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The Haverty Human Skeletons: Morphological, Depositional, and Geochronological Characteristics

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THE Haverty collection consists of a sample of modern *Homo sapiens* skeletal remains recovered from the western Los Angeles Basin of southern California in 1924. The sample consists of at least eight individuals: three males, three females, and two subadults of indeterminate sex. Several of these individuals are represented by nearly complete cranial and postcranial remains, an extremely rare occurrence in precontact native California remains. A group of conventional (decay-counting) ^{14}C determinations obtained on various organic fractions of the skeletons indicate an age of between about 4,000 and 10,000 ^{14}C years B.P. A suite of accelerator (or atomic) mass spectrometry (AMS)-based ^{14}C determinations obtained on a noncollagen organic bone component (osteocalcin) extracted from several of the Haverty skeletons yielded ages ranging between about 4,600 and 16,000 ^{14}C years B.P. The validity of the osteocalcin-based ^{14}C values suggesting the older ages for at least two of the Haverty skeletons currently are the subject of continuing investigation. If subsequent research confirms the essential accuracy of these results, at least two of the Haverty skeletons would represent the oldest human skeletal remains yet recovered in the New World.

In March 1924, during excavation of a major sewer outfall line in the western portion of the Los Angeles Basin, employees of the Thomas Haverty Construction Company encountered a human skull and cervical vertebrae at a depth of between 5.8 and 7 m. Over a period of several weeks, additional human skeletal fragments including human skulls and objects interpreted as artifacts were recovered from the excavations. A report of the discovery was read by Chester Stock, then chairman of the Department of Paleontology at the University of California, Berkeley, at the April, 1924, meeting of the National Academy of Sciences, and a short note was published by him in *Science* later that same year (Stock 1924). However, no further reports have yet been published on this skeletal series. No general discussion of the site context has been prepared beyond the brief description by Stock and later, often cryptic, comments based on it–e.g., Tieje (1926), Hay (1927), Taylor (1927, 1949), Heizer (1950, 1960), Wallace (1955), and Wormington (1957). Several publications have reported results of the application of radiocarbon and/or amino acid racemization (AAR) analysis on the Haverty bone samples. These measurements have been reported previously in the context of general studies bearing on the accuracy of ^{14}C and AAR determinations on bone (Taylor 1983; Taylor et al. 1984; Taylor et al. 1985; Ennis et al. 1986; Prior et al. 1986).

The purpose of this report is to provide the first comprehensive, multidisciplinary study of the Haverty skeletal series. This discussion includes a summary of the events associated with the original discovery, a reconstruction of the geologic and stratigraphic context of the locality, a description of the apparently associated archaeological materials, a full morphological description of the remains, and a summary of the current status of the dating evidence.

HISTORICAL CONTEXT

In his initial report, Stock (1924:2) referred to the skeletons only as "ancient human remains in Los Angeles, California," noting that the site was located "one-third of a mile [about 530 m.] west of . . . Angeles Mesa Drive [now Crenshaw Boulevard]." Other descriptions of the site locate it from 900 meters to a mile (1,610 m.) west of Angeles Mesa Drive and from 200 to 300 yards (about 180 to 275 m.) south of the "Pacific Electric Airline" – nearby tracks of the then-fully functioning Pacific Electric southern California interurban rail system. Figure 1 identifies what we believe, based on sources contemporary with the period of recovery, is the most probable location of the Haverty site. We should note that the Haverty (or Angeles Mesa) locality can be clearly distinguished from the site where Los Angeles (or Baldwin Hills) Man was recovered in 1936 (Clements 1938; Lopatin 1940). The listing of fossil hominids of the United States in the *Catalogue of Fossil Hominids* (Irwin 1975) contains an entry describing Los Angeles Man, but no description of the Haverty human skeletal materials was included.

Stock himself associated no specific site name with the Haverty skeletons. The newspapers called the skeletons first "Mesa Men" or the "Rancho Cunajo People," finally settling on the term "Haverty Group" in 1924, in honor of the construction company that had halted its work to allow scientists to investigate the area of the discovery. However, the 1940 catalogue of New World "Early Man" sites prepared by Sellards (1940:377) refers to the site as the "Angeles Mesa" locality. Heizer (1950, 1960) referred to the human remains as the "Angeles Mesa skeletons." In our view, the prior usage of "Haverty" as the designation for this skeletal series at the time of its recovery makes this the most appropriate terminology.

Despite Stock's specific statement that the skulls did not exhibit the "primitive features" of Neanderthals and that the remains "resemble closely those of American Indians," some contemporary newspaper accounts referred to the skeletons as representing a "race of giants." The assumption of size was based on a measurement of a femur, said to be about 18 1/2 in. (47 cm.) long, from which was derived a 7-ft. (2.1-m.) stature for one of the Haverty individuals. The popular press interpretations were based on alleged statements of those brought in to study the skeletons, together with the depth of the site, the possible association with extinct fauna, the mineralization of the bones, and the condition of the artifacts which were described as "petrified." At the time of the discovery, the newspaper articles speculated about the geological antiquity of the bones, basing their stories again on estimates reportedly made by the scientists present. These estimates ranged from 10,000 years to 23,000 years ago.

The discovery of the human bone material was brought to the attention of George Hess, vice president of the Haverty Construction Company, by George Sherman, foreman of

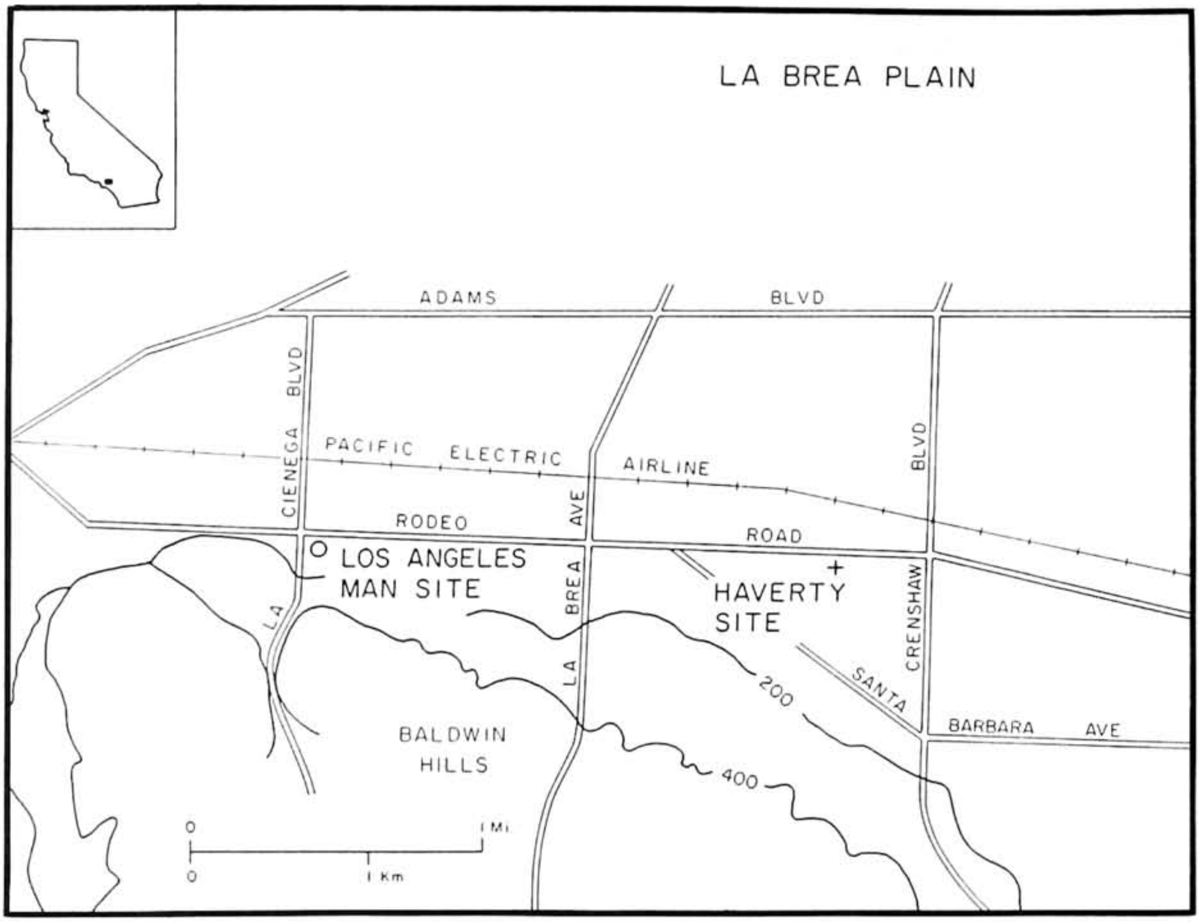


Fig. 1. Map of the inferred location of the Haverty locality in the Baldwin Hills region of western Los Angeles County, sited in terms of contemporary street names. The location of the "Los Angeles Man" locality is indicated also. Map based on studies by L. A. Payen.

the sewer excavation crew. Hess, who had an avocational interest in paleontology, contacted the Los Angeles Museum of History, Science and Art (LAMSA, now the Los Angeles County Museum of Natural History). With the permission of the museum director, William A. Bryon, two staff members of LAMSA, J. P. Herring, a mammalian taxidermist, and J. W. Lytle, an osteologist, visited the construction site. John C. Merriam, a nationally prominent paleontologist who was then a staff member of the Carnegie Institution of Washington, was contacted since he was in Los Angeles at the time. He suggested that Stock be invited to assist Bryon in supervising additional excavations in the area of the finds. Unfortunately, by the time of his first visit, the location indicated as the place of discovery had been covered with a 23-cm. layer of concrete.

