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CONTRIBUTIONS TO WESTERN ARCHAEOLOGY
AMINO ACID DATING AND EARLY MAN

IN THE NEW WORLD: A REBUTTAL

by Bert A. Gerow

DL-aspartic acid

UCLA 1695D

D/L = 0.32

L-leu-
D-asp

L-leu-
L-asp

BUFFER CHANGE

OLDUVAI GORGE
INTRODUCTION

Amino acid dating is of great interest to both the archaeologist and the physical anthropologist since, theoretically, the method could extend the present range of radiocarbon dating and also yield dates where only a few milligrams of protein matter are available.

For several years the U. S. Geological Survey in Menlo Park, the NASA-Ames Research Center in Mountain View, and the Department of Anthropology at Stanford University have collaborated on a feasibility study of amino acid dating on bone, utilizing archaeological and palaeontological samples. The present paper is based on the result of analyses of fourteen samples from seven sites along the peninsular side of south San Francisco Bay. While the data are admittedly limited, they are more than comparable to previously published results for a single restricted area characterized by minimal variations in mean annual air temperatures (Lajoie, Peterson and Gerow 1980).

One of the samples, the skeleton from the Sunnyvale East Channel, has received considerable notoriety as the result of an aspartic acid racemization date of approximately 70,000 years determined by J. L. Bada of Scripps Institution of Oceanography, University of California, San Diego. Richard McNeish has uncritically included this date along with other equally questionable aspartic acid dates from southern California in discussions of early man in the New World (McNeish 1976:320; Froncek 1977:160). Others have followed suit in introductory texts on archaeology and physical anthropology. Advocates of dates of this order of magnitude for fully modern humans in the Americas have seized upon Birdsell's suggestion that Homo sapiens sapiens may have appeared earlier in southeast Asia than in the Near East and Europe (Birdsell 1975:326).

It is important to realize that a number of reputable biochemists do not agree with J. L. Bada with respect to the reliability of amino acid dates on bone, and P. E. Hare of the Carnegie Institute of Washington has stated that probably few, if any, of the published amino acid dates are reliable, and some are possibly off by an order of magnitude (Hare 1974).

Undoubtedly, some will interpret these initial remarks as the resurrection and second coming of Hrdlička. For this reason we would like to stress that we are not concerned with rejecting the possibility of man's entry into the New World prior to 12,000 or so years ago, but with the uncritical acceptance by some professionals of amino acid dates of this order of magnitude, calculated from a single "calibration" sample, namely, the Laguna Beach fragmentary skull, whose original micro-environment and physical type are virtually unknown.

DISCUSSION

To the best of our knowledge not one of the advocates of the amino acid dating method on bone and of human antiquity in the Americas of this order of magnitude has ever visited the Sunnyvale East Channel locality. By mid-1973, prior to any amino acid racemization analyses, we had reached the conclusion based on several lines of corroborating evidence that the age of the Sunnyvale skeleton was less than 10,600 years and most probably 4,500 years or less. Much of this information was made available to J. L. Bada and associates at that time.
1. The skeleton occupied a well-defined grave pit 53 cm in diameter, 2.7 m from the present ground level and surrounded by the contrastive, grey colored, clayish silt from an overlying soil horizon. The relatively vertical walls of the pit could be traced upward 1.4 m from its bottom. The original surface from which the inhumation had taken place had been obliterated by probable "churning" as a result of seasonal swelling and cracking of the soil. The underlying soil horizon into which the burial was injected contains Rancholabrean fauna, specifically camelops, horse, and mammoth of L. Pleistocene or E. Holocene times. Fresh water snail shells collected from the lower soil horizon at the general level of the grave pit have yielded two radiocarbon dates of approximately 10,000 years. It seems likely that the original ground surface at the time of inhumation was more or less 1 m below the present ground surface. Similar grey clay silts have been deposited to a depth of 1.6 m in 3,000 to 3,500 years along the abandoned former channel of the San Francisquito Creek at the University Village site (SMA-77).

2. The location of the site corresponds to a common local prehistoric settlement pattern in that it was situated on a flood plain near the zero contour of the water table irrespective of its distance from the open waters of the bay in the willow composite zone between the resources of the oak forest and the salt marshes, as well as those of the bay (Gerow with Force 1968). The San Francisco Bay rose rapidly up until 5,000 to 6,000 years ago and has since continued to rise at a reduced rate of about 1 to 2 m per millenium (Sickel 1978). The soil containing all three bone samples from the Sunnyvale East Channel has almost certainly been deposited since the bay reached within a few meters of its present level.

3. The flattened condition of the cranium and a water ring in the lower half of the interior indicate that only a small amount of soil ever entered the foramen magnum. Locally, all crania, three to five thousand years old, have been firmly packed with surrounding matrix. Primary burials, tightly flexed posture and lateral position are typical of late burials as well as earlier burials; westerly orientation of the head in relation to the pelvis also occurs in early contexts, but is more frequently associated with intermediate period burials. An antler wedge tip, which was found 400 m north in an intrusive "refuse pit" at a depth of 2.1 m, has a radiocarbon date of 4460±95 years (I-6977) and may be contemporaneous with the burial. This is an artifact type characteristic of the San Francisco Bay region, early and late, as well as of coastal regions to the north.

4. Anthropometrically, the reconstructed skeleton is statistically indistinguishable in 32 standard measurements and indices from a local population of females dated by radiocarbon and cultural associations between approximately 400 and 1,600 years ago.

RESULTS

Listed on Table 1 are aspartic acid D/L values for our fourteen samples along with calculated rate constants (Kasp), $^{14}$C dates, and such environmental variables as depth from ground surface, percent of residual nitrogen (Dumas method), pH of soil matrix, and relationship to ground water table (G.W.T.). The samples are ordered according to increasing D/L values. With the exception of one sample, all are from sites within ten miles of Stanford University. The exception is the locus of the BART skeleton which was uncovered during the excavation of the Bay Area Rapid Transit station in San Francisco in 1969. Mean annual air temperatures vary between 13.6°C for San Francisco and 14.8°C for Redwood City, averaging 14.2°C (U.S. Department of Commerce 1964).
<table>
<thead>
<tr>
<th>Site/samples</th>
<th>aspartic D/L</th>
<th>$^{14}C$ age</th>
<th>Kasp</th>
<th>Depth (m)</th>
<th>Nitrogen %</th>
<th>pH</th>
<th>G.W.T.</th>
<th>Cal. Age*</th>
<th>$^{14}C$ &amp; Cal. Age Differ. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>BART tibia</td>
<td>0.069</td>
<td>4900±250</td>
<td>2.47x10^{-6}</td>
<td>14.0</td>
<td>3.5</td>
<td>6.3</td>
<td>-1</td>
<td>1928</td>
<td>-154%</td>
</tr>
<tr>
<td>MVD Camelops mandible</td>
<td>0.078</td>
<td>22350±(7)</td>
<td>9.42x10^{-7}</td>
<td>5.7-7.0</td>
<td>-</td>
<td>≤7.0</td>
<td>-1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stanford I cr.</td>
<td>0.089</td>
<td>5130±70</td>
<td>6.28x10^{-6}</td>
<td>6.1</td>
<td>1.34</td>
<td>6.38</td>
<td>+1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stanford II cr.</td>
<td>0.092</td>
<td>4350±125</td>
<td>8.11x10^{-6}</td>
<td>5.0</td>
<td>0.51</td>
<td>6.39</td>
<td>+1</td>
<td>5416</td>
<td>+22%</td>
</tr>
<tr>
<td>U.V. antler</td>
<td>0.096</td>
<td>3170±(4)</td>
<td>1.24x10^{-5}</td>
<td>≤2.3</td>
<td>2.94</td>
<td>&gt;7.0</td>
<td>θ?</td>
<td>6257</td>
<td>+97%</td>
</tr>
<tr>
<td>MVD Camelops tooth</td>
<td>0.10</td>
<td>22350±(7)</td>
<td>1.94x10^{-6}</td>
<td>5.7-7.0</td>
<td>-</td>
<td>≤7.0</td>
<td>-1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stanford III rib</td>
<td>0.10</td>
<td>2270±(80)</td>
<td>1.91x10^{-5}</td>
<td>2.85</td>
<td>0.83</td>
<td>6.9</td>
<td>+1</td>
<td>6900</td>
<td>+170%</td>
</tr>
<tr>
<td>U.V. # 52.338 cr.</td>
<td>0.125</td>
<td>3170±(4)</td>
<td>2.17x10^{-5}</td>
<td>2.3</td>
<td>1.41</td>
<td>7.66</td>
<td>θ?</td>
<td>10982</td>
<td>+245%</td>
</tr>
<tr>
<td>Castro Cr.</td>
<td>0.13</td>
<td>2910±100</td>
<td>2.53x10^{-5}</td>
<td>2.1</td>
<td>0.52</td>
<td>7.72</td>
<td>θ</td>
<td>9076</td>
<td>+180%</td>
</tr>
<tr>
<td>MVD Camelops tibia</td>
<td>0.25</td>
<td>22350±(7)</td>
<td>8.88x10^{-6}</td>
<td>5.7-7.0</td>
<td>-</td>
<td>≤7.0</td>
<td>-1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SEC radius</td>
<td>0.42</td>
<td>-</td>
<td>-</td>
<td>2.7</td>
<td>0.08</td>
<td>7.4</td>
<td>θ</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SEC antler</td>
<td>0.49</td>
<td>4460±95</td>
<td>1.07x10^{-4}</td>
<td>2.1</td>
<td>0.17</td>
<td>&gt;7.0</td>
<td>θ</td>
<td>76283</td>
<td>+1610%</td>
</tr>
<tr>
<td>SEC tibia</td>
<td>0.52</td>
<td>-</td>
<td>-</td>
<td>1.3</td>
<td>0.16</td>
<td>&gt;7.0</td>
<td>θ</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Key:  
- = below  
+ = above  
θ = seasonal fluctuation  
≤ = less than or equal to  
cr. = cranium  
G.W.T. = ground water table  
SEC = Sunnyvale East Channel, 1972

* Calculated age utilizing Kasp 6.28x10^{-5}
Of the fourteen bone samples, those of Stanford I and Stanford II have been dated by UCLA, utilizing the bone collagen technique applied by Rainer Berger to the Laguna Beach and the so-called Los Angeles “Man.” Seven \(^{14}C\) dates on wood from the Mountain View Dump at depths of 5.5 to 7.0 m range from 20,820±380 years to 23,600±520 years with an average of 22,350 years. All but one of the remainder have been dated by associated charcoal or in the case of the BART skeleton by organic material adhering to the pelvis. The single exception is the Castro Mound (SCI-1) skeleton which has been dated by reference to a \(^{14}C\) date on marine shell associated with Early Central California shell bead and shell ornament types found at the same sub-mound level and within a horizontal distance of approximately 10 m. The latter date has been corrected for possible “upwelling” by 500 years. The University Village (SMA-77) charcoal dates are supported by corroborating freshwater shell dates and cultural evidence (Gerow with Force 1968; Gerow 1974).

