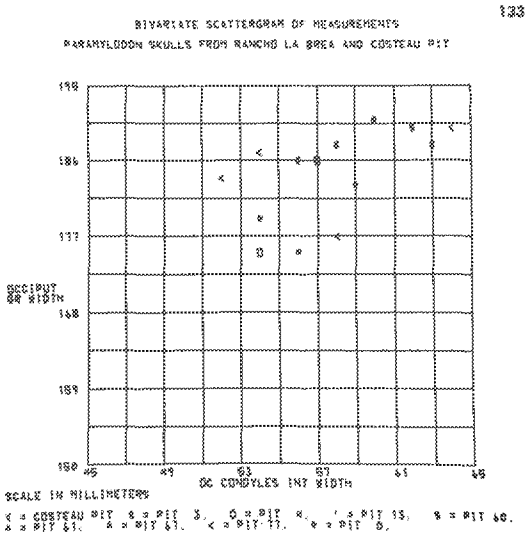
BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT & = PIT 3. @ = PIT 4. ' = PIT 13. % = PIT 60.
8 = PIT 61. & = PIT 63. < = PIT 77. @ = PIT 8.

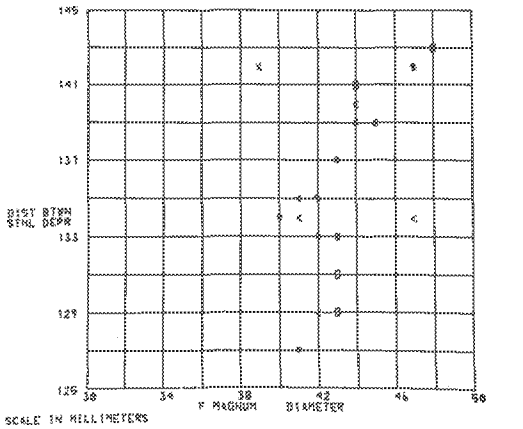




FIGURES 128-133. Comparison of skulls of *Paramylodon harlani* from Rancho La Brea and Costeau Pit. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: oc = occipital; int = internal; gr = greatest; f = foramen. Points of measurement are shown in figure 40.

134

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT

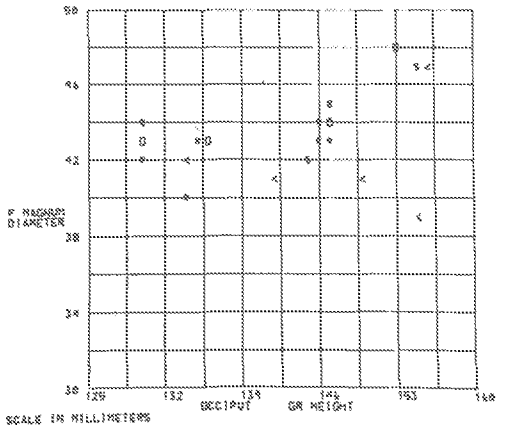


SCALE IN MILLIMETERS

x = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, & = PIT 61, A = PIT 67, < = PIT 77, 8 = PIT 8.

135

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT

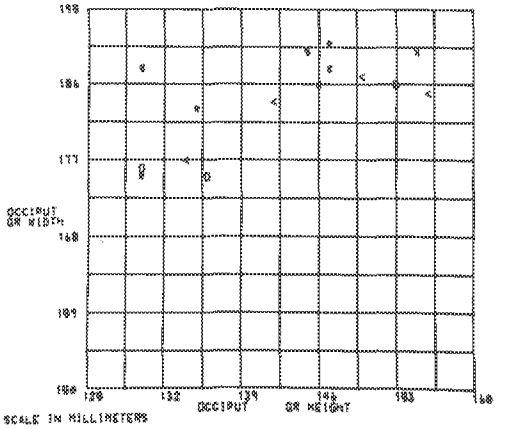


SCALE IN MILLIMETERS

x = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, & = PIT 61, A = PIT 67, < = PIT 77, 8 = PIT 8.