The Haverty Construction Company offered to cooperate by removing a portion of the concrete flooring and loaning some of its equipment to help in the recovery of any further skeletal materials. The Los Angeles County Board of Supervisors voted $5,000 to support the work at the site. This would be the equivalent of approximately $30,000 in 1990 dollars. Such support represents one of the first instances on record of significant public funding of archaeological investigations for western North America. Several prominent geologists and paleontologists in the region were present during the continued excavations as well as during the sorting and screening. These included Robert T. Hill, formerly of the United States Geological Survey, George E. Bailey, professor of geology at the University of Southern California, and Frederick W. Hodge, an archaeologist affiliated with the Museum of the American Indian, Heye Foundation.

After Stock arrived, workmen dug around the remaining concrete flooring and large sewer pipe that had been placed over the location where the first skull was found (Stock's Locality 1). They encountered human bones and interpreted them to be the incomplete remains of the postcranial skeleton associated with the original skull and vertebrae. Another skull was discovered when the trench was enlarged. After continued digging, one more skull was found within this same area. Although not specifically mentioned in the newspaper accounts of the excavation, a fourth skull also was uncovered during these explorations. In a separate excavation, a nearly intact skull and skeleton were located in what is recorded as a semiupright sitting position embedded in a stratum of sand. According to newspaper accounts, the collection of Haverty skeletal materials continued over a period of several weeks by direct excavation as well as through screening and washing of dirt previously removed in the digging of the sewer trench.

The geology of Locality 1 was characterized as composed of a sandy surface soil, then alternate layers of different types of sand and clay. The bones were embedded in a greenish-blue mica sandy clay. Freshwater mollusks, all of which were identified as extant species by A. J. Tieje of LAMSA, were used to lend support to the view that the skeletons at Locality 1 were deposited within a swamp or marsh environment. As topographic maps of the 1920s show, the area adjacent to the Haverty site at the time of the excavation was a low-lying marshy environment with permanent standing water.

In addition to the human skeletal remains, two objects interpreted as artifacts were recovered from Locality 1, the "human locality" (Stock 1924:3). These were a shaped piece of quartzite, regarded as an artifact by Edgar Hewett, and the pointed end of a bone awl. A flaked stone artifact, interpreted as a scraper, was located further up the trench at a depth of about 4 m. Animal bones were found reportedly at some distance from the human material, but, with the exception of a brief reference to camel bones, none of the material is specifically identified in any of the accounts.

In summarizing his interpretation of the Haverty materials, Stock (1924:3) concluded that

> at least six human individuals were found between the levels of 19 and 23 ft. [5.8 to 7.0 m.] below the surface and within an area of not more than 12 square feet [12 feet square?]. Five individuals represented in this group were adults. A sixth individual, somewhat younger, may be a female.

Stock also reported on investigations that he carried out at five other geological and paleontological deposits (Localities 2 through 6) within the Ballona Creek drainage close to the "human locality." Under his supervision, trenching was undertaken in an effort to connect some of these localities and determine the interrelationships of the geological strata. Based on these data, Stock concluded that there was an apparent continuous stratigraphic sequence down to the level where the human remains were encountered. The sequence was considered to have been undisturbed, although the west wall of the trench in which the skeletal material had been recovered initially seems to have collapsed on two occasions subsequent to the recovery of the bone samples. Figure 2 shows the site at the time of the excavation of the additional skeletal remains, indicating the depth from the surface and the stratigraphy.

Stock (1924:3) noted that the

> osseous material was not scattered and the skeletal elements for some of the individuals at least were observed to be in a normal position. . . . The osseous material was not washed in, and its occurrence suggests rather a miring under bogy [*sic*] or marsh conditions, presumably prior to the accumulation of the greater portion of the deposits that now overlie the human remains. . . . No remains of Pleistocene or recent mammals were secured from the deposits in which the human materials occurred.

From a survey of the newspaper accounts and Stock's own statement, five sets of skeletal remains were found at a depth of between 5.8 and 7 m. Stock (1924:5) concluded his study by stating that

> [w]hile the present report has not shown that the deposits containing the human remains are old in the sense that they belong to a geological period antedating the Recent period, the age of these beds and of the human remains might well be measured in terms of thousands of years, but not necessarily tens of thousands.

DEPOSITIONAL ENVIRONMENT

During his investigations, Stock collected 20 soil samples from varying depths from his Locality 1. These samples ranged from the surface to what then would have been the bottom of the trenched area. To determine if the original interpretations of the origin of the sediments and nature of the depositional environment of the human and associated faunal remains are valid, these samples were examined for distribution of clastic grain sizes and for the presence of fragments of aquatic mollusks.

Previous authors (Merriam 1924; Clements 1938; Lopatin 1940), in their discussions of the sediments from the Haverty and adjacent sites, have variously referred to the entombing and overlying sediments as river sands, sandy clay, and gravel. The samples examined contain no clasts in the gravel size range. However aggregate sandy clay "lumps" form persistent cohesive agglutinations in the >1 phi (500 microns and larger) population. Mineral content of the sediments indicates an igneous origin, such as the nearby San Gabriel Mountains. Quartz, muscovite mica (somewhat altered by weathering), feldspar, hornblende and occasional accessory minerals (biotite, lithic clasts, augite) are found as angular and subangular grains in the sand-size clastic populations, indicating both short transport and residency of the clasts in their journey to the site of deposition. An abundance of gypsum ($CaSO_4 \cdot 2H_2O$) in spherical nodules of fine crystals is found in several of the samples from a depth of about 15 cm. below the surface to about 2.7 m. They form *in situ* from ground waters charged with dissolved calcium sulfate at shallow depth, and probably represent several episodes of epigenetic diagenesis.

Aquatic mollusks from the Haverty site were identified by Tieje as including the pulmonate gastropods *Helisoma trivolis* Say, *H. ammon* Gould, *Lymnaea cubensis* Pfieffer, *L. (Galba) truncculata* Muller, *Physa* sp. cf. *P. hypnorum* Linnaeus, an indeterminate *Physa* sp., and the sphaerid bivalve *Pisidium*, species undetermined. The molluscan assemblage occurred between 4.3 and 4.6 m. below the surface in two units. Shell fragments were recovered from two of the soil samples in our possession collected by Stock, but no fragments were complete enough to allow species identification. Thus, there is no independent means to confirm or revise the molluscan fauna originally identified by Tieje.

Although air breathers, the gastropods of the Haverty site assemblage are typically

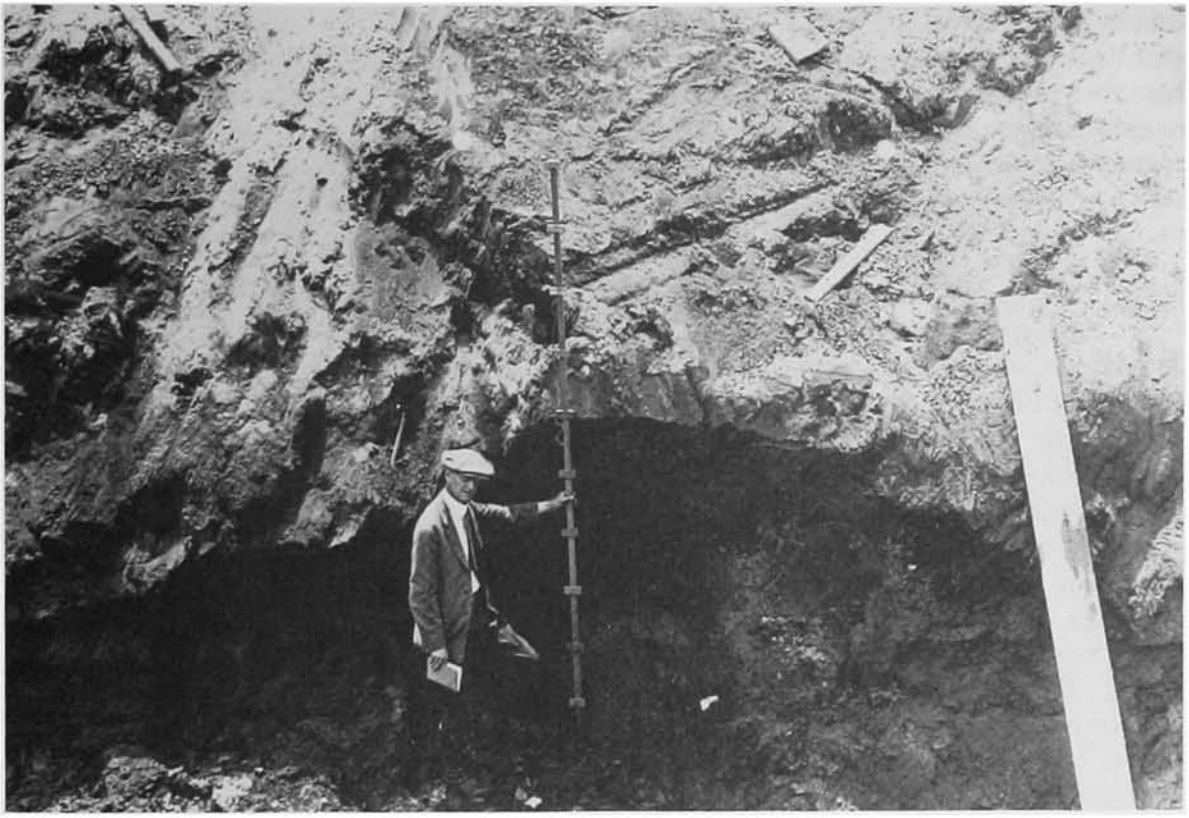


Fig. 2. Photograph of the Haverty locality taken in 1924 during excavation. An unidentified individual is holding a measuring rod that appears to be divided into one-foot increments.

found together only in water bodies with durations measured in years, rather than in ephemeral ponds which lack as varied a fauna and have durations of weeks or months. The sphaerid clam *Pisidium* is capable of withstanding short periods of desiccation, but generally must be in a fully aquatic environment. There is the possibility that the shells represent a transported assemblage from the Los Angeles River or one of its tributaries, but the coincident occurrence of *Helisoma*, *Physa*, and *Lymnaea* is more typical of quiet ponded waters such as marshes than of running water. It would appear that the presence of the molluscan fauna in two adjacent samples, and neither above nor below them stratigraphically, represents a time of permanent water stand during a deposition of less than 1 m. of sediment. This envisioned marsh environment would have received sediments from nearby stream drainages as overbank deposits and secondarily directly from intermittent or minor stream flow.