Since cremation or “cooking” could seriously affect the degree of racemization, we note that none of the samples analyzed exhibited any signs of charring or scorching. Also, all but one possessed the normal pattern of relationship for seven amino acids corresponding to unheated bones (Bada et al. 1974). The exception is a tibial shaft fragment from the Sunnyvale East Channel which is a highly degraded sample, but which shares roughly the same value of aspartic acid racemization as do the other two samples from that locality.

Looking first at Table 1, as a whole, no simple correlation between aspartic acid D/L values and any of the variables is apparent. However, inverse trends between aspartic acid D/L and rate constant on the one hand, and depth below ground water, on the other, are suggestive. \(^{14}C\) dates and aspartic acid D/L values do not exhibit even a trend, either positive or negative.

Next, contrasting specific localities, we note that for Stanford I, II, and III, which were all exposed by erosion at varying depths along the San Francisquito Creek, a fairly consistent correlation between depth and age can be shown (Table 2). Incomplete data for the Greer Road site has been added for purposes of exposition. If one uses the depth and \(^{14}C\) age of any one of the four, a fair approximation of the ages of the other three can be determined. Stanford I, which is the oldest, was at the greatest depth, has the lowest D/L and pH but the highest percentage of residual nitrogen. Apart from depth below ground surface one should comment on the presence of oaks, redwoods, bay laurels, and elders along the present banks of the San Francisquito Creek (Cooper 1926).

The BART sample, which was recovered 14.0 m below ground surface and 7.9 m below sea level is an extreme example of a micro-environment which experienced rapid burial.

The Mountain View Dump samples, also below sea level, represent Rancho Labrean fauna (camelops) and are associated with an average \(^{14}C\) date four times as great as those of Stanford I, II, and the BART skeleton. Of the three samples, none exhibit a D/L value lower than the BART D/L, and only one is lower than those for Stanford I, II, and III. Unfortunately, at present, residual nitrogen percentages have not been determined for the Mountain View Dump samples, and a soil pH of less than 7.0 is inferred from the Department of Agriculture Soil Survey of Santa Clara County. However, that the samples were recovered between 5.5 and 7.0 m below the ground surface and below the water table but higher than BART is consistent with their intermediate D/L ratios.

The three samples from the Sunnyvale East Channel exhibit the highest D/Ls and the lowest percentages of nitrogen. The tibial fragment has the highest D/L of the three, was at the shallowest depth, and was visibly the most degraded. All
TABLE 2. $^{14}$C DATES AND AGES CALCULATED FROM BURIAL DEPTHS FOR FOUR SITES ON SAN FRANCISQUITO CREEK

<table>
<thead>
<tr>
<th>Site</th>
<th>$^{14}$C date</th>
<th>SI = 6.1 m</th>
<th>SII = 5.0 m</th>
<th>SIII = 2.85 m</th>
<th>Greer Rd = 1 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanford I</td>
<td>5130±70</td>
<td>841 yrs</td>
<td>4205 yrs</td>
<td>2397 yrs</td>
<td>841 yrs</td>
</tr>
<tr>
<td>Stanford II</td>
<td>4350±125</td>
<td>5367 yrs</td>
<td>2480 yrs</td>
<td>797 yrs</td>
<td>870 yrs</td>
</tr>
<tr>
<td>Stanford III</td>
<td>2270±80</td>
<td>4859 yrs</td>
<td>3982 yrs</td>
<td>796.5 yrs</td>
<td>3982 yrs</td>
</tr>
<tr>
<td>Greer Road</td>
<td>765±80</td>
<td>4667 yrs</td>
<td>3825 yrs</td>
<td>2180 yrs</td>
<td>765 yrs</td>
</tr>
</tbody>
</table>

lay within the level of a seasonally fluctuating water table in an alkaline, grey clay silt. The plant cover has been characterized by the term "willow-composite" in contrast to the "oak forest" (Cooper 1926).

To the extent that temperature is a primary factor affecting the rate of racemization, then, published data on mean annual air temperatures are totally inadequate for determining the temperature history of a given bone sample. Clearly, the lowest rates of racemization are in localities of rapid alluviation, as exemplified by the BART skeleton and sites along the San Francisquito Creek. The highest are in localities of slow alluviation like the Sunnyvale East Channel.

The difficulty we have found in assessing the southern California bone racemization data cited in Bada's several publications lies in a general neglect of information on specific micro-environments and on physical types represented. With the exception of the so-called Los Angeles "Man" and probably the fossil horse bones, all of the southern California samples were recovered from depths of less than two meters in what appear to be alkaline soils.

Table 3 summarizes published data from San Diego, Orange, and Los Angeles counties. The fourteen available samples are presented by county and in order of increasing aspartic acid D/L values. A mean annual air temperature of 16.1°C seems to have been assumed by Bada for all of his southern California data, although U. S. Department of Commerce figures indicate higher averages for San Diego and Los Angeles areas.

Advocates of aspartic acid dates in the forty to fifty thousand year range for southern California samples have accepted shell carbonate $^{14}$C dates for W-9 and ORA-64 but have rejected a suite of six Holocene shell dates from W-34A, the site of the Del Mar skeleton, on the grounds that they have probably been contaminated by more recent carbonates. Why the same argument would not apply equally to those from sites W-9 and ORA-64 is not clear. That sixteen radiocarbon dates performed in three different laboratories on shell carbonate bracket the occupation of ORA-64 between 6,000 and 7,000 years ago does not guarantee that these are not also contaminated. Presumably, a feasibility test would either include or reject all shell carbonate $^{14}$C dates. Furthermore, one wonders, since southern California soils are commonly alkaline, why ion exchange with older carbonates could not also have occurred.

If the Del Mar $^{14}$C dates are accepted, no neat linear correlation or trend of D/L ratios and time is evident.
The Sunnyvale individual is a female, judged to have been about twenty-five to thirty years of age at the time of death. Morphologically, she is fully modern, with a well developed chin, thin cranial walls, canine fossae, short face, and sub-quadratic orbits. The lateral incisors exhibit "shoveling" on the lingual side. The latter is a common Amerindian physical trait shared with populations of East Asia.

Of 32 cranial and post-cranial measurements and indices presently available for the Sunnyvale female, all fall within corresponding ranges for a series of 48 females from ALA-329, a local late prehistoric site; 24 of them differ from the ALA-329 means by less than one sigma of standard deviation (Table 5).

Statistically speaking, the Sunnyvale female and the ALA-329 series are indistinguishable in all respects and can be considered as belonging to a single deme or breeding population. Such a population would correspond closely to E. W. Gifford's San Francisco Bay cranial type which he described as intermediate in all of sixteen selected measurements and indices in comparison with his six other postulated regional types.

Interestingly, the reconstructed Del Mar skull (SDM-16704) from southern California, dated at 41,000-48,000 years by aspartic acid racemization (Bada 1975, Table 7) corresponds closely to Gifford's Santa Catalina type. The latter is the only one of seven types with a cranio-facial index over 100. S.L. Rogers (1963, 1974), of the San Diego Museum of Man, who has measured and made morphological observations on a series of "La Jolla" skeletons, including the Del Mar skull, refers to the latter as "phenozygous," which merely means that the distance between the cheek bones is greater than the maximum width of the head. This feature is clearly apparent in a photograph of the skull from a frontal position. Gifford also ascribed to his Santa Catalina type the following characteristics: lowest cranial index, lowest height/length index, lowest gnathic index, longest cranium, and broadest nose. These distinctive features are shared with the Del Mar skeleton.

Historically, Santa Catalina and San Clemente Islands and the adjacent mainland were inhabited by the Gabriellino, and Gifford (1926) regarded his prehistoric Santa Catalina type as most similar to his living Western Mono type, also a Uto-aztecan group.

T. D. Stewart (1941) long ago reviewed the cranial data gathered by Gifford and the statistical study of much the same data by von Bonin and Morant (1938) and concluded that California crania differed chiefly in skull shape (cranial index), relative skull height (mean height index), and size (linear measurements). The inter-regional contrast in cranial index has already been referred to, but, additionally, the Santa Catalina type is characterized by the lowest mean height index (78.3 for males; 77.8 for females). Based on a reconstructed basion-bregma height, the mean height index for the Del Mar skull is 80. The sums of Gifford's average linear measurements for both sexes of the Santa Catalina type are greater than comparable sums for the San Francisco type by almost 200 mm. (Gifford 1926, Table 32).