136

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT

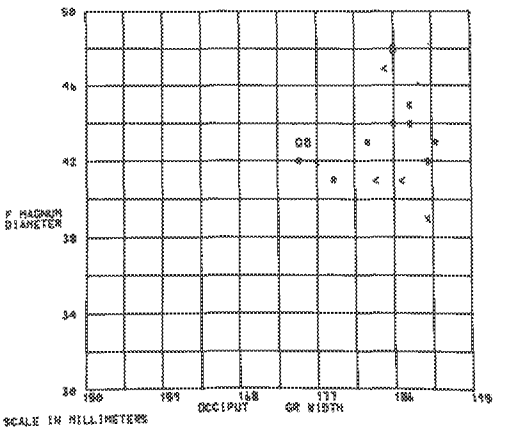


SCALE IN MILLIMETERS

x = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, & = PIT 61, A = PIT 67, < = PIT 77, 8 = PIT 8.

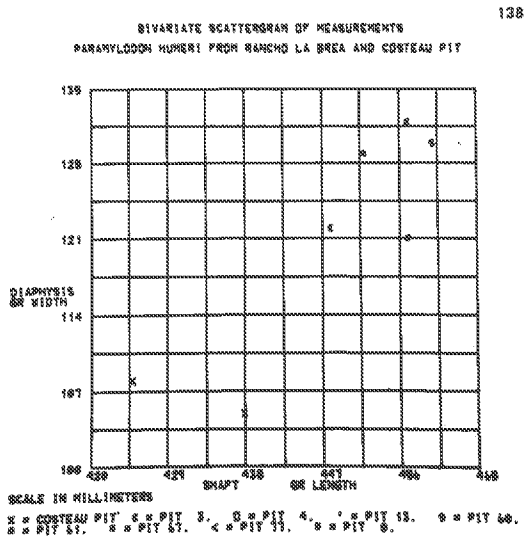
137

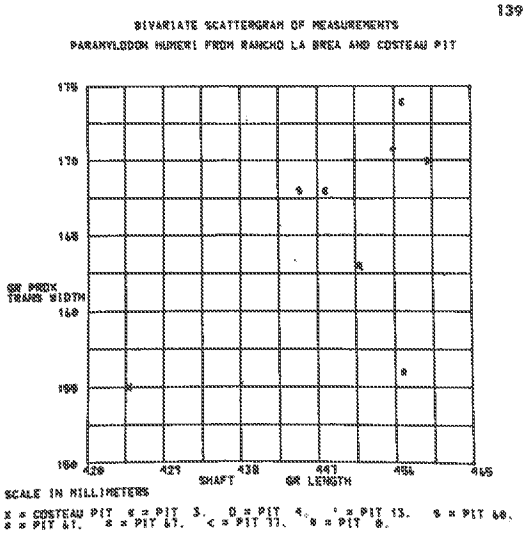
BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON SKULLS FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

x = COSTEAU PIT 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, & = PIT 61, A = PIT 67, < = PIT 77, 8 = PIT 8.

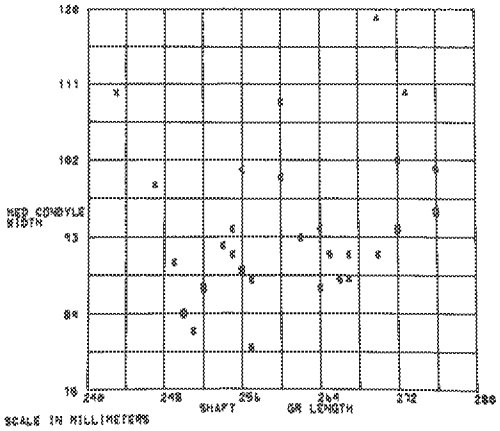




FIGURES 134-139. Comparison of skulls and humeri of *Paramylodon harlani* from Rancho La Brea and Costeau Pit. Pit ◊ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: dist = distance; btwn = between; sthl = stylohyal; depr = depressions; f = foramen; gr = greatest; prox = proximal; trans = transverse. Points of measurement are shown in figures 40-41.