Based on the most recent assessment, the original investigators appear to have been accurate in their reconstruction of the depositional setting of the Haverty site. The majority of the sediments originated during flood stages from overbank deposits, spreading away from the main stream channels as the natural levees were breached. No evidence suggests that the bones were redeposited from the main channel, however. For a period sufficient to deposit approximately 60 cm. of sediment, the immediate area of the site was occupied probably by a shallow body of water in which a varied molluscan fauna flourished. None of the samples indicates any evidence of disturbance since deposition. This supports the contention that the human remains and associated mammalian fauna are contemporary with the sediments in which they occur.

ARCHAEOLOGY

In 1961, the Haverty skeletons, records, newspaper accounts, and related photographs were transferred from LAMSA to the Department of Anthropology, University of Southern California. At the time of the transfer, two artifacts and the series of soil samples noted in the previous section were present, but not the possible quartzite artifact described by Hewett. The two artifacts transferred were the bone awl and a scraper for which there is no written reference in Stock's account. On the back of the scraper is the following catalogue information: "Section No. 9, 500+36, Depth 12', bottom of boulder bed." It is assumed that the scraper was recovered during one of the excavations undertaken by Stock, but at some distance from the location of the human skeletons. After the recovery of the bone awl and the possible quartzite artifact, Bryan had taken both of them to the San Diego Museum of Man for Hewett to examine.

Fig. 3. Artifacts found at or near the Haverty locality. Upper, bone awl fragment 53 mm. long; lower, scraper 51 mm. in maximum dimension. Original location presumed to have been in the vicinity of the extended portion of the trench excavated following discovery of the human skeletal materials.

The fragment of the bone awl measures 53 mm. in length, 5 mm. in diameter at the broken end, and 2 mm. in diameter at the tip (Fig. 3). It appears partially mineralized and has a dark mottled external appearance. While the tip is still sharp, there is definite flattening on the sides from use. The overall appearance is that it was highly polished prior to being interred.

The flake scraper (Fig. 3) is composed of a dark chert-like material. This was struck from a larger cobble, and part of the original cortex covers the dorsal surface. The ventral surface is relatively smooth and slightly concave, with a well-defined bulb of percussion. The cortex was partially removed by flaking, and two of the sides have been retouched to create use edges. The greatest length is 51 mm., the maximum width 45 mm., and the thickness 15 mm. The use edges are respectively 21 mm. and 47 mm. in length. According to a newspaper account (Los Angeles *Times*, April 12, 1924), the suggested quartzite implement was a fragment roughly quadrangular in shape, about 11 cm. long, 10 cm. wide and 2.5 cm. thick, with a reported weight of nearly 1 kg. This artifact was found with the third skeleton. Although described as having been found in the sedimentary layers of the "human locality" (Stock 1924:3), neither the awl nor the quartzite scraper appears to have been directly associated with the skeletal remains. The position of the scraper in the site is even less certain, as the only information available is that it was found at a depth of about 3.7 m.

PHYSICAL ANTHROPOLOGY

Stock originally (1924:3) stated that the Haverty human remains represented at least six individuals. The first formal, but unpublished, anthropometric study of the Haverty series was undertaken in 1957 (Redwine 1957). This study identified eight, or possibly nine, incomplete individuals along with some miscellaneous cranial fragments, carpals, tarsals, and phalanges that could be assigned to any of the individuals recognized. A reexamination of the Haverty sample for this report has confirmed that at least eight individuals are present. Some cranial and postcranial fragments remain unconvincingly associated with a few of the numbered individuals, so that the total number of individuals may therefore be higher.

Crania and Dentition

The sex and suggested morphological age of the currently recognized eight Haverty skeletons are listed in Table 1. Individuals 3, 4, and 5 have the pubic symphyses preserved, and age determinations were made for these specimens according to the criteria of McKern and Stewart (1957). Individuals 1 and 8 are both subadult with the M2s erupted and the M3s still in crypt. Cranial and postcranial remains are present for Individual 1, but Individual 8 is definitely known from only a hemimaxilla; some small cranial fragments may, however, be part of this individual. Individuals 2 and 6 are adult females and consist of incomplete cranial, dental, and postcranial remains. Individual 7, also female, consists of a nearly complete cranium and the cervical vertebrae, but no other postcranial remains are clearly associated with this specimen. Individuals 3, 4, and 5 are adult males with associated cranial, dental, and postcranial remains. Individual 5 includes a cranium lacking only certain basilar portions of the temporal and occipital bones.

The crania of the adults, both male and female, are similar morphologically and are large. Table 2 lists the cranial data for Individuals 3, 5 and 7. The crania of Individuals 5 (Fig. 4) and 7 (Fig. 5) were sufficiently complete that cranial capacity could be determined. These values are 1,380 cc. and 1,310 cc., respectively. The cranial indices for males range from mesocrany to the lower range of brachycrany; for the female (Individual 7), it is in the higher range of mesocrany. Indices of cranial height relative to length and breadth could be obtained only for Individual 7 (the only specimen preserving the basion). This indicates a medium length relative to the height and a low-medium breadth relative to the cranial height. The fronto-parietal index ranged from metriometopic to eurymetopic for the two males and was stenometopic for Individual 7, indicating a medium to broad parietal breadth relative to the minimum frontal breadth.

The indices derived from facial, nasal, and orbital measurements listed in Table 2 are from Individuals 5 and 7. The facial indices were at the upper limit of mesoprosopy (Individual 5) and leptoprosopic (Individual 7), i.e., medium- and long-faced relative to bizygomatic breadth, respectively. The meseny demonstrated by the upper facial index for Individual 7 indicates that this facial length was based on mandibular symphyseal height. The orthognathous gnathic index of Individual 7 is in the high range of this index and reflects a medium alveolar prognathism. Although measurements were not possible, the adolescent male (Individual 1) exhibits a slight alveolar prognathism, and the remaining adults showed higher levels of prognathism.

Table 1
PHYSICAL, BIOGEOCHEMICAL, ^{14}C AND AMINO ACID RACEMIZATION (D/L_{ASP}) DATA ASSOCIATED WITH THE HAVERTY SKELETONS[a]

Haverty Individual	Sex	Age (years)	N[b] (%)	Gly/Glu[c]	^{14}C Age (years B.P.)	D/L_{asp} (total)	Apparent AAR Age[d] $k_{asp} = 1.08 \times 10^{-5}$
1	(?)	13-14	1.1	4.06	5,350 ± 150 (UCR-1349A)[e] 5,280 ± 180 (UCR-1349D)[e] 5,260 ± 520 (UCR-3082/CAMS-442)[f] 5,540 ± 230 (UCR-3083/CAMS-439)[g]	0.12 ± .00	4,700 ± 600
2	Female	40+	0.0022	2.06	2,730 ± 190 (UCR-3084/CAMS-445)[f] 4,630 ± 260 (UCR-3087/CAMS-438)[g]	0.48 ± .012	41,000 ± 1,500
3	Male	22-28	0.0022	2.00	10,500 ± 2000 (UCLA-1924)[h]	0.49 ± .004	43,000 ± 500
4	Male	23-39	0.024	2.23	4,050 ± 100 (UCR-1568A)[e] 5,200 ± 400 (GX-1140)[e] 7,900 ± 1440 (UCLA-1924A)[i] 3,870 ± 350 (UCR-3086/CAMS-440)[f] 12,600 ± 460 (UCR-3088/CAMS-433)[g] 13,500 ± 220 (UCR-3090/CAMS-434)[g,j] 5,250 ± 90 (HA-104A)[k] 15,900 ± 250 (HA-104B)[k]	0.32 ± .014	24,000 ± 1,500
5	Male	33-39	0.38	3.91	4,710 ± 190 (UCR-3089/CAMS-441)[f] 11,960 ± 500 (UCR-3085/CAMS-437)[g]	0.30 ± .006	22,000 ± 600
6	Female	30+	0.38	2.61	-	0.34 ± .005	26,000 ± 500
7	Female	40+	-	-	-	-	-
8	(?)	13-14	-	-	-	-	-

a From Ennis et al. (1986); Prior et al. (1986); Ajie et al. (1990).
b Amino acid nitrogen content.
c Gly = Glycine; Glu = Glutamic Acid.
d See Bada and Helfman (1975) for the basis on which original AAR-age estimates were derived. See also Bada (1985) and Ennis et al. (1986) for more recent discussions. Errors cited on AAR-derived ages reflect analytic precision only.
e Various organic fractions obtained by differential solubility in acid/base/water.
f Gelatin fraction obtained by methods of DeNiro and Epstein (1981) and Schoeninger and DeNiro (1984).
g Osteocalcin fraction obtained by methods summarized in Ajie et al. (1990). Chemical separations and combustion by H. Ajie, UCLA; graphitization at UCR Radiocarbon Laboratory; AMS analysis at Lawrence Livermore National Laboratory, Livermore, California (J. Vogel, personal communication).
h Berger and Protsch (1989:59).
i R. Berger, personal communication.
j Duplicate analysis from split of CO_2 from UCR-3088/CAMS-433.
k HA-104A gelatin fraction, HA-104B osteocalcin fraction. Chemical separations and combustion by H. Ajie, UCLA, graphitization and AMS measurements at DSIR, New Zealand.