It is important to point out that the Laguna Beach skull and the so-called Los Angeles "Man," which have \(^{14}\)C dates of 17,150±1470 (UCLA-1233A) and greater than 23,600, respectively, are morphologically and contextually largely unknown. Nobody seems certain as to the original locus of the Laguna Beach skull, which is Bada's calibration sample. R. Berger indirectly quotes T. D. Stewart to the effect that a preliminary examination of the Laguna skeleton suggests a female of the "Santa Barbara" type (Berger et al. 1971:44). The Los Angeles "Man" consists
<table>
<thead>
<tr>
<th>Site/samples</th>
<th>aspartic D/L</th>
<th>$^{14}$C age</th>
<th>Kasp</th>
<th>Depth (m)</th>
<th>Nitrogen %</th>
<th>pH</th>
<th>G.W.T.</th>
<th>Cal. Age*</th>
<th>$^{14}$C &amp; Cal. Age Differ. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>W9, SDM-19241</td>
<td>.154</td>
<td>6700±150</td>
<td>1.27x10$^{-5}$</td>
<td>-</td>
<td>-</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>5878</td>
<td>-12.3%</td>
</tr>
<tr>
<td>W2, SDM-18402 lb</td>
<td>.16</td>
<td>?</td>
<td>0.46</td>
<td>-</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>W12A, SDM-16709</td>
<td>.189</td>
<td>8360±75</td>
<td>1.45x10$^{-5}$</td>
<td>≤1.83</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>W12A, SDM-16724</td>
<td>.347</td>
<td>-</td>
<td>-</td>
<td>≤1.83</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>W2, SDM-16755 rib</td>
<td>.36</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>W12A, SDM-16740</td>
<td>.458</td>
<td>-</td>
<td>-</td>
<td>≤1.83</td>
<td>0.21</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>W34A, SDM-16704 fe</td>
<td>.47</td>
<td>6800±100</td>
<td>6.47x10$^{-5}$</td>
<td>≤1.83</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>-</td>
<td>30349</td>
<td>+346</td>
</tr>
<tr>
<td>W2, SDM-16742 cr</td>
<td>.50</td>
<td>-</td>
<td>-</td>
<td>≤1.83</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Del Mar cr</td>
<td>.52</td>
<td>6800±100</td>
<td>7.45x10$^{-5}$</td>
<td>≤1.83</td>
<td>0.10</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>34920</td>
<td>+413.5%</td>
</tr>
<tr>
<td>fe</td>
<td>.53</td>
<td>6800±100</td>
<td>7.65x10$^{-5}$</td>
<td>≤1.83</td>
<td>&gt;7.0?</td>
<td>+1?</td>
<td>-</td>
<td>35872</td>
<td>+427.5%</td>
</tr>
<tr>
<td>Extinct horse, leg bone &amp; scapula</td>
<td>.53</td>
<td>37400±(2)</td>
<td>1.39x10$^{-5}$</td>
<td>?</td>
<td>&gt;7.0?</td>
<td>-1?</td>
<td>48162</td>
<td>+28.8</td>
<td></td>
</tr>
<tr>
<td>CRA-64</td>
<td>.17</td>
<td>6900±140</td>
<td>1.47x10$^{-5}$</td>
<td>0.6-0.7</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>7011</td>
<td>+1.62%</td>
</tr>
<tr>
<td>Laguna Beach cr</td>
<td>.25</td>
<td>17150±1470</td>
<td>1.08x10$^{-5}$</td>
<td>≤1.75</td>
<td>0.26</td>
<td>&gt;7.0</td>
<td>+1?</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Los Angeles &quot;man&quot; cr</td>
<td>.35</td>
<td>&gt;23600</td>
<td>≤4.0</td>
<td>0.30</td>
<td>&gt;7.0</td>
<td>?</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Key: - = below  
+ = above  
θ = seasonal fluctuation  
≤ = less than or equal to  
> = greater than  
lb = long bone  
cr = cranium  
fe = femur  
G.W.T. = ground water table  

* All ages calculated utilizing Kasp 1.45x10$^{-5}$ except extinct horse in which instance Kasp 1.08x10$^{-5}$ was utilized.
mainly of the occipital bone and adjacent portions of the parietals, and neither sex nor morphological type can be inferred with any degree of certainty. In at least one instance (Protsch 1976) incompleteness of cranial criteria has been interpreted as an absence of Mongoloid characteristics.

Advocates of the validity of early California dates based on aspartic acid racemization of bone have seized upon uncertain evidence, such as the Tasmanoid adolescent male skeleton from Niah Cave, Borneo, that fully modern may have evolved earlier in southeast Asia or Africa than the Near East and Europe, where evidence of *Homo sapiens sapiens* is lacking prior to approximately 35,500 years ago. In the case of the Niah Cave find, a date of 38,000+1000 years (UCLA) has been determined on shell collected at the level of the burial. Since inhumation is involved, the skeleton could be much more recent, as has been pointed out by Gabriel Lasker (Lasker 1976:311).

CONCLUSIONS

From a feasibility study of amino acid dating on bone based on the analyses of fourteen archaeological and palaeontological samples from a relatively restructured geographical area along the San Francisco peninsula we conclude:

1. No first order reversible reaction correlation exists between amino acid D/L values of these bone samples and time. Assuming that temperature is the most important variable, it is clear that varying rates of alluviation and type of floral ground cover in a given locality with presumably the same mean annual air temperature will have a definite effect on the calories of heat received and, consequently, the rate of racemization. Since in our series well-preserved bone samples, irrespective of age, occurred at greater depths, and seem to be characterized by low D/Ls, pHs below 7.0, and relatively higher percentages of residual nitrogen, we suspect that all these conditions of the micro-environment, as well as temperature, play a role in determining the rate of racemization. Consequently, reliance on published data of mean annual air temperature and single "calibration" samples for calculating other dates whose true rates of racemization are unknown, will usually lead to random results if the series of samples from a restricted locality is large enough.

2. On the basis of several lines of evidence, we find an aspartic acid age of 70,000 years for the Sunnyvale Skeleton to be off by at least one order of magnitude.

Since the size of the southern California series of samples is no larger than our series, and information of specific micro-environments, on stratigraphic and archaeological contexts, and on anthropometric data is relatively poorer, we can find no basis for accepting any dates on human bones, calculated from aspartic acid D/L ratios, of the order of magnitude proposed by J. L. Bada and associates.

3. An interpretation of the geological and archaeological contexts of the Sunnyvale skeleton has been offered in the light of local geomorphology and ¹⁴C dates. Human bones and Rancho Labrean fauna do not co-occur in the same soil stratum. The locality lies near the zero water-table contour, as do University Village, Castro, and several other prehistoric sites in the region. San Francisco Bay has only assumed its historic size within the last five to six thousand years, and the present levee systems, alluvial fans and flood basins were probably initiated at that time. The burial matrix is a grey clayey silt of recent origin,
visibly intruding into an earlier yellow horizon associated with Rancho-Labrean fauna.

4. An anthropometric comparison of the Sunnyvale female with a comparable series from a late local prehistoric site indicates a single physical type contrasting with other regional types proposed by Gifford for California. The Del Mar male belongs to another physical type, although both are fully modern and Mongoloid with respect to dentition. The idea that two distinct physical types entered California or developed here fifty to seventy thousand years ago and remained genetically isolated and morphologically unchanged during that period is totally unacceptable in the light of present knowledge of population movements in prehistoric California.

5. Finally, the several lines of evidence examined provide no support for the notion based on amino acid dating of bone that a variety of *Homo sapiens sapiens* characterized by a well-developed chin, thin skull bones, canine fossae (maxillary depressions), a short face, sub-quadrate orbits, and shovel-shaped incisors entered the New World fifty to seventy thousand years ago.

<table>
<thead>
<tr>
<th>TABLE 4. INTERLABORATORY COMPARISON OF ASPARTIC ACID D/L RATIOS IN BONE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>San Diego, California</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1. W34A (Del Mar)</td>
</tr>
<tr>
<td>SDM-16704</td>
</tr>
<tr>
<td><strong>San Francisco Peninsula</strong></td>
</tr>
<tr>
<td>2. Sunnyvale skeleton</td>
</tr>
<tr>
<td>LSJM 72.1108</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3. Stanford I</td>
</tr>
<tr>
<td>Stanford Geo. Mus.</td>
</tr>
<tr>
<td>2915; LSJM 22.1000</td>
</tr>
<tr>
<td>4. Stanford II</td>
</tr>
<tr>
<td>LSJM 63.1303</td>
</tr>
</tbody>
</table>
Selected cranial and post-cranial measurements (mm) and indices for the Sunnyvale skeleton and corresponding data for a late series from ALA-329. ( ) = estimates based on reconstructions.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Sunnyvale</th>
<th>ALA-329</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>25-30</td>
<td>66% = 18-35</td>
</tr>
<tr>
<td>Cranial Measurements</td>
<td>mean</td>
<td>range</td>
</tr>
<tr>
<td>1. glabella-occipital length</td>
<td>179</td>
<td>173.60</td>
</tr>
<tr>
<td>2. maximum width</td>
<td>140</td>
<td>133.95</td>
</tr>
<tr>
<td>3. biauricular width</td>
<td>(105)</td>
<td>106.65</td>
</tr>
<tr>
<td>4. auricular-bregma height</td>
<td>(113)</td>
<td>111.35</td>
</tr>
<tr>
<td>5. minimal frontal diameter</td>
<td>92</td>
<td>89.60</td>
</tr>
<tr>
<td>6. nasalia upper breadth</td>
<td>13</td>
<td>12.21</td>
</tr>
<tr>
<td>7. nasion-bregma arc</td>
<td>122</td>
<td>119.11</td>
</tr>
<tr>
<td>8. bregma-lambda arc</td>
<td>119</td>
<td>116.70</td>
</tr>
<tr>
<td>9. transverse arc</td>
<td>(320)</td>
<td>299.04</td>
</tr>
<tr>
<td>10. maximum circumference</td>
<td>507</td>
<td>493.32</td>
</tr>
<tr>
<td>11. left parietal thickness</td>
<td>4.7</td>
<td>6.26</td>
</tr>
<tr>
<td>12. condylo-symphysial length</td>
<td>105</td>
<td>103.46</td>
</tr>
<tr>
<td>13. bicondylar width</td>
<td>(117)</td>
<td>118.21</td>
</tr>
<tr>
<td>14. height of symphysis</td>
<td>32</td>
<td>32.19</td>
</tr>
<tr>
<td>15. bigonial width</td>
<td>96</td>
<td>95.49</td>
</tr>
<tr>
<td>16. height of ascending ramus</td>
<td>54</td>
<td>51.86</td>
</tr>
<tr>
<td>17. minimum breadth of ascending ramus</td>
<td>35</td>
<td>32.91</td>
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Cranial Indices