140

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT

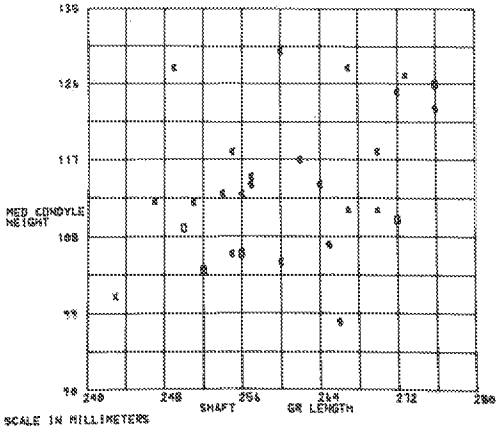


SCALE IN MILLIMETERS

X = COSTEAU PIT, < = PIT 3, D = PIT 4, ' = PIT 13, 6 = PIT 60, 8 = PIT 61, & = PIT 67, < = PIT 77, * = PIT 8.

141

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT

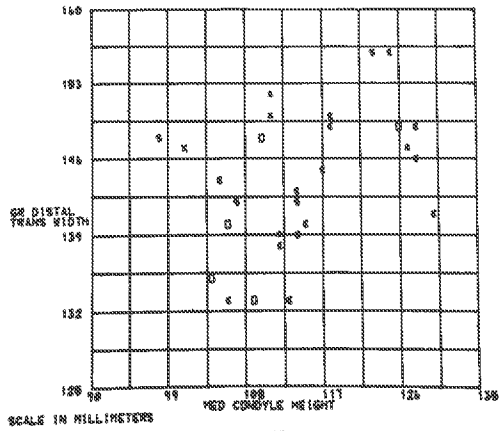


SCALE IN MILLIMETERS

X = COSTEAU PIT, < = PIT 3, D = PIT 4, ' = PIT 13, 6 = PIT 60, 8 = PIT 61, & = PIT 67, < = PIT 77, * = PIT 8.

142

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT

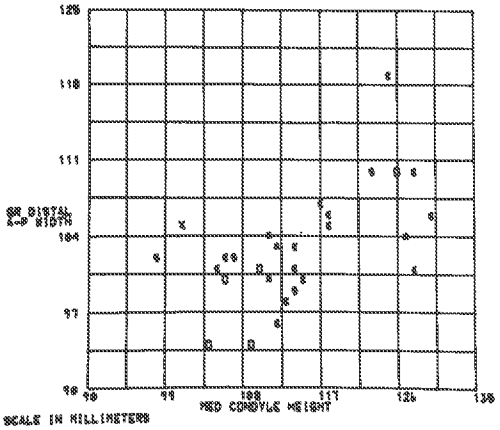


SCALE IN MILLIMETERS

X = COSTEAU PIT, < = PIT 3, D = PIT 4, ' = PIT 13, 6 = PIT 60, 8 = PIT 61, & = PIT 67, < = PIT 77, * = PIT 8.