The orbital indices for Individuals 5 and 7 are hypsichonchic, and the nasal indices range from mesorrhiny to platyrrhiny. High nasal indices, indicating a broad nasal aperture, are not uncommon among prehistoric skeletal material from California (Thompson 1950).

The palates of one male and one female are well enough preserved that indices for the external palatal measurements could be obtained; both are brachyuranic, indicating broad palates. All of the preserved palates, including those of the juveniles which were too incomplete for measurement, are broad and high. The mandibles are in better condition than the craniofacial remains, and those measurements are also listed in Table 2.

In the adult males, brow ridge size is medium to large; it is small in the female, as is the glabellar area. Although inia are small in all crania with a preserved occipital area, the nuchal lines are medium in size. The occipital regions are markedly curved, forming occipital buns, which are medium to pronounced in size. Supramastoid crests are large to very large in both male and female crania. The mandibles are large and well-

Table 2
MEASUREMENTS ON HAVERTY SKULLS[a]

Element		Haverty Individual 3	5	7
Calvarium Length:	G-OP	184.0	188.5	185.0
	G-O	--	146.0	136.0
	B-OP	--	149.0	153.0
	G-B	109.0	105.5	103.0
	B-L	121.0	108.5	116.0
	L-I	68.0	65.0	83.0
	I-O	--	51.0	41.0
	L-O	--	140.0	109.0
	BA-PR	--	--	95.0
	BA-N	--	--	98.0
Calvarium Width:	Bi-EU	147.0	147.0	144.5
	Bi-Ast	112.0	127.0	118.5
	Bi-FT	109.0	99.5	92.0
	Bi-ZY	--	144.5	131.0[b]
	Bi-Ast	144.0	133.0	142.0
Calvarium Height:	GN-N	--	130.0	121.5
	IDS-N	--	74.0	69.5
	BA-B	--	--	134.5
	Po-B	126.0	115.0	125.0
	Po-BA	--	--	17.0
Cranial Index		79.8	77.9	78.1
Cranial Module		--	--	154.6
Length-Height Index		--	--	72.7
Length-Breadth Index		--	--	93.0
Fronto-Parietal Index		74.1	67.6	63.6
Cranio-Facial Index		98.2	--	90.6
Face:	Facial Index	--	89.9	92.5
	Upper Facial Index	--	51.2	53.4
	Cranio-Facial Index	--	--	--
	N-Ns	--	49.5	47.0
	Bi-AL	--	24.5[b]	25.0
	Nasal Index	--	49.4	53.1
	Orbital Height (L)	--	37.5	35.0
	Bi-MF	--	--	27.0
	MF-EC	--	39.0	37.5
	Orbital Index	--	96.1	93.3
	Interorbital Index	--	--	27.1
	OL-STA	--	44.5	48.0
	PR-ALV	--	47.0	49.5
	Bi-ECT	66.0	66.0	61.5
	Bi-END	38.5	39.5	36.0
Maxillo-Alveolar Index		--	140.0	124.2
Cranial Thickness:	AST (L)	8.0	9.5	9.0
	L	9.0	6.0	--
	B	9.0	8.5	--
Cranial Capacity (cc.)		1,310.0	1,380.83	--
Mandible:	Bi-Go	113.0	111.0	88.0
	Bi-CDL	138.0	136.0	126.0
	GN-IDI	38.5	36.0	37.0
	GN-Go	100.0	93.5	91.0
	Asc. Ramus Height (L)	69.0	70.0	58.5 (R)
	Asc. Ramus Mininum Br. (L)	39.0	37.0	33.0
	Mandibular Index	81.8	81.6	69.8
	Zygomatic-Gonial Index	--	76.5	--
	Fronto-Gonial Index	96.4	89.6	104.5
	Gnathic Index	--	--	97.9

[a] All linear measurements are expressed in millimeters. Surface measurements are chords.
[b] Estimated.

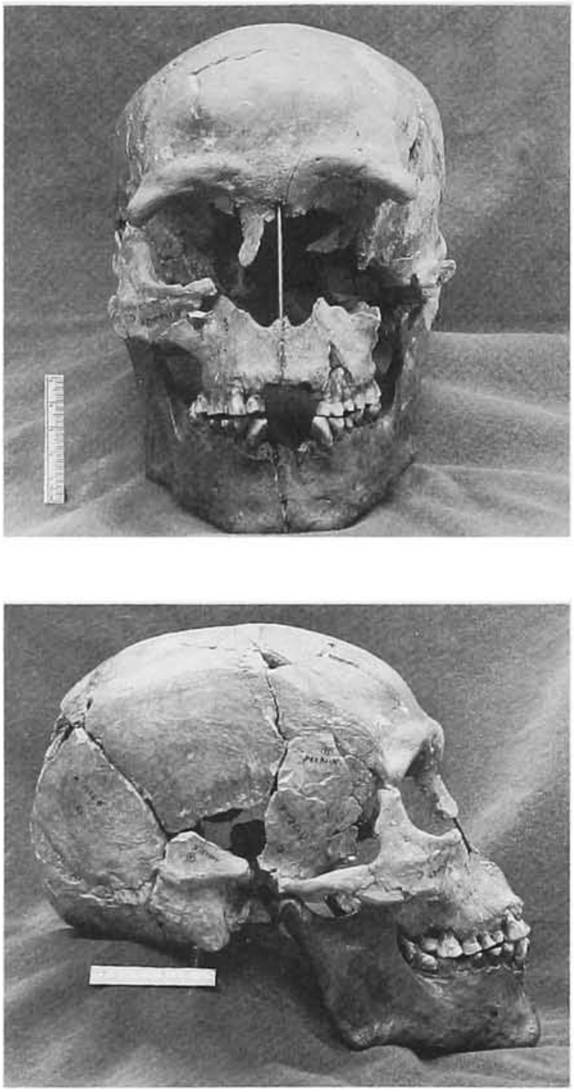


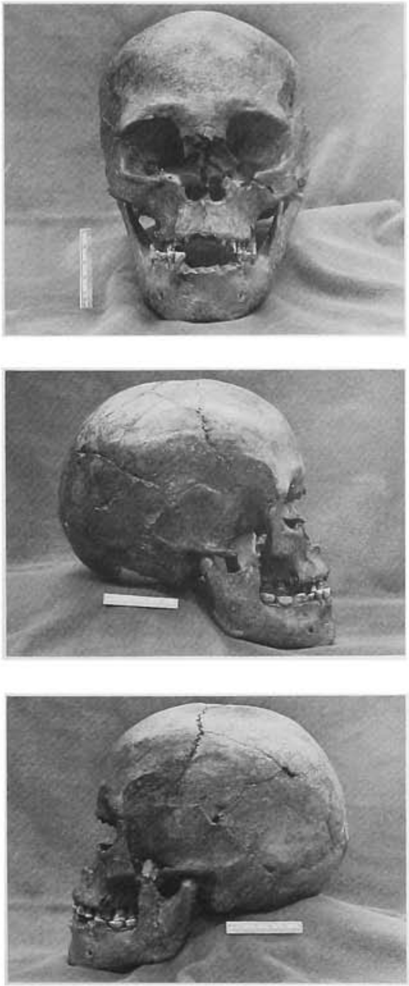
Fig. 4. Cranium of Individual 5. Upper, frontal view; lower, right lateral view. Photographs by Andrew J. Nelson.

muscled, with square chins in the adult and juvenile male and rounded chins in the females. All the mandibles have deep symphyses and show medium alveolar prognathism. Individuals 3 and 7 exhibit large mandibular tori, while Individuals 2 and 5 show small mandibular tori.

In general, the brow ridge and glabellar development is marked, and above this the frontal region arches back to the coronal suture, giving the effect of a bulging forehead. Although the temporal lines are sharply delineated, the muscular attachments of the occipital are small, with no inion projections even in the males, and the occipital regions are bun-shaped. None of these individuals have more than a medium development of muscle or ligamentous attachments craniofacially, although the cranial sizes are relatively large.

Dental pathology, in the strict sense, is minimal in the Haverty sample. The antemortem loss of only one tooth, the RI^1 of Individual 7, can be demonstrated unequivocally in this series. In this case, the alveolus is only partially filled with spongy bone, indicating that the loss of the tooth did not long precede death. In other cases (mandibles in Individuals 5 and 7 and the maxilla in Individual 5) the anterior arch of the jaws was broken postmortem, and portions of the alveolus have been lost. A few small occlusal caries may be present, although the possibility that these represent postmortem artifacts or exposure of the pulp cavities due to severe attrition (see below) cannot be ruled out. Calculus deposits and periodontal disease are also minimal.