<table>
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<tr>
<th></th>
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<th>ALA-329</th>
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<tbody>
<tr>
<td>18. cranial index 2/1 x 100</td>
<td>78.2</td>
<td>77.19</td>
</tr>
<tr>
<td>19. fronto-parietal index 5/2 x 100</td>
<td>65.7</td>
<td>66.96</td>
</tr>
<tr>
<td>20. auric.-breg. ht. l. ind. 4/1 x 100 (63.1)</td>
<td>64.28</td>
<td>58.4-70.1</td>
</tr>
<tr>
<td>21. modified (bregma) module 1+2+4/3</td>
<td>144</td>
<td>139.64</td>
</tr>
<tr>
<td>22. mandibular index 12/13 x 100 (89.7)</td>
<td>88.00</td>
<td>77.4-99.1</td>
</tr>
<tr>
<td>23. fronto-gonial index 15/5 x 100 104.3</td>
<td>105.33</td>
<td>88.0-126.7</td>
</tr>
<tr>
<td>24. modified (bregma) mean ht ind 2x4/1+2 x 100</td>
<td>(70.8)</td>
<td>72.39</td>
</tr>
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Post-cranial Measurements

<table>
<thead>
<tr>
<th></th>
<th>Sunnyvale</th>
<th>ALA-329</th>
</tr>
</thead>
<tbody>
<tr>
<td>25. femur: maximum length L</td>
<td>(370)</td>
<td>411.30</td>
</tr>
<tr>
<td>26. tibia: maximum length L</td>
<td>(320)</td>
<td>338.58</td>
</tr>
<tr>
<td>27. tibia: mid. dia. ant.-post. L</td>
<td>29</td>
<td>27.05</td>
</tr>
<tr>
<td>28. tibia: mid. dia. lateral L</td>
<td>17</td>
<td>18.64</td>
</tr>
<tr>
<td>29. tibia: nutrient for. ant.-post. L</td>
<td>31</td>
<td>29.92</td>
</tr>
<tr>
<td>30. tibia: nutrient for. lateral L</td>
<td>20</td>
<td>20.04</td>
</tr>
</tbody>
</table>

Post-cranial Indices

<table>
<thead>
<tr>
<th></th>
<th>Sunnyvale</th>
<th>ALA-329</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. tibia: middle index L 28/27 x 100</td>
<td>59.6</td>
<td>69.09</td>
</tr>
<tr>
<td>32. tibia: index of platycnemia L 30/29 x 100</td>
<td>64.5</td>
<td>67.14</td>
</tr>
</tbody>
</table>
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A HYPOTHESIS ON INLAND CHUMASH BURIAL PRACTICES

by T. E. Gutman

from Grant 1965:4.
Major interest from 1542 on by the early explorers, as well as by archaeologists in the 20th Century, has centered on the large Chumash communities along the southern California coast. It is probable that the Chumash socio-political organization and customs developed to their high levels as a result of this complex human agglomeration.

Recently archaeologists have paid increasing attention to the inland extension of the Chumash settlement area, which was characterized by year-round occupation (at least in the later stages of such occupation).

The settlement of the inland areas has been found to consist of many small sites, with smaller numbers of large villages. The present paper deals with the hypothesis that this dispersed living pattern led to specific changes in the mortuary customs which had previously evolved in conjunction with sedentary conglomerate living in large villages, each with a large established cemetery.

In the course of excavations at VEN-268, located in the Conejo watershed of Thousand Oaks, two isolated human bones were found: a left ulna and a right fibula. The dark brown, silty midden of the pit was found to be badly disturbed by rodent burrows, so much so that a lone bead was located on bedrock at 80 cm, while the bones were found at 30 cm. While it is possible that rodents had carried the bones into the pit, an alternative hypotheses, that the isolated bones are the remains of a primary burial which was exhumed to be reburied in a "proper" village cemetery, is also possible.

At first glance this may seem unlikely. An examination of the literature, ethnographic and otherwise, however, lends considerable credibility to this possibility.

Kroeber states categorically that "The Chumash, alone among their neighbors, buried the dead" (1925:556). All early explorers, from Cabrillo through Father Font (with the second Anza expedition of 1775/1776), Lt. Fages (with the Portola expedition of 1770/1771) and naturalist Longinos Martinez (during his journey of 1792) commented on the size and structural segregation of Chumash village cemeteries. John P. Harrington tells us that "the Chumash liked to be buried next to their ancestors" and that "Chumash families were often buried in plots based on hereditary ties" (as cited by L. King 1969:49). Some burial ceremonies are reported in detail by the early explorers. Not only does this indicate much ritual at the time of burial, but additional ceremonies for former chiefs or other important persons were observed in an anniversary mourning ritual (Kroeber 1925:567; cf. Harrington as cited by L. King 1969:52). Approximately every three years a major mourning ceremony was held in the fall (Hudson and Underhay 1978:46; Harrington 1942).

The Chumash also had developed remarkable gravemarkers. Longinos Martinez reported in 1792:

Next to the village they have a cemetery, in which all those who die in the rancheria are buried. Above each grave they place a board, some 3 varas long and one-half a vara wide, painted in black and white squares and triangles, which is sunk into it and a pole 3 or 4 times as long as the board, also painted with the same colors, at the end of which they usually place trophies. If the man was a fisherman, they place hooks and lines; if a hunter, deer antlers, bow and arrows, etc. They also put on the grave the rib of a whale, in the form of a bow the length of the grave. The whole cemetery is enclosed by a stockade (1938:41-42).
The Chumash were no savages who disposed of their dead without proper respect. They marked their graves, danced in commemorative ceremonies, and maintained their cemeteries well.

The practice of reburial has been repeatedly identified. Campbell Grant in his chapter on Eastern Chumash in the *Handbook of North American Indians* refers to it specifically (Grant 1978:512), even if without documentation or reasons. The most important reference, however, is in the careful study Linda King has made of the Medea Creek cemetery. She wrote:

Disarticulated bones have long been noted as a distinct feature of Chumash cemeteries (Orr 1943:21). The explanation offered has been that the Chumash practiced burial of many bodies in a small area, with the result that older bodies were cut through and then re-deposited in the same grave. At Medea this explanation sufficed for most, but not all of the groups of disarticulated bones in the cemetery. Although disintegration and rodent disturbance confused the pattern, it is felt that at Medea the disarticulated were sometimes the result of other activities, such as: bundle burial of bones, cleaned elsewhere; exhumation of bodies and their removal to reburial areas; or reexposure and rearrangement of the bones (1969:30).

To find only two human bones at VEN-268 was not an exceptional occurrence, even if not completely routine. At VEN-294 a few disarticulated bones and fragments were found under a bed of large unmodified stream cobbles. These quite possibly were the remains of a removed primary burial. VEN-294 is a much larger site than VEN-268, but it should also be noted that prior to our most recent excavation there, four regular flexed burials were found in the same general area as the disarticulated bones. At VEN-39, a site not far from VEN-294, but high up on the mountain, only one child's (or infant) burial was found. While records are presently unavailable, memory of several participants in the 1967 excavation suggests that this burial was disarticulated, and that an abalone shell was found in association with it (Michael Glassow and Ernestine Elster, personal communication).

At a number of hamlet-sized sites in the same Conejo watershed no burials at all were encountered. This includes excavations at VEN-125 (in the Oak Park area), VEN-607, 608, 609, 610; the latter two are rockshelters, against the wall of the Sini Hills. No burials were found at VEN-271 in the Thousand Oaks area. Further west on the flank of the Santa Monicas at VEN-535, 536, and 537, no human bones or burials were found. While this is also true of VEN-65, located nearby, this latter site has been identified as a Millingstone horizon site and for that reason is not comparable to the other Late Chumash occupation sites.

In our time frame are sites such as VEN-261, VEN-122, and VEN-606, where burials were found. Only one was located at each of the first two, but the latter contained twelve. Interestingly enough, at VEN-606, one disarticulated partial child's burial was found which contained shell-inlaid flutes and beads. It could easily be that in this child's burial we have a reburial at a "family" burial plot; while the body was incomplete, the grave offerings indicate a ritual context. It thus appears that at VEN-606 we have found a "proper" cemetery.

From a perspective of four years of consistent and active participation in a large number of Inland Chumash excavations and surveys, David Whitley states categorically "that during the Late period small villages did not contain burial grounds" (1979:128).
It can be assumed that the original political and social organization of the Chumash developed in the coastal villages, which due to the easy acquisition of subsistence became large, and in fact, became the most complex sedentary settlement of any recorded hunting and gathering society. When, presumably, population pressure brought about permanent inland area occupation, a number of adaptations became necessary, including greater dispersal of subsistence acquisition. Accordingly, mortuary practices may have required adjustment.

The warmer temperatures in the inland areas may have necessitated immediate burial of persons who died in outlying hamlets in a temporary tomb (primary burial), while reburial at a more convenient and possibly ritually determined time would take place at the cemetery of a larger village with which the hamlet was connected. The existence of such larger cemeteries at major village sites is ethnographically known and has been archaeologically verified.

If the hypothesized attachment of the dispersed sites in the politico-religious organization of the Chumash to the nearest larger village included use of an area cemetery in its hierarchical manifestations, such a fact would be of major importance. If such reburial practice could be firmly established by further verification in future excavations, it would certainly tend to verify the politico-religious stratification of late inland Chumash society and tend to confirm the model constructed by Whitely and Clewlow (1979). Finding unusual numbers of disarticulated burials at large cemeteries, such as Medea, could then be, at least partially, explained. Accidentally missing two bones at VEN-260, or a few small ones at VEN-294 during exhumation for reburial would be equally explained, as this could easily happen.

The purpose of this paper will have been fulfilled if those who work in the Inland Chumash area will look for evidence (positive or negative) of possible reburial practices, with the removal of bodies from the small hamlets to larger and more established village cemeteries.

This paper was initially presented at the Second Annual Inland Chumash Research Symposium, held at Santa Barbara on September 8, 1979.

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A PROJECTILE POINT TYPOLOGY

FOR THE WILAMETTE VALLEY, OREGON

by John R. White
INTRODUCTION

In time it usually becomes necessary, or at least advantageous, to establish, to the extent possible, uniform and workable regional projectile point typologies. Communication alone is a justifiable enough reason for this. This typology was devised originally in order to handle the projectile points from the Hurd site, OR-LA-44 (White 1975a), however, increased archaeological work carried out in the greater Willamette Valley of Oregon in the last several years and the associated, highly individualistic approaches adopted in describing the recovered artifacts, particularly the important and diagnostic projectile points, are also in good part responsible for its devisal.