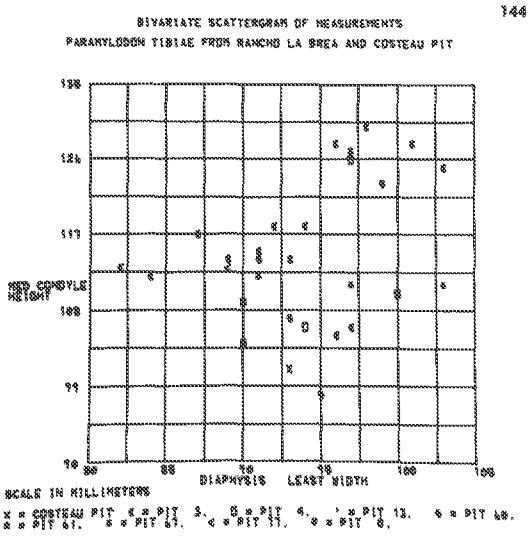
143

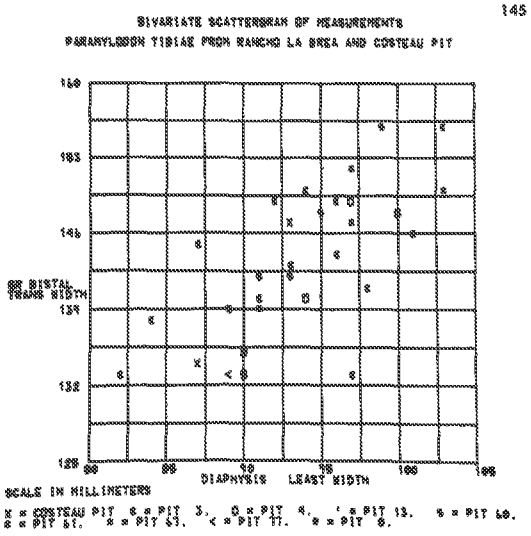
BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT



SCALE IN MILLIMETERS

X = COSTEAU PIT, < = PIT 3, D = PIT 4, ' = PIT 13, 6 = PIT 60, 8 = PIT 61, & = PIT 67, < = PIT 77, * = PIT 8.

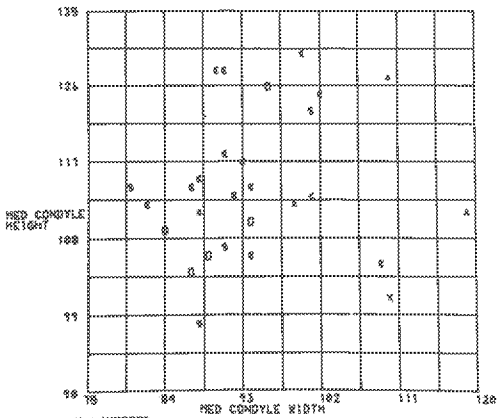




FIGURES 140-145. Comparison of tibiae of *Paramylodon harlani* from Rancho La Brea and Costeau Pit. Pit ◇ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: med = medial; gr = greatest; a-p = anteroposterior. Points of measurement are shown in figure 42.

146

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT

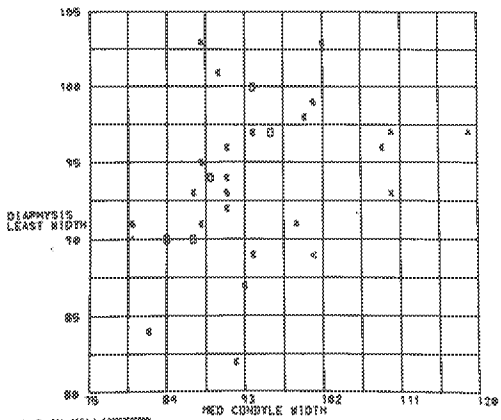


SCALE IN MILLIMETERS

X = COSTEAU PIT, 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, 8 = PIT 61, 8 = PIT 63, < = PIT 77, 8 = PIT 8.

147

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT

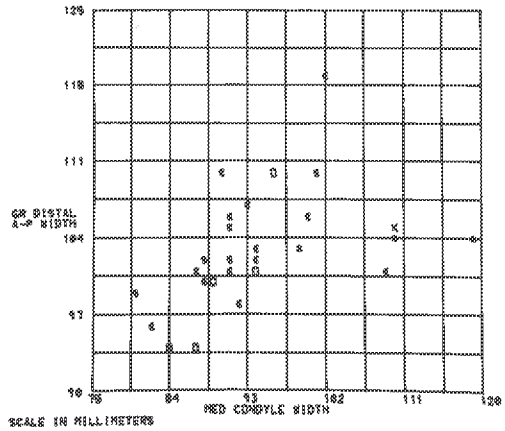


SCALE IN MILLIMETERS

X = COSTEAU PIT, 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, 8 = PIT 61, 8 = PIT 63, < = PIT 77, 8 = PIT 8.