Several teeth in the Haverty series show anomalous positioning. Individual 5 shows a distal displacement of the LI^1. The alveolus in the normal position of this tooth is closed and the LI^1 (lost postmortem) has been displaced to approximately the usual position of the LI^2. Concomitantly, the LI^2 has been moved distally and lingually so that it now rests behind (lingual to) the LC^-. Impaction of the third molar is present in Individuals 2, 3, and 5. Individuals 2 and 3 show impaction of only the RM_3, while this condition is bilateral in Individual 5. This latter individual also shows impaction of the RM^3. The form and degree of the impaction is identical in all cases. In these individuals the mesial, interproximal surface of the third molar has



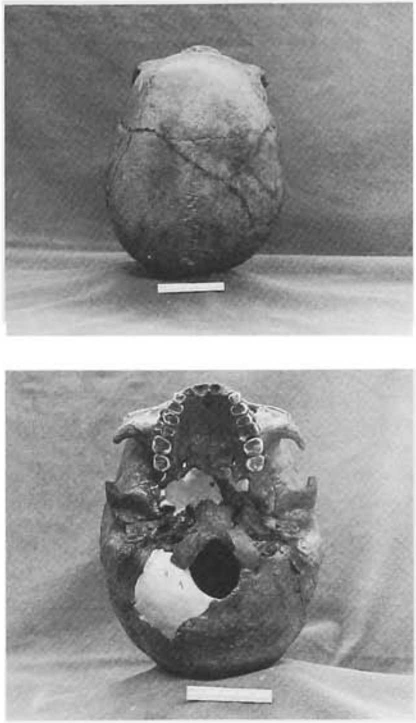


Fig. 5. Cranium of Individual 7. Upper left, frontal view; center left, right lateral view; lower left, left lateral view; upper right, vertical view; lower right, basal view. Photographs by Andrew J. Nelson.

impacted against the distal, interproximal surface of the second molar, tilting the occlusal surface of the third molar forward. Occlusal wear facets on the third molar therefore are limited to the distal portion of the tooth.

Two individuals in the Haverty series show rotation of their premolars. In Individual 2, the buccal ends of the long axes of the L, and R P_3 have rotated mesially so that these axes form an angle of about 45 degrees with the long axes of the P_4s. In Individual 5, the buccal end of the long axis of the RP^3 has rotated distally so that the angle formed with the long axis of the P_4 is approximately 30 degrees. The LP^3 of this individual also is rotated distally but to a lesser extent.

Moderate to severe attrition and related conditions can be identified in the Haverty sample. This related suite of characters, following Reinhardt (1983), can be termed the "severe attrition syndrome." It has been identified in other California populations, both earlier and later than Haverty, and in a number of Old World populations (Reinhardt 1983). The severe attrition syndrome is a complex pattern initiated by heavy masticatory stress and culminating in dental loss and alveolar bone pathology. According to Reinhardt, heavy chewing stress leads first to severe occlusal attrition with loss of enamel and dentin and, finally, exposure of the pulp cavity. Exposure of the pulp cavity results in abscessing at the root apices. The masticatory stresses, both occlusal and lateral (after flattening of the occlusal surface), will lead to weakening of the buccal alveolar plate and this, in combination with the abscessing, loosens the bony foundation of the tooth. Continued heavy mastication will result in a tooth with its occlusal surface shifted lingually and roots tilted and exposed buccally. In the late stages of the severe attrition syndrome (before tooth loss), attrition will extend along the buccal surfaces of the crowns, particularly on M^1, and onto the roots themselves.

Individual 7 demonstrates the advanced stages of the severe attrition syndrome. The M^1s bilaterally show complete loss of the occlusal enamel and dentin with exposure of the pulp cavity. Large apical abscesses are present bilaterally, and the apices of the buccal roots are exposed. On the right, the abscess is so large that the lingual root of the M^1 can be seen from the buccal surface of the maxilla. The other teeth of Individual 7 show loss of occlusal enamel but without exposure of the pulp cavity. On the right maxilla, the roots have tilted and are exposed buccally, and the occlusal surface of the tooth has tilted lingually. Individual 2 shows less advanced stages of the attrition syndrome. Table 3 lists the measurements on the available teeth in the Haverty series. Measurements were made only on the PM-M series since postmortem tooth loss and/or severe attrition made measurements on the anterior teeth uninformative or unreliable.

No major pathologies or trauma are apparent in any of the bones. Slight to moderate osteophyte formation is present in the lumbar vertebrae of all adults. A basioccipital fragment and cervical spine, mostly probably associated with Individual 2, shows additional pathology. On the basioccipital fragment, the basilar process at basion is deeply indented, and the narrow crest which normally extends along the anterior border of the foramen magnum between the condyles is deeply eroded. The anterior arch of Cl is similarly deeply indented. Moreover, the apex of the odontoid process of C2 shows flattening and facetting along its superior margin. These eroded areas apparently reflect an osteolytic process secondary to loss of or damage to the synovial tissues in the occipital-atlantal region. Moderate osteolysis also has occurred on the inferior and superior articular facets of the

Table 3
DENTAL MEASUREMENTS

Haverty Individual			Maxilla					Mandible				
			P^3	P^4	M^1	M^2	M^3	P_3	P_4	M_1	M_2	M_3
1	R	BL[a]	-	-	10.6	10.4	9.0	-	-	-	10.3	9.3
		MD[b]	-	-	10.4	11.7	10.9	-	-	-	11.7	10.9
	L	BL	-	-	-	-	10.2	-	-	-	10.3	9.3
		MD	-	-	-	11.8	10.6	-	-	-	11.8	10.6
2	R	BL	-	-	-	-	-	-	-	-	-	9.2
		MD	-	-	-	-	-	-	-	-	-	11.1
	L	BL	-	-	-	-	-	-	-	-	-	-
		MD	-	-	-	-	-	-	-	-	-	-
3	R	BL	9.5	9.2	10.9	12.3	-	8.2	8.3	10.9	11.0	11.4
		MD	7.0	6.5	9.8	10.8	-	6.7	7.1	11.4	11.6	11.7
	L	BL	9.8	-	11.0	11.7	12.6	8.3	8.3	10.9	11.0	11.5
		MD	7.6	-	9.7	10.6	10.7	6.9	7.3	11.5	11.2	12.1
5	R	BL	-	-	-	-	-	8.4	8.5	11.0	11.0	11.2
		MD	-	-	-	-	-	7.9	7.3	11.1	11.4	11.2
	L	BL	-	-	-	-	-	8.5	-	11.4	10.9	-
		MD	-	-	-	-	-	8.0	7.3	11.1	11.3	-
7	R	BL	9.1	9.3	-	11.0	10.3	7.9	8.0	10.6	10.5	10.9
		MD	-	6.6	-	10.0	9.5	7.0	7.0	10.8	11.2	10.4
	L	BL	9.3	9.0	-	11.1	10.6	-	8.0	10.5	10.6	10.3
		MD	-	-	-	10.0	9.4	-	-	10.8	11.4	11.3
8	R	BL	-	-	10.7	-	-	-	-	-	-	-
		MD	-	-	10.8	-	-	-	-	-	-	-
	L	BL	-	-	-	-	-	-	-	-	-	-
		MD	-	-	-	-	-	-	-	-	-	-

[a] Bucco-lingul diameter (mm.).
[b] Mesio-distal diameter (mm.).

remaining cervical vertebrae confirming the probable synovial nature of this condition. These observations are consistent with moderate osteoarthritis of the cervical spine. Osteophyte formation also has occurred in this individual along the margins of the cervical and thoracic vertebral bodies.

Several nonmetric variables were observed in the Haverty series. The crania of Individuals 2 and 7 show a number of lambdoidal sutural ossicles. Double mental foramina are present on the right side in Individual 5. Individual 7, which is fully adult, shows Huschke's foramina bilaterally. In the right humerus of Individual 2 an olecranon foramen is present; the left humerus of this individual lacks its distal portion.

Postcranial Skeleton

Early reports of the Haverty collection had referred to the individuals as "giants" and while this is clearly an overstatement, the Haverty individuals are large in comparison with at least one other southern California prehistoric native American skeletal series. Because of the range in ^{14}C values obtained on this material (Table 1), comparisons with clearly contemporaneous populations could not be made at this time. However, for the purposes of a brief comparative analysis, osteometric data were collected on a small sample (n = 26) from Malibu, California (CA-LAn-264) now housed in the Museum of Culture History, University of California, Los Angeles. The collection from CA-LAn-264 is associated with a ^{14}C determination of 1,245±60 ^{14}C years (UCLA-1886), based on organic extract from human bone. Sex determination was made on the basis of associated os coxae. All Malibu individuals were adult and without obvious pathology. Standard osteometric data (Martin 1928) were taken on humeri, femora, and tibiae. *T*-tests, using separate variances, were run on all variables. The adjustment for separate variances was used since in this comparative analysis the population variances were not assumed to be equal.

The most striking differences between the Haverty and Malibu samples (Table 4) are in bone lengths and articular sizes; shaft dimensions, while generally larger in the Haverty sample, are significantly larger in only a few diameters. Of these, the humeral circumference and tibial midshaft anterior-posterior (AP) dimensions are the most significant ($P < 0.005$). Within a skeletal series, long-bone lengths generally show a wide range of variation, and while this remains true in this case, all the Haverty males show humeral, femoral, and tibial lengths well above the means of the Malibu male sample. All male Haverty humeral lengths are, in fact, above the range of the Malibu males; in femoral and tibial lengths only Haverty Individual 5 falls within the Malibu male range. In terms of absolute long-bone lengths, Haverty Individual 3 is extraordinary. Humeral length of this individual is 3.42 s.d. above the Malibu male mean, while femoral length is 2.76 s.d. and tibial lengths are 2.21 s.d. above that value. Overall, it is very unlikely ($P < 0.01$) that Haverty long-bone lengths would be found in the Malibu males. In the long bones of the Haverty females, only the humeri are complete enough for length measurements. Both female Haverty humeri are within the Malibu female range; Number 6, in fact, falls below that mean (-0.6 s.d.).

The Haverty series differ even more strikingly from the Malibu comparative series in their articular sizes. For example, the mean vertical head diameters of the Haverty male humeri are above the Malibu male mean ($t = -7.69$, $P < 0.005$). Slightly smaller differences are seen in this value in the females, although the Haverty female mean is still significantly above the Malibu female mean ($t = -7.00$, $P < 0.005$). Femoral head size, while not as dramatically different in the two series, again is larger in the Haverty series ($P < 0.02$). The Haverty femora are also large; the mean bicondylar breadth is also larger at a similar level of significance.