Ideally a point typology (or any typology for that matter) should be inclusive enough to adequately describe the range of variation and at the same time be of manageable size. Too much "lumping" may blur meaningful variation, while too much "splitting" may create differences of little usefulness. The two considerations must be taken together, or, as so often happens, the resultant classification may contain so many types that it is imponderable. Cordell (1967) described 30 common and 11 unique types for the Lingo site (OR-LA-23). Miller (1970) reanalysed the points from the Lingo site, combined them with those from the two Benjamin sites (OR-LA-41 and OR-LA-42), and came up with 32 types and several subtypes.

In constructing a comprehensive point typology for the Willamette Valley, I was guided by these forementioned considerations and by the requirement that the typology be inclusive of data already gathered and yet flexible enough to incorporate any new finds. An attempt was made to combine the virtues of both "lumping" and "splitting" by structuring the framework in terms of types, subtypes, and varieties. The types were determined on the basis of size, outline, and hafting configuration. Significant differences in one aspect led to the creation of a subtype. Minor differences were considered as defining varieties of a type and given no special designation.

This typology is primarily based on the examination of the projectile points recovered from the Hurd (OR-LA-44), Benjamin (OR-LA-41 and OR-LA-42), Lingo (OR-LA-29), Fuller, and Panning sites. Published or available data from the Simrock (OR-LIN-21), Kropf (OR-LIN-22), Scoggins Creek (OR-WN-4), Fall Creek (OR-LA-31, OR-LA-33, OR-LA-34, and OR-LA-36), Spurland, Halsey, Tangent, Shedd, Perkin's Peninsula, Franklin, and Alvadore sites were also taken into account. Subsequent to the initial creation of this typology, several site collections were made, two of which, the Simons (OR-LA-116) and Siuslaw Falls (OR-LA-173) sites had their point inventories described in terms of this typology (Pettigrew 1975). Point collections from the Lynch (OR-LIN-36), Davidson (OR-LIN-34), Indian Ridge (OR-LA-194), and Baby Rock Shelter (OR-LA-53) sites were each classified in a different manner by their respective investigators—the Lynch site was actually described in two different ways by two different researchers—and are herein fitted into the proposed typology.

Table 1, following the type descriptions, is included as an aid in correlating this typology with several previously constructed typologies. While in most cases previous types could be absorbed directly into the new system, in a few cases it was necessary to split a previous type into two or more, and on other occasions to merge several types into one.
THE WILIAMETTE VALLEY POINT TYPES

Type 1

Description: Small, thin, unstemmed points. Triangular to sub-triangular in outline. The sides range from straight to slightly convex.

Subtypes: a, convex; b, straight; and c, concave bases.

Varieties: Two varieties appear to be present; one is very small, the other appreciably larger (although still relatively small).

Length: $R = 0.90-2.30 \text{ cm.} \ \bar{x} = 1.48 \text{ cm.}$

Width: $R = 0.60-1.50 \text{ cm.} \ \bar{x} = 0.91 \text{ cm.}$

Thickness: $R = 0.10-0.50 \text{ cm.} \ \bar{x} = 0.22 \text{ cm.}$

Occurrence: Located generally in the upper levels at the Lingo and Benjamin sites. At the Hurd site, 70% occur in the top half of the deposit (White 1975a:172, Table 2).

Remarks: Here, as in all other types (except Type 2), serration was not considered as a taxonomic criterion as it was occasionally present in all types and was apparently independent of form.

Previous Types or Classes Absorbed: Types I, II, IIIa, IIIb (Miller 1970:53-54); Type 13 (Woodward, Murdy, and Young 1975:382, Figure 2a); Types 19, 20, and 21 (Murdy and Wentz 1975: 359, Figure 2i, j, and k); Form Class 13y and 13z (Davis 1970:20); Type NBb (Collins 1951:Figure 1); Davidson site Form Classes 13, 19, 20, 22, and 24 (Davis, Aikens, and Henrickson 1973:Figure 11); Lynch site Form Classes 19a, 19b, and 20 (Davis, Aikens, and Henrickson 1973:Figure 15); Types 6 and 7 (Sanford 1975:259, Figure 8t-bb); "Cottonwood Triangular" (Olsen 1975:478, Figure 5j).

Type 2

Description: Medium to small points, the sides of which are deeply serrated or notched.

Subtypes: a, straight-stemmed; b, stemless.

Length: $R = 1.30-2.30 \text{ cm.} \ \bar{x} = 1.65 \text{ cm.}$

Width: $R = 0.80-1.65 \text{ cm.} \ \bar{x} = 1.02 \text{ cm.}$

Thickness: $R = 0.20-0.30 \text{ cm.} \ \bar{x} = 0.24 \text{ cm.}$

Occurrence: Type 2a is found in the upper third of the deposits at the Benjamin and Lingo sites. At the Hurd site, 74% of Type 2a specimens are found in the top half of the deposit. Type 2b is not found at these sites, but occurs with some frequency on the surface of certain Pleasant Hills area sites.

Remarks: The serration of these points is inordinately deep.

Previous Types or Classes Absorbed: Type IIIc (Miller 1970:54); Form Classes 12w and 12x (Davis 1970:20); Davidson site Form Class 2 (Davis, Aikens, and Henrickson 1973:Figure 11); Lynch site Form Class 16c (Davis, Aikens, and Henrickson 1973:Figure 15); Type 16 (Sanford 1975:261, Figure 10f-h).
Description: Medium to thick points with straight to slightly convex sides, straight shoulders and wide expanding stems.

Subtypes: a, broad; b, narrow.

Length: Subtype a: $R = 2.50 - 3.40$ cm. $X = 3.02$ cm.
Subtype b: $R = 2.30 - 3.10$ cm. $X = 2.83$ cm.

Width: Subtype a: $R = 1.90 - 2.30$ cm. $X = 2.14$ cm.
Subtype b: $R = 1.10 - 1.70$ cm. $X = 1.40$ cm.

Thickness: $R = 0.46 - 0.80$ cm. $X = 0.56$ cm.

Occurrence: Found uniformly distributed throughout the deposit at the Benjamin, Lingo, and Hurd sites.

Remarks: These points appear to be more common in Valley Edge and Narrow Valley Plain sites than in Primary Flood Plain and Riparian sites (White 1975b:48, Table 2).

Previous Types or Classes Absorbed: Types XVII, XXII, XXVII (Miller 1970:57-58); Type 2 (Murdy and Wentz 1975:353, Figure 1c); Form Class 3g and 3h (Davis 1970: 15-16); Lynch site Form Class 6c (Davis, Aikens, and Henrickson 1973:Figure 15); "Side-Notched" (Olsen 1975:477, Figure 5d).

**Type 4**

Description: Medium-thick to thick, leaf-shaped bipoins.

Subtypes: a, true bipoins; b, more rounded base.

Length: $R = 2.10 - 5.30$ cm. $X = 3.16$ cm.

Width: $R = 1.00 - 1.70$ cm. $X = 1.36$ cm.

Thickness: $R = 0.50 - 0.75$ cm. $X = 0.63$ cm.

Occurrence: Type 4a is found in the top third of the deposits at the Lingo, Benjamin, and Hurd sites. All four specimens from Hurd came from the top half of the deposit. Ninety percent of Type 4b points are found in the bottom half of the deposit at these sites.

Remarks: This type is referred to elsewhere as the Cascade type (Newman 1966:11-14).

Previous Types or Classes Absorbed: Types V, VI, VII, and VIII (Miller 1970:54-55); Perforator Type 2 (Woodward, Murdy, and Young 1975:388, Figure 3b); Form Class 1a and 1b (Davis 1970: 14-15); Types NAb and NAb$_2$ (Collins 1951:Figure 1); Davidson site Form Classes 1 and 3 (Davis, Aikens and Henrickson 1973:Figure 11); Lynch site Form Class 13 (Davis, Aikens, and Henrickson 1973:Figure 15); Type 9 (Sanford 1975:259, Figure 9 a-3); Type V (Henn 1975:461, Figure 4f).

**Type 5**

Description: Medium to thick points with convex sides, rounded shoulders, and a relatively broad contracting stem.

Subtypes: a, broad; b, narrow.

Length: $R = 2.10 - 3.70$ cm. $X = 3.01$ cm.

Width: Subtype a: $R = 1.25 - 1.75$ cm. $X = 1.45$ cm. Subtype b: $R = 1.10 - 1.30$ cm. $X = 1.17$ cm.

Thickness: $R = 0.28 - 0.90$ cm. $X = 0.46$ cm.

Occurrence: Relatively uniform vertical distribution from top to bottom of the
Lingo, Benjamin, and Hurd sites. A low frequency point type in Primary Flood Plain sites and Riparian sites, and much more common in Narrow Valley Plain and Valley Edge sites.

Previous Types or Classes Absorbed: Types XXVI, XXVIII and XXIX (Miller 1970:59-60); Type 1lb (Woodward, Murdy, and Young 1975:381, Figure 1L); Form Class lc and ld (Davis 1970:15-19); Davidson site Form Classes 15 and 25 (Davis, Aikens, and Henrickson 1973:Figure 11); Lynch site Form Class 21 (Davis, Aikens, and Henrickson 1973:Figure 15).

Type 6

Description: Medium-thick to thick leaf-shaped points with wide convex base.
Subtypes: None at present.
Length: R = 2.10-4.25 cm. X = 3.59 cm.
Width: R = 1.65-2.30 cm. X = 1.99 cm.
Thickness: R = 0.50-1.10 cm. X = 0.72 cm.
Occurrence: Uniform vertical distribution from top to bottom at Lingo and Benjamin sites. The three specimens from the Hurd site were all in the top one-fourth of the deposit. Type 6 appears to be rare in Willamette Valley sites; only eleven have been reported to date.

Previous Types or Classes Absorbed: Type IV (Miller 1970:54); Type I (Henn 1975:459, Figure 4a, b).