148

BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT

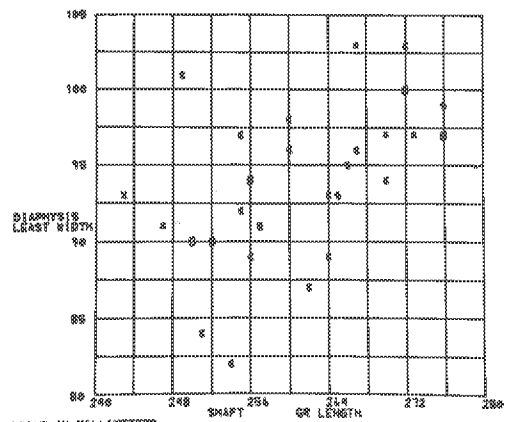


SCALE IN MILLIMETERS

X = COSTEAU PIT, 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, 8 = PIT 61, 8 = PIT 63, < = PIT 77, 8 = PIT 8.

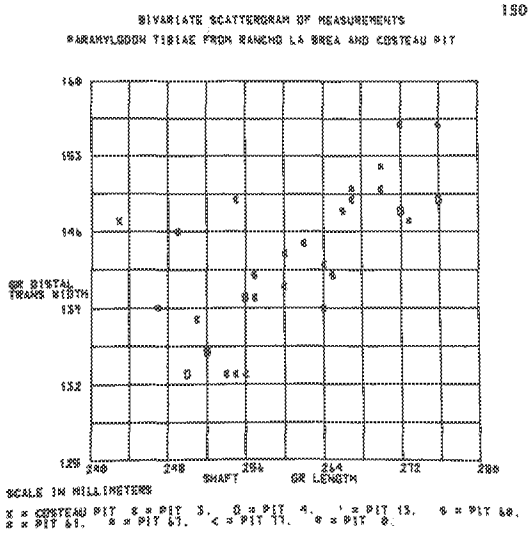
149

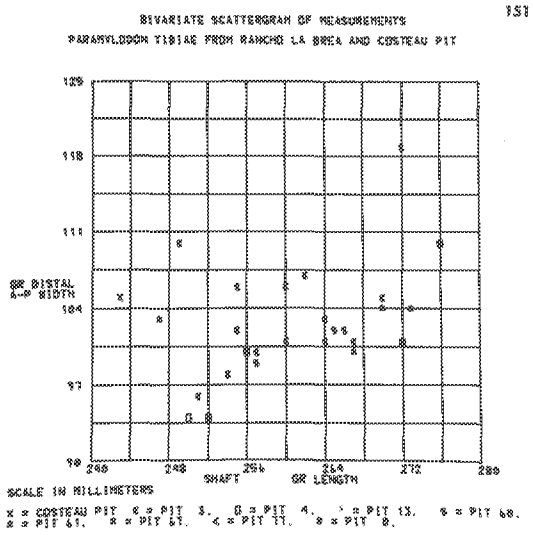
BIVARIATE SCATTERGRAM OF MEASUREMENTS
PARAMYLODON TIBIAE FROM RANCHO LA BREA AND COSTEAU PIT