Stature was estimated on the basis of humeral, femoral, and tibial lengths using formulae for male "Mongoloids" (Trotter and Gleser 1958). For the humerus and femur the estimated mean stature for the Haverty male series is above the means estimated for the male Malibu series. Stature-based on tibial lengths are somewhat closer in the two samples, giving an estimated height for the Haverty males some 6.7 cm. taller than that inferred from humeral and femoral data.

Various robusticity indices were constructed that demonstrate a number of bivariate and trivariate relationships between shaft parameters. All of the Haverty robusticity indices are close to the Malibu means, indicating that bone proportions did not differ between the two groups. Therefore, the large articular sizes and greater shaft lengths in the Haverty sample should not be unduly emphasized since they represent an allometric reflection of larger body size.

However, large body size is not unusual in western North America in general. While an early Sacramento Valley skeletal series analyzed by Newman (1957) are not quite as large in absolute measurements as the Haverty series, it does demonstrate the presence of robust traits in prehistoric populations in California. Studies of several prehistoric skeletal series from Nevada show large body size; this is seen especially in the "Lovelock People" from northwestern Nevada

Table 4
COMPARATIVE POST-CRANIAL MEASUREMENTS[a]

	Haverty						Malibu				
							Females (N = 9)			Males (N = 14)	
Measurement	Range	No. 2	No. 3	No. 4	No. 5	No. 6	Mean	S.D.	Range	Mean	S.D.
Humerus											
Length	282.0-324.0	294.0	348.0	330.0	336.0	282.0	290.2	13.6	274.6-313.0	301.8	13.5
Mid shaft, ML	17.7-25.8	17.7	21.8	21.5	22.6	19.7	17.1	1.2	14.9-18.5	21.1	2.0
Mid shaft, AP	17.1-24.5	19.8	23.2	22.2	21.2	18.4	18.7	1.1	17.2-20.9	21.0	2.0
Mid shaft, CIRC	55.0-79.0	58.0	70.0	69.0	69.0	57.0	55.6	2.6	53.0-61.0	64.7	6.2
Least CIRC	57.0-71.0	55.0	67.0	65.0	64.0	54.0	51.7	2.9	49.0-57.0	60.0	4.8
Vertical head	39.6-43.8	40.5	49.9	45.7	48.7	41.6	37.3	0.7	36.6-39.1	41.6	1.3
Robusticity index	17.3-22.2	18.7	19.3	19.7	19.0	19.1	17.9	0.9	16.2-19.1	19.9	1.6
Stature (Mongoloid male)		161.9	176.4	171.6	173.2	158.7	160.91	4.16		163.8	4.16
Femur											
Oblique length	370.0-450.0	-	469.0	455.0	445.0	-	400.1	19.8	381.0-442.0	419.2	18.0
Mid shaft, ML	21.9-28.7	-	29.2	27.5	26.0	-	22.9	1.4	21.0-24.0	24.5	1.7
Mid shaft, AP	26.5-33.4	-	33.6	36.0	29.3	-	26.1	2.5	22.7-31.5	29.5	1.6
Vertical head	41.0-46.4	-	50.0	50.7	45.7	-	39.0	1.6	36.6-41.5	43.8	1.6
Bicondylar breadth	73.0-84.5	-	88.5	78.0	83.8	-	69.0	1.9	64.9-70.7	76.9	3.0
Robusticity index	11.6-13.8	-	13.4	12.8	12.4	-	12.2	0.5	11.3-13.3	12.9	0.6
Stature (Mongoloid male)		-	173.4	170.3	166.2	-	-	-		161.7	3.6
Tibia											
Total length	330.0-389.0	-	392.0	371.0	382.0	-	335.6	21.1	317.0-383.0	354.2	17.1
Medial condyle, ML	27.9-33.3	-	32.0	32.6	33.8	-	28.1	1.3	26.1-30.9	30.4	1.6
Medial condyle, AP	41.6-50.7	-	48.3	48.0	44.8	-	40.8	2.4	38.8-45.7	44.5	2.2
Lateral condyle, ML	28.0-34.3	-	35.7	36.0	33.5	-	29.0	1.9	27.3-32.1	31.2	1.7
Lateral condyle, AP	33.5-43.2	-	39.6	43.0	38.5	-	33.9	3.5	29.2-40.3	37.3	2.3
Mid shaft, AP	28.5-34.7	-	37.6	34.2	34.3	-	26.5	1.7	24.6-29.6	31.1	1.9
Mid shaft, ML	13.9-21.6	-	20.8	22.1	21.0	-	17.5	1.7	14.8-21.0	19.0	1.8
Robusticity index	62.6-97.0	-	75.4	83.9	74.2	-	63.6	6.0	58.1-77.9	73.7	8.0
Stature		-	175.1	170.1	172.7	-	-	-		166.0	3.27

[a] All linear measurements are expressed in millimeters.

(Stark 1983; Brooks et al. 1984). The majority of the osteological measurements and observations of individuals from these regions indicate robust structure, although male height generally does not exceed 6 ft. (1.82 m.). Recent data from the Stillwater series of the Lovelock People includes some males with measurements equal to or larger than those of the Haverty series.

Even today many California and Great Basin aboriginal peoples exhibit highly robust skeletal characteristics in both the male and female populations. Examples of such robusticity are found in groups of the Mojave Desert such as the Chemehuevi and Mohave currently living along the lower Colorado River. These robust characteristics, seen in the Lovelock series, some Early Central California crania, and other Great Basin skeletal groups, support a view that the Haverty series from a morphological perspective is not unique in western North America.

GEOCHRONOLOGY

Initial Geochronological Data

Attention was redirected to the Haverty skeletal collection in the mid-1970s as a result of a suggestion that at least one of the skeletons exhibited an age of >50,000 years. This age was inferred on the basis on a relatively high (ca. 0.5) D/L_{asp} ratio reported on a sample of Haverty bone. As far as the authors are aware, the actual D/L_{asp} value on which this age estimate was based has not been published. An unpublished paper (Austin 1976:5) stated that Haverty (Angeles Mesa) material had been dated by aspartic acid racemization to over 50,000 years with a reference to "Bada, 1975, personal communication." The fact that a relatively high D/L_{asp} ratio had been obtained on an Haverty bone was confirmed by one of us (RET) by personal communication from P. M. Masters as cited by Taylor (1983:651).

This inferred amino acid racemization age was approximately an order of magnitude greater than the initial ^{14}C age estimates obtained on organic fractions extracted from bones taken from Haverty Individual 4 obtained by a commercial ^{14}C facility, Geochron Laboratories, Inc. (5,200±400 ^{14}C years B.P. GX-1140), and by the Isotope Laboratory, University of California, Los Angeles (7,900±1,440 ^{14}C years B.P., UCLA-1924A). The Haverty skeletons were one of a number of California human skeletal samples which, on the basis of their D/L_{asp} values, were assigned ages in the 40,000- to 70,000-year range (Bada et al. 1974; Bada and Helfman 1975). The initial ^{14}C results and middle Holocene age assignment subsequently were confirmed by three ^{14}C analyses carried out by the Radiocarbon Laboratory, University of California, Riverside (UCR), on various organic fractions (total acid-soluble organics and total acid-insoluble organics after gelatin conversion with base-soluble fraction removed) of bones from Haverty Individuals 1 and 4 (UCR-1349A, UCR-1349D, and UCR-1568A) (Taylor 1983; Taylor et al. 1984). The fact that the Haverty skeletons exhibit relatively high D/L_{asp} ratios, 0.48 on Individual 2 and 0.49 on Individual 3, was confirmed by measurements carried out by one of us (CAP) as reported in Table 1.

Evaluation of Amino Acid Racemization and Radiocarbon Data

The lack of concordance between AAR- and ^{14}C-inferred ages as exemplified in the Haverty skeletons also was noted for a number of other human skeletons from California sites. The use of accelerator (or atomic) mass spectrometry (AMS) permitted researchers to obtain direct ^{14}C analysis on milligram-sized amounts of specific organic extracts – including total amino acids components – of a number of human bones assigned

Pleistocene ages on the basis of their D/L_{asp} values. AMS ^{14}C analyses also were conducted on two skeletons (Laguna and Los Angeles) which had been assigned late Pleistocene ages on the basis of earlier conventional ^{14}C determinations. One of these, the Laguna skeleton, had been employed as the calibration sample to calculate the k_{asp} value for the purpose of inferring an AAR age for the series of southern California skeletons. The AMS ^{14}C analyses indicated that both the Laguna and Los Angeles skeletons are of Holocene age. These investigations resulted in major revisions in the Pleistocene age assignments inferred from D/L_{asp} as well, in two instances, from earlier ^{14}C values. In every case, the AMS ^{14}C age indicated a Holocene age for the human skeletons (Taylor et al. 1983; Taylor et al. 1985).

As part of efforts to clarify the nature of the racemization phenomenon in bone and to understand the source of the major discrepancies between AAR- and ^{14}C-inferred ages, biogeochemical studies have been undertaken by a number of investigators over the last decade (e.g., Williams and Smith 1977; Smith et al. 1978; Von Endt 1979, 1980; Kessels and Dungworth 1980; Matsu'ura and Ueta 1980). The studies of the UCR group in this area have been reported by Ennis et al. (1986), Prior et al. (1986), and Taylor et al. (1989). As a result of these studies, it is now generally accepted that the original implicit model employed to deduce AAR values does not hold for a significant number of bone samples (Bada 1985). Some of the additional parameters that now must be considered include (1) the influence of the chemical state of the amino acids on racemization kinetics; (2) the requirement that a calibration sample and a sample to be dated have experienced essentially identical temperature histories; (3) the effects of bacterial and other types of contamination; (4) the actual D/L ratio at time zero in the racemization process in different bones; and (5) homogeneity of D/L ratios in fossil bone from the same skeleton or from skeletons with identical ages and temperature histories (Ennis et al. 1986).