Type 7

Description: Medium length, thin to medium-thick points, slightly concave to convex sides, with corner notching and expanding stem.
Subtypes: a, triangular; b, spade-shaped.
Varieties: Type 7a points range from short and broad to long and narrow.
Length: Subtype a: R = 1.10-3.00 cm. X = 2.06 cm.
Subtype b: R = 1.40-1.79 cm. X = 1.63 cm.
Width: Subtype a: R = 0.80-2.00 cm. X = 1.45 cm.
Subtype b: R = 1.00-1.70 cm. X = 1.37 cm.
Thickness: R = 0.20-0.50 cm. X = 0.31 cm.
Occurrence: Located in the top third of the deposit at the Lingo and Benjamin sites. At the Hurd site it has a uniform vertical distribution from 0 to 60 cm. Type 7a constitutes the predominant point type at the Hurd site.

Previous Types or Classes Absorbed: Type XIV (Miller 1970:57); Types 1 and 2 (Woodward, Murdy, and Young 1975:379, Figure 1a, b and c); Types 1 and 9 (Murdy and Wentz 1975:351, 353, 354, Figure 1a, b, and k); Form Classes 6k, 6L, 6m and 7n (Davis 1970:17-18); Type Sb3 (Collins 1951:Figure 1); Davidson site Form Classes 9 and 16 (Davis, Aikens, and Henrickson 1973:Figure 11); Lynch site Form Classes 6a, 7a, 7b, 16a, and 16b (Davis, Aikens and Henrickson 1973:Figure 15); Types 3 and 4 (Sanford 1975:256, Figure 7v-hh, Figure 8a-p).
Type 8

Description: Thin triangular points, slightly concave to convex sites, corner-notched with a contracting stem.

Subtypes: a, normal stem length; b, stems of exceptional length.

Length: $R = 1.20-3.40$ cm. $X = 1.99$ cm.

Width: $R = 0.95-1.95$ cm. $X = 1.41$ cm.

Thickness: $R = 0.16-1.53$ cm. $X = 0.31$ cm.

Occurrence: This type constitutes the dominant type at the Benjamin sites, where it occurs most frequently in the upper third of the deposits. It constitutes the second most plentiful type after type 7a at the Hurd site, where 75% of the specimens occur in the top half of the deposit.

Previous Types or Classes Absorbed: Types XIII and XX (Miller 1970:57-58); Types 8 and 9 (Woodward, Murdy, and Young 1975:381, figure li, j); Types 5, 11, 12, and 13a (Murdy and Wentz 1975:353, 357, Figure lg, m, Figure 2a, b); Davidson site Form Classes 10, 14, and 26 (Davis, Aikens, and Henrickson 1973:Figure 11); Lynch site Form Classes 10b, 14, 15b, and 17 (Davis, Aikens, and Henrickson 1973 Figure 15); Types 1, 5, 12, and 14 (Sanford 1975:256, 260, Figure 7a-g, i-k, Figure 9q-s, Figure 9p-s, bb-ee); "Corner-Notched" (Olsen 1975:477, Figure 5c).

Type 9

Description: Thin to medium-thick spade-shaped points, relatively short and broad, with basal-notching and short contracting stem.

Subtypes: None at present.

Varieties: Point tip ranges from relatively sharp to rounded.

Length: $R = 1.20-2.10$ cm. $X = 1.79$ cm.

Width: $R = 0.80-1.80$ cm. $X = 1.55$ cm.

Thickness: $R = 0.14-0.42$ cm. $X = 0.32$ cm.

Occurrence: Associated with upper third of the deposit at the Lingo and Benjamin sites. Six of the eight specimens from the Hurd site were found in the top half of the deposit.

Previous Types or Classes Absorbed: Type XVI (Miller 1970:57); Type 14 (Murdy and Wentz 1975:358, Figure 2d); Form Class 9p (Davis 1970:18); Lynch site Form Class 9 (Davis, Aikens, and Henrickson 1973:Figure 15); Type 1 (Sanford 1975:256, Figure 7h).

Type 10

Description: Thin to medium-thick triangular points, with straight to slightly convex sides, basal-notching and straight stem.

Subtypes: None at present.

Length: $R = 1.20-3.00$ cm. $X = 1.89$ cm.

Width: $R = 1.20-1.90$ cm. $X = 1.43$ cm.

Thickness: $R = 0.20-0.50$ cm. $X = 0.31$ cm.

Occurrence: Found in the upper third of the deposit at the Lingo and Benjamin sites. At the Hurd site, 68% were in the upper half of the deposit. Specimens of this type from the Panning Mound tend to be larger than those from other valley sites (average length 2.51 cm).
Previous Types or Classes Absorbed: Types XI, XV, and XVIII (Miller 1970:56-58); Type 6 (Murdy and Wentz 1975:354, Figure 1h); Form Class 8o (Davis 1970:18);
Type SBB (Collins 1951:Figure 1); Davidson site Form Classes 6, 8b, and 11 (Davis, Aikens, and Henrickson 1873:Figure 11); Lynch site Form Classes 5, 8a, 8b, and 11
(Davis, Aikens, and Henrickson 1973:Figure 15); Types 11 and 13 (Sanford 1975:260, Figure 9j-o, t-aa).

Type 11

Description: Thin triangular points with straight sides, corner-removed, with straight or contracting stem.
Subtypes: a, short and broad; b, long and narrow.
Length: Subtype a: \( R = 1.20-2.00 \) cm. \( X = 1.63 \) cm.
Subtype b: \( R = 1.70-2.90 \) cm. \( X = 2.03 \) cm.
Width: Subtype a: \( R = 1.00-1.40 \) cm. \( X = 1.20 \) cm.
Subtype b: \( R = 0.70-1.20 \) cm. \( X = 0.91 \) cm.
Thickness: \( R = 0.16-0.44 \) cm. \( X = 0.28 \) cm.
Occurrence: Not found at the Lingo site. Type 11a is located in the uppermost part of the deposit at Benjamin Site No. 1. A uniform vertical distribution of type 11a and 11b points occurs at the Hurd site.

Previous Types or Classes Absorbed: Types XXI, XXX, and XXXII (Miller 1970:58-60); Types 3, 4, 5, 7, 10, and 11a (Woodward, Murdy, and Young 1975:380, 381, Figure ld-f, h, k, and l); Types 3, 4, 10 and 13b (Murdy and Wentz 1975:353, 357, Figure ld, e, 1, Figure 2c); Form Classes 5j and 11v (Davis 1970:17-19); Davidson Form Classes 5, 12, and 17 (Davis, Aikens, and Henrickson 1973:Figure 11); Lynch site Form Classes 6b and 15a (Davis, Aikens, and Henrickson 1973:Figure 15); Types 2 and 15 (Sanford 1975:256, 261, Figure 71-u, Figure 10a-e); "Corner-Notched" (Olsen 1975:477, Figure 5b).

Type 12

Description: Large, thick points, straight to slightly convex sides, straight shoulders and straight or rectangular stem.
Subtypes: None at present.
Length: \( R = 3.20-5.20 \) cm. \( X = 4.13 \) cm.
Width: \( R = 1.60-2.50 \) cm. \( X = 1.84 \) cm.
Thickness: \( R = 0.50-0.76 \) cm. \( X = 0.62 \) cm.
Occurrence: A rare point type; none at the Lingo or Hurd sites, one at each of the two Benjamin sites, where they occur in the bottom half of the deposits.
Remarks: In some cases the shoulders may be slightly rounded.

Previous Types or Classes Absorbed: Types XII and XIX (Miller 1970:56-58); Types 7 and 8 (Murdy and Wentz 1975:354, Figure 1i, j); Form Class 4i (Davis 1970:16); Davidson site Form Class 4 (Davis, Aikens, and Henrickson 1973:Figure 11).

Type 13

Description: Large, thick points with straight to slightly convex sides, side-notched with broad, thick, expanding stem.
Subtypes: None at present.
Length: \( R = 3.20-5.40 \text{ cm.} \) \( X = 4.47 \text{ cm.} \)
Width: \( R = 1.70-2.40 \text{ cm.} \) \( X = 2.08 \text{ cm.} \)
Thickness: \( R = 0.70-0.90 \text{ cm.} \) \( X = 0.78 \text{ cm.} \)

**Occurrence:** A rare point type in valley plain sites. The single specimen from the Hurd site was a surface find. This type occurs in surface finds in upper valley sites.

**Remarks:** One specimen from one of the Benjamin sites (OR-LA-41) measures 7.30 cm in length, and may represent an aberrant form.

**Previous Types or Classes Absorbed:**
- Type XXIII (Miller 1970:58);
- Type 17 (Murdy and Wentz 1975:358, Figure 2g); "Unique" (Sanford 1975:262, Figure 10g); Type III (Henn 1975:461, Figure 4d); "Corner-Notched" or "Side-Notched" (Olsen 1975:477, figure 5a, f).

**Type 14**

**Description:** Thick side-notched points with convex sides and convex base.

**Subtypes:** a, Short and broad; b, long and narrow.

Length: Subtype a: \( R = 1.80-3.40 \text{ cm.} \) \( X = 2.81 \text{ cm.} \)
Subtype b: \( R = 2.95-4.20 \text{ cm.} \) \( X = 3.39 \text{ cm.} \)

Width: Subtype a: \( R = 1.00-1.80 \text{ cm.} \) \( X = 1.49 \text{ cm.} \)
Subtype b: \( R = 0.90-1.45 \text{ cm.} \) \( X = 1.15 \text{ cm.} \)

Thickness: \( R = 0.20-0.80 \text{ cm.} \) \( X = 0.53 \text{ cm.} \)

**Occurrence:** Rare at the Hurd site; one specimen (type 14a) was found in a firepit which originated in the top half of the deposit at a depth of 43 cm. Several were found on the surface of upper valley sites.

**Previous Types or Classes Absorbed:** Types XXV and XXVI (Miller 1970:59); type 12 (Woodward, Murdy, and Young 1975:382, Figure 1n); Types 15 and 16 (Murdy and Wentz 1975:358, Figure 2e, f); Form Classes 2e and 2f (Davis 1970:15-16); Davidson site Form Class 18 (Davis, Aikens, and Henrickson 1973:Figure 11); Lynch site Form Class 1 (Davis, Aikens, and Henrickson 1973:Figure 15); Type 17 (Sanford 1975:261, Figure i-k).