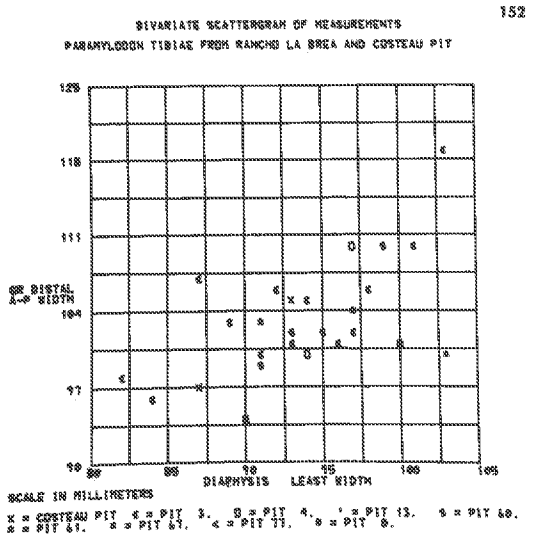
SCALE IN MILLIMETERS

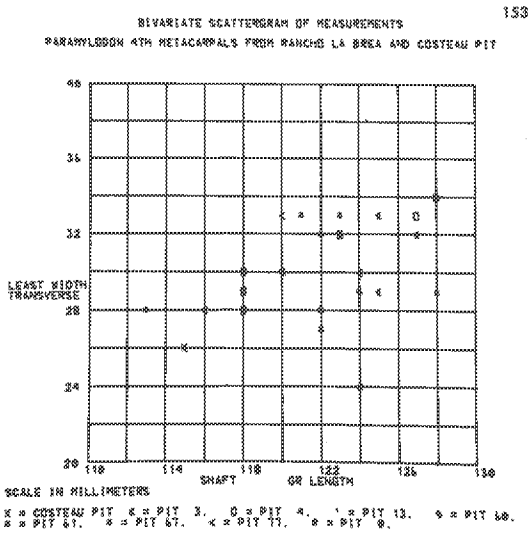
X = COSTEAU PIT, 6 = PIT 3, D = PIT 4, ' = PIT 13, % = PIT 60, 8 = PIT 61, 8 = PIT 63, < = PIT 77, 8 = PIT 8.

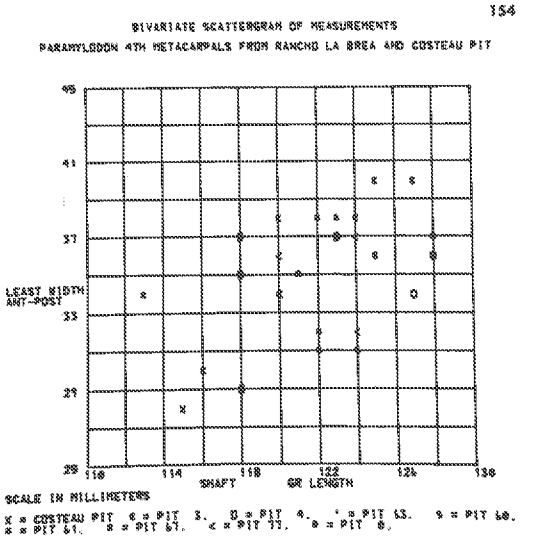


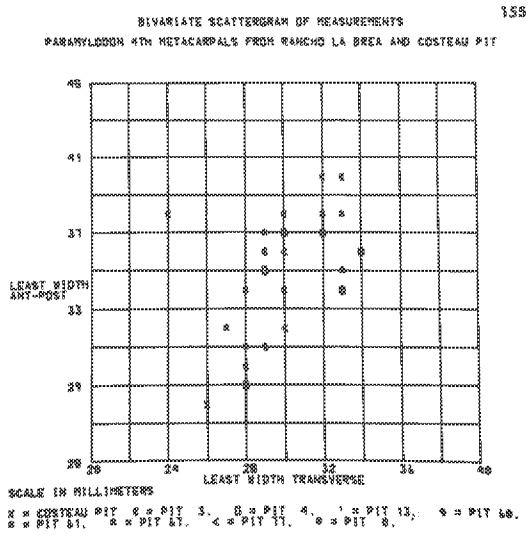


FIGURES 146-151. Comparison of tibiae of *Paramylodon harlani* from Rancho La Brea and Costeau Pit. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: med = medial; gr = greatest; trans = transverse; a-p = anteroposterior. Points of measurement are shown in figure 42.









FIGURES 152-155. Comparison of tibiae and 4th metacarpals of *Paramylodon harlani* from Rancho La Brea and Costeau Pit. Pit ⊙ shown in diagrams represents a combination of all Rancho La Brea pits not listed separately. All specimens represented are adults. Abbreviations used are: gr = greatest; a-p = anteroposterior; ant = anterior; post = posterior. Points of measurement are shown in figures 42-43.

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