As listed in Table 1, AAR-inferred ages of approximately 40,000 years could be derived on Haverty Individuals 2 and 3 if the original model and k_{asp} used by Bada et al. (1974), 1.08×10^{-5} $year^{-1}$, to infer AAR ages for the original series of coastal southern California human skeletal samples to which AAR ages were assigned. The problematic nature of this approach is immediately evident when the range in D/L_{asp} ratios and resultant AAR-derived ages are noted. If it is assumed that all of the bones in the Haverty skeletal series are of similar age, the range in D/L_{asp} values exhibited in the individual skeletons may be seen as reflecting the effects of variations in one or more of the parameters noted in the previous paragraph.

The effect of variations in the chemical state of the amino acids is illustrated in the Haverty samples by noting the covariation in two indices of degree of preservation of the proteinaceous component (primarily the protein collagen) with their total D/L_{asp} values. The two indices illustrated in Table 1 are the amino acid nitrogen value and the ratio of the amino acids glycine (Gly) and glutamic acid (Glu) in the total fraction. In fresh, modern, fat-free bone, the amino acid nitrogen value is about 3% and the Gly/Glu ratio about 4. Fossil bones exhibiting these values are considered to have their collagen structure still intact. Decreases in these values reflect the progressive dissolution of the collagen due to the effects of various biogeochemical diagenetic processes.

In Table 1, the relatively high D/L_{asp} ratios exhibited in Haverty Individuals 2 and 3 are correlated with very low nitrogen values and Gly/Glu ratios. These values indicate that these bones have lost their collagen-like characteristics. By contrast, in Haverty Individual 1, the relatively low D/L_{asp} value is associated with a nitrogen value and Gly/Glu ratio that suggests a bone with its collagen structure essentially intact. The pattern of increasing D/L_{asp} ratios correlated with decreasing nitrogen and Gly/Glu values is exhibited in the remainder of the Haverty skeletons. This characteristic pattern also has been observed in a much larger suite of bone samples from a late prehistoric southern California archaeological locality, the Encino Village site (CA-LAn-43). In this case, bone samples which, on the basis of archaeological and ^{14}C data, were known to not exceed 2,000 years B.P. in temporal range exhibited D/L_{asp} values ranging from 0.1 to almost 0.6. Again, the same relationship was found: as amino acid nitrogen content decreased, there was a general trend for the D/L_{asp} values to increase (Taylor et al. 1989). These views are in agreement with those of previous investigators who concluded that time and effective mean annual environmental temperature are not the only significant variables that must be taken into account in deriving age estimates on the basis of D/L_{asp} values. For the purpose of deriving temporal relationships among bone samples, comparison of D/L_{asp} ratios should be made only on chemically comparable organic fractions. These conditions are not met in the bones in the Haverty collection.

Based on the initial series of ^{14}C values, the ages of the Haverty skeletons were assigned to the middle Holocene, i.e., 4,000 to 6,000 ^{14}C years B.P. However, ^{14}C values obtained by the Isotope Laboratory, University of California, Los Angeles, on Haverty Individuals 3 and 4 indicated a significantly older age. Unfortunately, the relatively large counting/statistical errors associated with both of these values rendered their comparison with the other ^{14}C values somewhat problematic. The significantly inflated statistical errors associated with both of these ^{14}C values, 10,500±2,000 (UCLA-1924) and 7,900±1,440 (UCLA-1924B), reflected the lack of sufficient sample and the relatively low organic content of the bone material used for the analysis. In both cases, low organic yields are associated with amino acid nitrogen values of less than 0.1% and amino acid compositional data (as illustrated in Table 1 by glycine/glutamic acid [Gly/Glu] ratios) suggesting that the collagen contained in these bones was significantly denatured.

Recent studies have suggested that anomalous ^{14}C age estimates on bone can be obtained when the samples are characterized by organic residues in low and trace concentrations which do not exhibit a collagen-like amino acid pattern (Hedges and Law 1989; Stafford et al. 1990). Researchers attempting to isolate autochthonous organics from bone in cases where the collagen has been significantly denatured and removed from the bone matrix have directed attention to the use of one or more of the noncollagen organic components of bone. A set of paired measurements have examined ^{14}C ages exhibited in collagen and noncollagen organic fractions extracted from four of the Haverty skeletons (Ajie et al. 1990).

Osteocalcin Radiocarbon Data

Osteocalcin is one of a number of noncollagenous proteins contained in mammalian bone. It was discovered in the laboratory of Peter Hauschka of the Harvard School of Dental Medicine in the early 1970s during a search for the source of the calcium-binding amino acid, gamma-carboxyglutamic acid (Gla). In fresh bone, osteocalcin comprises about 1% of the total bone protein and some 10% to 20% of the noncollagenous proteins. Other major noncollagen proteins in bone include osteonectin, proteoglycan, osteopontin, and two types of sialoprotein.

Previous researchers (references in Ajie et al. [1990]) have noted that a potentially important characteristic of osteocalcin is that it appears to bind to the hydroxyapatite matrix, the major mineral fraction in bone. In such a configuration, it could prove to be very biogeochemically stable. This suggestion is supported by studies in which osteocalcin was isolated from bovid bones ranging in age from about 12,000 years to 13 million years and was found to be biochemically indistinguishable from modern counterparts. In addition, the distribution of osteocalcin in nature appears to be limited to vertebrates. Osteocalcin has not as yet been detected in arthropod exoskeletons or in microorganisms. Because of its apparent strong binding to hydroxyapatite, there is the potential that osteocalcin can be isolated from bone free of humic and fulvic acids, polysaccharides, or other common soil contaminants. Finally, previous studies indicate that the concentration of osteocalcin in fossil bone does not decrease in response to the diagenetic processes that reduce the collagen concentration. This lends support for the view that this protein is strongly bound to the mineral matrix, protecting it in bones from the biological, chemical, and physical agents responsible for the denaturization of collagen.

Paired osteocalcin and gelatin ^{14}C values obtained on Haverty Individuals 1, 2, 4, and 5 are listed in Table 1. The isolation of gelatin was accomplished using methods outlined by DeNiro and Epstein (1981) and Schoeninger and DeNiro (1984). The osteocalcin fractions were obtained using procedures outlined by Poser et al. (1980). In each case, the ^{14}C measurements were performed using AMS techniques. For Haverty Individual 1, the gelatin and osteocalcin values are entirely concordant with the previously obtained ^{14}C values. For Haverty Individual 2, both gelatin and osteocalcin ^{14}C values reflect a higher ^{14}C activity in both fractions,yielding ^{14}C ages younger than that indicated by the ^{14}C data associated with Haverty Individual 1. Finally, while the gelatin ^{14}C values for Haverty Individuals 4 and 5 are essentially compatible with the original suite of ^{14}C values, the osteocalcin ^{14}C determinations for these two skeletons range between about 13,000 and 16,000 years. It should be emphasized that the ^{14}C data obtained on osteocalcin isolated from the Haverty skeletons represent the first attempt to employ this noncollagen component of bone in ^{14}C studies. Since no biochemical tests were conducted on the extracts to determine the purity of the osteocalcin, it is conceivable that other organic products could be present. Future studies will be required to clarify the factors that might contribute to the serious discordance in the collagen/osteocalcin values for Haverty skeletons 4 and 5.

SUMMARY AND CONCLUSIONS

The Haverty skeletal series consists of at least eight individuals of both sexes, adults and subadults. The number of individuals, the combination of adolescents and adults, both male and female, and the possible presence of artifacts, suggests a burial locale. Possible substantition that these represent deliberate burials may be found in the accounts that at least one of the skeletons possibly was articulated and in a sitting position. With the evidence that this was a marshy area, the undisturbed deposits suggest a series of shallow grave sites in earth hillocks within a marshy environment. Some individuals are relatively complete, making this a virtually unique skeletal collection in comparison with other, often very fragmentary, early native American materials.

The cranial sizes and humeral, femoral, and tibial variables of the Haverty skeletons are well above the means of some other southern California native American prehistoric skeletal series and, from a morphological perspective, show pronounced robusticity. This is a contrast to other local native American populations, which were often very delicately built. This contrast represents a clear indication of the morphological heterogeneity of native populations in western North America, a situation not unlike that seen, for example, in precontact southeast Australia (Thorne 1971). Although the current geochronological status of the skeletons requires continued study, even if all or some of the Haverty series are conclusively demonstrated to be late Pleistocene in age, it is unlikely that their robusticity is solely a reflection of an early morphotype. Late populations in western North America (i.e., the Lovelock People, the Mohave, and Chemehuevi) also demonstrate robust morphology so that "robusticity" does not necessarily correlate with antiquity. It also is unlikely that their robust morphotype represents an adaptational pattern since the area where they were recovered (coastal southern California) also was populated by very gracile populations such as that from Malibu. The La Brea female also represents a population with this delicate morphotype. The pronounced heterogeneity of these coastal southern California populations may reflect multiple entries into the New World.