**Type 15**

**Description:** Medium to thick, short, broad, straight-sided, diamond-shaped point with broad contracting stem.

**Subtypes:** None at present.

Length: \( R = 2.00-2.50 \text{ cm.} \) \( X = 2.29 \text{ cm.} \)
Width: \( R = 1.30-1.70 \text{ cm.} \) \( X = 1.49 \text{ cm.} \)

Thickness: \( R = 0.30-0.70 \text{ cm.} \) \( X = 0.51 \text{ cm.} \)

**Occurrence:** Not found at the Lingo, Benjamin, or Hurd sites. Rare at other sites in the valley. Seven found at the Fuller Mound.

**Previous Types or Classes Absorbed:** Type 6 (Woodward, Murdy, and Young 1975:380, Figure 1g); Type 5Aa (Collins 1951:Figure 1); Davidson site Form Class 23 (Davis, Aikens, and Henrickson 1973:Figure 11).

**Type 16**

**Description:** Small, thin, side-notched triangular point with concave base.

**Subtypes:** None at present.
Length:  \( R = 1.30-2.20 \text{ cm.} \quad X = 1.70 \text{ cm.} \)

Width:  \( R = 1.10-1.60 \text{ cm.} \quad X = 1.24 \text{ cm.} \)

Thickness:  \( R = 0.20-0.40 \text{ cm.} \quad X = 0.25 \text{ cm.} \)

Occurrence: Found in the upper levels of valley sites where it occurs only rarely. Not found at the Lingo or Hurd sites. Several specimens observed from surface collections taken in the extreme upper valley.


Previous Types or Classes Absorbed: Type XXXI (Miller 1970:60); Type 12 (Woodward, Murdy, and Young 1975:382, Figure 1n); Lynch site Form Class 22 (Davis, Aikens, and Henrickson 1973:Figure 15); Type 8 (Sanford 1975:259, Figure 8cc-ee); "Desert Side-Notched" (Olsen 1975:478, Figure 5g, h, and i).

This typology, once devised, was very helpful in establishing the chronological periods in Upper Willamette prehistory. Typological comparisons between the various sites were facilitated and ultimately, when the periods were established, it could be readily seen that various point types tended to be associated with certain time frames. Period II (6000-4000 B.C.) contained only point types 4a and 4b (Cascade bipoints); Period III (4000-250 B.C.) contained the larger, thick points, e.g. types 3a, 12, 13, 14a, and 14b (often found at sites of this period in conjunction with types 4a and 4b); and Period IV (250 B.C.-A.D. 1700) preponderated in small stemmed point types (e.g. types 2a, 5a, 7a, 7b, 8a, 8b, 9, 10, 11a, 11b, 15, and 16, and unstemmed types 1a, 1b, 1c, and 2b (White 1979:556-568). The point typology argued for herein would therefore seem to have chronological as well as taxonomic relevance.

It is fully expected that as archaeological work continues to expand in the Willamette Valley that projectile points will be recovered that fail to conform to the precise dimensional or conformational limits set forth here. Many (most?) of the anomalies of this kind can be easily handled by the establishment of subtypical or varietal categories. On those occasions (probably rare) when the morphology is such that it resists placement in any of the existing typical, subtypical, or varietal categories, a new type may have to be established. The above typology is flexible enough to minimize, but at the same time to accept, such an eventuality.

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INDIAN, SEA OTTER, AND SHELLFISH INTERRELATIONSHIPS

by Betty S. Davis
Evidence from fur trade records and from present sea otter densities in nearshore waters of central California indicates that the southern sea otter, *Enhydra lutris nereis*, once numbered many thousands along the coast of the contiguous United States, from the Strait of Juan de Fuca southward to Morro Hermoso, Baja California, with over 16,000 sea otters estimated in California waters alone.

Ogden, utilizing fur trade records, recognized two major discontinuous zones in the distribution of the southern sea otter—one between the Strait of Juan de Fuca and the northern California coast at Trinidad Bay, and the other between south Los Angeles County and Baja California (Ogden 1941). Both ethnological and archaeological evidence support Ogden's proposed northern gap in sea otter distribution (Kroeber and Barrett 1960). Ethnography and archaeology for southern California Indians south of Malibu Point, however, provide both positive and negative evidence of the proposed southern discontinuity in sea otter distribution. While several sources report that sea otter pelts were highly prized by the aboriginal population of the area, and were used for barter in the late 18th century, only two of many published archaeological reports from the area mention the presence of sea otter remains (Winterborne 1969 and Walker 1952). Thus, archaeological data from southern California support Ogden's conclusions while ethnological data do not (Woodhouse et al. 1977).

The prehistoric situation, in which large numbers of sea otters foraged for shellfish in pristine intertidal and subtidal coastal waters from Washington to Baja California over a period of perhaps several million years, is in stark contrast to the present situation where fewer than 2,000 otters forage along less than 200 miles of central California coastline—a 10% segment of their former range which is now shared with many more shellfishermen than in their days of coexistence with coastal Indians.

Because of the returning sea otter's appetite for certain shellfish resources prized by modern man as gourmet items, and because of the otter's gradual entry over the last decade into already heavily impacted and declining human shellfisheries (abalone and Pismo clam), managed by the California Department of Fish and Game for burgeoning numbers of sport and commercial fishermen, a conflict has arisen as the otters have added to the impact on these fisheries. The fishermen want to have California sea otters restricted to a limited segment of central California coast in order to reserve remaining shellfisheries outside the otters' present range for human purposes. The California Department of Fish and Game (CDFG) supports the fishermen's viewpoint, concluding that:

It's clear that within the sea otter's stabilized foraging range there can be virtually no human harvest of abalones, *Haliotis* spp. (except for a few taken intertidally); red crab, *Cancer productus*; rock crab, *Cancer antennarius*; sea urchins: *Strongylocentrotus franciscanus* and *S. purpuratus*; and Pismo clam, *Tivela stultorum* (Miller 1974).

In apparent contradiction to the foregoing contention is the extensive evidence from California coastal middens which indicates a considerable human harvest of shellfish by Indians in earlier times, when there were many more otters.
foraging for shellfish in California nearshore waters. However, the CDFG dis-
counts the latter midden evidence as follows:

One of the more interesting aspects of sea otter interactions is
the theoretical relationship between Indians, sea otter, and the
invertebrates utilized by both. We know that sea otters were har-
vested by California Indians for food and furs, but the sea otter
was never very important to the natives (Amoss 1972). We also know
that abalones were quite important to the California Indians (Cox
1962) and large numbers of abalone shells occur in coastal Indian
middens.

The large number of abalone shells in Indian middens does not
necessarily indicate there were dense populations of exposed
abalones in aboriginal times. A few abalones taken by each of
several Indians during low tide at a rate now being harvested by
shorepickers in the sea otter's range can yield a respectable
pile of abalone shells over several generations.

Abalones are transported by the force of large storm swells
from the subtidal zone into and occasionally above the intertidal
zone. This source of abalones could account for many large shells
found in Indian middens (Miller 1974).

In a later, more detailed refinement of the latter hypothesis the CDFG
(1976) has stated:

There has been much speculation of the significance of the
large numbers of shellfish remains in middens along the California
coast resulting in various theories concerning the interactions be-
tween man and sea otters existing before the arrival of techno-
logical man...In areas where there are numerous interstices into
which sea otters cannot reach, there is still small take of red and
black abalones during low tides, and Indians could have harvested
a steady supply of abalones from these crevices. Mussels are also
available in the crevices as well as in the upper splash zone in
rugged areas where sea otters have difficulty foraging at high
tide. Also, some shellfish could have been tossed into the inter-
tidal zone by large storm swells as was witnessed in 1960 in central
and northern California. Indian middens on the offshore islands of
southern California are rich in large abalone shells and other shell-
fish remains but without careful study of the numbers of shells pre-
sent within a definite time period, conclusions are limited...there
may have been an occasional harvest of sea otters by insular in-
habitants resulting in periods of shellfish abundance since sea
otter bones have been found in insular middens (CDFG 1976).

The CDFG further suggests the "...possibility that aboriginal hunters
may have kept sea otter stocks below maximum population levels in at least some
areas" (CDFG 1976).

Considering Indians and Pismo clams, the CDFG (1976:Appendix D-1, p. 11)
states:
Pismo clams have been utilized in Monterey Bay by man for thousands of years; first by aboriginals who used them for food and shell disc beads. However, Pismo clam shell fragments are apparently scarce in Indian middens of the Monterey area and John Fitch (California Department of Fish and Game, personal communication) reports Pismo clam shells present in southern California middens, but the shells are mostly from small sized clams. Weymouth (1923) states "It may be of interest in passing to note that apparently the Indians did not use the Pismo clam to any great extent, as far as can be told from an examination of kitchen middens near Oceano. On one mound examined there were numbers of young Tivela but no adults; no young or adults were noted in any other mounds" (CDFG 1976).

In response to the speculations and explanations of the CDFG (Miller 1974) about the occurrence of shell material in coastal Indian middens--extensive deposits accumulated in the presence of many more thousands of sea otters and far fewer humans than are present along the California coast today--Dr. Sylvia Broadbent, Professor of Anthropology at the University of California at Riverside has commented:

The amount of abalone shell in Indian coastal middens from Humboldt to San Diego Counties is simply fantastic, and it is very difficult to see how it can be accounted for by collecting at the rate of modern shorepickers in or out of the sea otter's range, unless that rate is much more considerable than Fish and Game seems to imply. There are stretches of coastline where for literally miles there is nothing but solid sites, especially on the Monterey Peninsula and in the San Luis Obispo and Santa Barbara areas. Washed-up shells can't account for very much, and would show a seasonal variation (more large shells in winter months) for which there is absolutely no archaeological evidence. And this sort of thing can be established archaeologically. Moreover, the archaeological and ethnohistorical evidence makes it quite clear that by no means all the abalone shell removed from the Pacific stayed in the coastal middens; it was an important item of trade, distributed far and wide, into Arizona and New Mexico, at least as early as 500 A.D., and all over the Great Plains in protohistoric times. It was an important material for beads and pendants in the Early Horizon of the Sacramento-San Joaquin Delta area from about 1000 B.C. on (there, incidently, there was a change in preferences or availability from Haliotis cracherodii in the early period to H. rufescens by about 1000 A.D.).