A view that the Haverty skeletons were of Pleistocene age was suggested by a relatively high D/L_{asp} value exhibited on one skeleton. This conclusion was not supported by the initial set of ^{14}C values, which assigned a middle Holocene age to two of the skeletons, although two other ^{14}C values subsequently obtained suggested a somewhat older age. Radiocarbon determinations on osteocalcin extracted from two of the skeletons suggest a terminal Pleistocene age for these specimens. In our view, these results should be not accepted without additional supporting evidence. The assumption that all of the Haverty skeletons are of similar age also may need to be reassessed. Studies to determine the conditions under which osteocalcin ^{14}C values provide accurate age estimates are currently under way as are the potential sources and effects of contamination in these samples. These investigations are being undertaken cognizant of the fact that if the validity of the osteocalcin ^{14}C values on these samples are subsequently supported, then at least two of the Haverty *Homo sapiens* would become the oldest human skeletal samples in the Western Hemisphere.

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REFERENCES

Ajie, H. O., I. R. Kaplan, P. J. Slota, Jr., and R. E. Taylor
1990 AMS Radiocarbon Dating of Bone Osteocalcin. Nuclear Instruments and Methods in Physics Research B52:433-437.

Austin, J.
1976 A Test of Birdsell's Hypothesis on New World Migrations. Paper presented at the annual meeting of the Society for California Archaeology, San Diego.

Bada, J. L.
1985 Amino Acid Racemization Dating of

Fossil Bones. Annual Review of Earth and Planetary Science 13:241-268.

Bada, J. L., and P. M. Helfman
1975 Amino Acid Racemization of Fossil Bones. World Archaeology 7:160-173.

Berger, R., and R. R. R. Protsch
1989 UCLA Radiocarbon Dates XI. Radiocarbon 31:55-68.

Brooks, S., C. Stark, and R. H. Brooks
1984 John Reid's Redheaded "Giants" of Central Nevada: Fact or Fiction? Nevada Historical Society Quarterly 27:243-252.

Clements, T.
1938 Age of the "Los Angeles Man" Deposits. American Journal of Science 36:137-141.

DeNiro, M. F., and S. Epstein
1981 Influence of Diet on the Distribution of Nitrogen Isotopes in Animals. Geochimica et Cosmochimica Acta 45:341-351.

Ennis, P., E. A. Noltmann, P. E. Hare, P. J. Slota, Jr., L. A. Payen, C. A. Prior, and R. E. Taylor
1986 Use of AMS ^{14}C Analysis in the Study of Problems in Aspartic Acid Racemization-Deduced Age Estimates on Bone. Radiocarbon 28:539-546.

Hay, O. P.
1927 The Pleistocene of the Western Region of North America and Its Vertebrated Animals. Carnegie Institution of Washington Publication No. 322B.

Hedges, R. E. M., and I. A. Law
1989 The Radiocarbon Dating of Bone. Applied Geochemistry 4:249-253.

Heizer, R. F.
1950 Observations on Early Man in California. Berkeley: University of California Archaeological Survey Reports No. 7:5-9.
1960 Observation on Early Man in California. Kroeber Anthropological Society Papers 1:28-33.

Irwin, H. T.
1975 United States of America. In: Catalogue of Fossil Hominids, Part III: Americas, Asia, Australasia, K. P. Oakley, B. G. Campbell, and T. I. Molleson, eds., pp. 31-45. London: Trustees of the British Museum (Natural History).

Kessels, H. J., and G. Dungworth
1980 Necessity of Reporting Amino Acid Compositions of Fossil Bones Where Racemization Analyses are Used for Geochronological Applications: Inhomogeneities of D/L Amino Acid in Fossil Bones. In: Biogeochemistry of Amino Acids, P. E. Hare, T. C. Hoering, and K. King, Jr., eds., pp. 527-542. New York: John Wiley and Sons.

Lopatin, I. A.
1940 Fossil Man in the Vicinity of Los Angeles, California. Proceedings of the Sixth Pacific Science Congress of the Pacific Science Association 4:177-181. Berkeley and Los Angeles: University of California Press.

Martin, R.
1928 Lehrbuch der Anthropologie in Systematischer Darstellung. Jena: Verlag Von Gustav Fischer.

Matsu'ura, S., and N. Ueta
1980 Fraction Dependent Variation of Aspartic Acid Racemization Age of Fossil Bone. Nature 286:883-884.

McKern, T. W., and T. D. Stewart
1957 Skeletal Age Changes in Young American Males, Analyzed from the Standpoint of Identification. Natick, MA: Headquarters Quartermaster Research and Development Command, Technical Report EP-45.

Merriam, J. C.
1924 Present Status of Investigations Concerning Antiquity of Man in California. Science 60:1-2.

Newman, R. W.
1957 A Comparative Analysis of Prehistoric Skeletal Remains from the Lower Sacramento Valley. Berkeley: University of California Archaeological Survey Report No. 39.

Poser, J. W., F. Esch, N. C. Ling, and P. A. Price
1980 Isolation and Sequence of the Vitamin K-Dependent Protein from Human Bone. Journal of Biological Chemistry 225:8685-8691.

Prior, C. A., P. J. Ennis, E. A. Noltann, P. E. Hare, and R. E. Taylor
1986 Variations in D/L Aspartic Acid Ratios in Bones of Similar Age and Temperature History. In: Proceedings of the 24th International Archaeometry Symposium, J. S. Olin and M. J. Blackman, eds., pp. 487-498. Washington: Smithsonian Institution Press.

Redwine, P.
1957 An Anthropometric Study of Ancient Man in the Los Angeles Region. MS on file at the Department of Anthropology, University of Nevada, Las Vegas.

Reinhardt, G.
1983 Relationship Between Attrition and Lingual Tilting in Human Teeth. American Journal of Physical Anthropology 61:227-239.

Schoeninger, M. J., and M. J. DeNiro
1984 Nitrogen and Carbon Isotopic Composition of Bone Collagen from Marine and Terrestrial Animals. Geochimica et Cosmochimica Acta 48:625-639.

Sellards, E. H.
1940 Early Man in America, Index to Localities, and Selected Bibliography. Bulletin of the Geological Society of America 51:373-432.

Smith, G. G., K. M. Williams, and D. M. Wonnacott
1978 Factors Affecting the Rate of Racemization of Amino Acids and Their Significance to Geochronology. Journal of Organic Chemistry 43:1-5.

Stafford, T. W., Jr., P. E. Hare, L. Currie, A. J. T. Jull, and D. Donahue
1990 Accuracy of North American Human Skeleton Ages. Quaternary Research 34:111-120.

Stark, C.
1983 The Determination of Variation in Skeletal Remains in Nevada Through the Use of Discrete Morphological Traits and Anthropology. Master's thesis, University of Nevada, Las Vegas.

Stock, C.
1924 A Recent Discovery of Ancient Human Remains in Los Angeles, California. Science 60:2-5.

Taylor, T. G.
1927 Environment and Race. London: Oxford University Press.
1949 Environment, Race and Migration. Toronto: University of Toronto Press.

Taylor, R. E.
1983 Non-concordance of Radiocarbon and Amino Acid Racemization Deduced Age Estimates on Human Bone. Radiocarbon 25:647-654.

Taylor, R. E., L. A. Payen, B. Gerow, D. J. Donahue, T. H. Zabel, A. J. T. Jull, and P. E. Damon
1983 Middle Holocene Age of the Sunnyvale Human Skeleton. Science 220:1271-1273.

Taylor, R. E., L. A. Payen, and P. J. Slota, Jr.
1984 Impact of AMS ^{14}C Determinations on Consideration of the Antiquity of *Homo sapiens* in the Western Hemisphere. Nuclear Instruments and Methods in Physics Research B5:312- 316.

Taylor, R. E., L. A. Payen, P. J. Slota, Jr., R. Gillespie, J. A. J. Gowlett, R. E. M. Hedges, A. J. T. Jull, T. H. Zabel, D. J. Donahue, and R. Berger
1985 Major Revisions in the Pleistocene Age Assignments for North American Human Skeletons by C-14 Accelerator Mass Spectrometry: None Older than 11,000 C-14 Years B.P. American Antiquity 50:136-140.

Taylor, R. E., P. J. Ennis, P. J. Slota, Jr., and L. A. Payen
1989 Non-Age Related Variations in Aspartic Acid Racemization in Bone from a Radiocarbon-dated Late Holocene Archaeological Site. Radiocarbon 31:1048-1056.

Thompson, S. T.
1950 Nasal Lengths and Breadths in Western North America. MS on file at the Anthropology Library, University of California, Berkeley.

Thorne, A.
1971 Mungo and Kow Swamp: Morphological Variation in Pleistocene Australians. Mankind 8:85-89.

Tieje, A. J.
1926 The Pliocene and Pleistocene History of the Baldwin Hills, Los Angeles County, California. American Association of Petroleum Geologists Bulletin 10:502-512.

Trotter, M., and G. Gleser
1958 A Re-evaluation of Estimation of Stature Based on Measurements of Stature Taken During Life and of Long Bones After Death. American Journal of Physical Anthropology 16:79-123.

Von Endt, D. W.
1979 Techniques of Amino Acid Dating. In: Pre-Llano Cultures of the Americas, R. Humphrey and D. Stanford, eds., pp. 71-100. Washington: Anthropological Society of Washington.

1980 Protein Hydrolysis and Amino Acid Racemization in Sized Bone. In: Biogeochemistry of Amino Acids, P. E. Hare, T. C. Hoering, and K. King, Jr., eds., pp. 297-304. New York: John Wiley & Sons, Inc.

Williams, K. M., and G. G. Smith
1977 A Critical Evaluation of the Application of Amino Acid Racemization to Geochronology and Geothermometry. Origins of Life 8:91-144.

Wallace, W. J.
1955 A Suggested Chronology for Southern California Coastal Archaeology. Southwestern Journal of Anthropology 11:214-230.

Wormington, H. M.
1957 Ancient Man in North America. 4th Edition. Denver: Denver Museum of Natural History.