It is hard to imagine that a population the size of the Indian one could have harvested as much as they did out of the present intertidal population of abalone. I doubt that they were doing very much deep diving for abalone; they certainly didn't have the equipment modern divers use, and one would expect the sources to make some fuss about it if they were doing a lot of deep diving without equipment, and the historical sources don't mention it. I think they must have been taking most of them from the intertidal zone. As far as I can see, this has to mean that there were a lot more abalones in the intertidal zone than there are now, in spite of uncontrolled and abundant sea otter populations. If there were more in the intertidal zone, I don't see why there
wouldn't also have been more in the subtidal zone too. It's hard to imagine the otters restricting themselves to below the tidal zone while the Indians harvested the intertidal zone. I've seen otters hunting in the intertidal water at high tide.

The argument that "within the sea otter's stabilized foraging range there can be virtually no human harvest of abalones... red crab... rock crab... sea urchins..." etc. is historically absurd. Before European-inspired cataclysmic hunting of the otters, there was considerable human harvest of all these and other intertidal animals. It is very clear that the Indians flourished, the otters flourished, and so did abalones, sea urchins, crabs, mussels, chitons, oysters, clams, and so on and so forth (Broadbent 1975).

If Indians were only harvesting abalones from the upper splash zone and areas of the intertidal within small crevices, as the CDFG theorizes, this would suggest that the numbers of larger abalones should be limited in the Indian middens. However, Rashkin (1972) states that the Indian middens of Monterey County contain abalones which "...often appear to have been in excess of 10 inches in diameter, definitely mature individuals." Further, such evidence from a series of recent excavations indicates that abalones far exceed any other shells in Monterey Bay area middens (Joseph Morris, personal communication). Abalones were so prominent that they were used for dating purposes. Over 3,500 years of abalone harvesting by Indians is evidenced through middens dated at 2110 B.C., 190 A.D., 1290 A.D., and 1520 A.D. During the latter excavations, archaeological features 6 meters long and 60 centimeters deep, composed of large, 10-12" abalone shells, were found packed so tightly a finger could not be inserted between shells—and included along with them were whale bone pry bars and pounding stones, indicating the abalones were picked or pried loose by Indians, not just washed ashore after large storms. Of course, many other large shells from the coast went inland along Indian trade routes.

From the Aleutian realm of the northern sea otter, Enhydra lutris lutris, however, comes recent evidence (Simenstad et al. 1978) that as a key predator the Aleut may have upset the natural system, involving sea otters, shellfish and other faunal elements, by controlling otter numbers and thus diminishing otter foraging impacts on sea urchin stocks used by these aboriginals for food. Earlier, Estes and Palmisano (1974) had noted in the course of ecological studies that at otter-occupied Aleutian Islands today, dense populations of northern sea otters limit kelp-grazing sea urchins to sparse populations of small-sized individuals and that this regulation of these grazers by otters helps to maintain robust kelp beds and a rich associated fauna of fish, birds, and marine mammals.

Examination of midden remains in the Aleutians suggests that aboriginal Aleuts locally disturbed the foregoing natural system, long maintained by sea otters, by overexploiting the otters—thus minimizing or eliminating their keystone regulatory role in the community and permitting sea urchins to flourish. In Aleut middens studied, the abundance of sea otter bones through the strata is directly related to the abundance of marine fish and seals and inversely related to the abundance of shellfish, such as sea urchins and limpets. The latter findings are consistent, then, with present day observations of biotic communities in the Aleutians at islands with and without sea otters. The regulatory role of the Aleuts in controlling otter numbers is thought to have been constant over relatively long periods of time because "...sea otter populations were seldom, if ever,
subject to disruptive disturbance from predation or climatic-geological catastrophes" (Simenstad et al. 1978).

In assessing the latter evidence from the Aleutians, and conclusions drawn from this evidence, questions have been raised as to whether enough consideration has been given to: a) possible effects on Aleutian marine flora and fauna of relatively slowly-occurring events like a constant rise in sea level since about 5000 B.C.; b) whether Aleut middens were known to be continuously occupied; c) whether the same number of Aleuts were living in the sites throughout history; and d) whether the Aleut could have seriously depleted (or eliminated) the large numbers of sea otters presumably occupying the area (Albert Elsasser, personal communication).

The foregoing background information and resume of contradictory viewpoints and evidence regarding the possible relationships and interactions of the Indians, sea otters, and shellfish lead to the following questions that the Friends of the Sea Otter would like to see answered.

**RESEARCH QUESTIONS**

1. Does the overall amount, range in size, and distribution through time (and seasonally) of shells deposited in coastal Indian middens along the Eastern Pacific shoreline from Washington to mid-Baja California support the contention that a) within the sea otter's stabilized foraging range there can be virtually no human harvest of abalones, clams, mussels, urchins, etc.--except at the low rate presently being harvested by shorepickers, intertidal gleaners, or from those being tossed up by storms; and b) that shells found in coastal Indian middens are generally medium-sized to small, reflecting perhaps that only a few large shellfish were available to Indians because of the foraging prowess of the sea otter?

2. Is there any archaeological evidence to suggest that more large abalone shells are found near the surface of middens, or were deposited in midden features during winter months (when storm-tossed shells from the subtidal might have been made available to Indians)?

3. Is there any archaeological evidence to suggest that in some areas there may have been periods of localized overexploitation of shellfish by coastal Indians? If so, can this be correlated with the population size and movements of local groups?

4. Does the amount and distribution of sea otter bones in coastal midden deposits indicate that the hunting of otters by Indians took a relatively minor toll and was limited to providing furs for tribal dignitaries (or occasionally for food) or does midden evidence indicate that hunting of otters was conducted intensively enough in certain areas to reduce or control sea otter numbers sufficiently to preserve shellfish stocks for aboriginal use?

5. Does the amount and distribution of sea otter bones from all known coastal middens from Washington to mid-Baja California suggest that there was once a relatively continuous and even distribution of sea otters along the coastline or that there were pronounced gaps in the distribution, or fewer otters, in certain areas (e.g., the Strait of Juan de Fuca to Trinidad Bay, northern California and from south Los Angeles county to Baja California).
INFORMATION NEEDED

1. A quantitative analysis of faunal collections from excavated midden sites, including the size distribution of intact shells and a correlation of faunal remains with a contemporaneous time scale (and season of deposition, if possible); such information to include:

   a) Measurements of age, thickness, and depth from the surface of any midden features containing abalone shells over 8" long; number of 8" or larger shells present and accompanying artifacts used to pry them up and process them; time period over which such abalone shell features were deposited; time period over which any gaps in the vertical distribution of abalone shell strata may have occurred.

   b) Age, estimation of quantity of crushed shells, and size distribution of intact Pismo clams in coastal middens along sandy beach areas from the northern end of Monterey Bay (or Half Moon Bay) to Morro Hermoso, Baja California.

   c) Age, size distribution, and quantity of mussels in middens south of the Strait of Juan de Fuca.

   d) Quantitative and qualitative osteological evidence of sea otter bones in middens, especially from sites north of Trinidad Bay and south of Los Angeles to Baja California, with an indication as to the correspondence in numbers of skulls, teeth, penis bones, and long bones present, so that total numbers of otters represented in midden remains can be reasonably estimated.

2. A compilation of all available ethnological evidence from Washington to mid-Baja California that indicates use of sea otters by coastal Indians and any peculiarities of tribal depositional behavior in certain coastal groups which might result in the absence of sea otter bones in the middens, though otters were known to have been taken by such groups.

3. An updated listing of all archaeological excavations made along the coast from Washington to mid-Baja California, including the present repositories of faunal collections from all sites, and the present locations and availability of all published or unpublished reports generated by such excavations.

4. An annotated map of the coast of the contiguous United States and Baja California indicating, where possible, estimated sizes of aboriginal tribes and periods of occupancy as they occurred along the west coast.

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HALCYON BAY, AN ANCIENT ESTUARY?

by Charles E. Dills
INTRODUCTION

Archaeological data can be a source of non-archaeological information. If good pollen records were kept in all excavations, a great deal could be learned about history of the flora, fauna and weather of an area. In this paper I will try to show that archaeological data can be used to suggest the existence of an ancient bay.

The San Luis Obispo County Archaeological Society maintains maps and records for the county and works under the Regional Office of the California Archaeological Site Survey. We are concerned with several problems, one of which is an attempt to determine the settlement patterns of this county which were used by the aboriginal population.

It is a bit early for results since we feel the county, with over 825 known sites, is only about 10-20% surveyed. While studying the USGS maps of the more well-surveyed parts of the county, an interesting correlation was observed. Of the approximately 50 sites located around the existing estuary of Morro Bay, only one is below the 40 foot contour line. Several more are as high as 100 feet. But even these are within several hundred yards of the bay. About 90% of the sites are along the 40 foot contour line. It seems to suggest that what is now at 40 feet used to be at water level.

As a test of this observation, five likely areas were chosen from the map. A two-hour survey resulted in the recording of three of these areas as sites, one as a possible site, and one not properly checked due to dense grass.

The success of this observation led to a study of other portions of the county. The town of Arroyo Grande is situated on a large sand rise at about 100 feet in elevation along the north bank of Arroyo Grande Creek. Los Berros Creek joins Arroyo Grande Creek shortly before they empty into the Pacific Ocean. They drain the area north and east of Arroyo Grande much as Chorro Creek drains the area east of Morro Bay.

Along the south bank of the creek is a flat area of truck farms and flower fields known as Cienega Valley. It is bordered on the east by the sudden bluffs of Nipomo Mesa, up to 200 feet in elevation. The pointed southern end of Morro Bay is known as Shark Inlet. The pointed southern end of Cienega Valley has a series of small lakes on the leeward side of the dunes: Pipeline, Celery, Hospital, Big Twin, Small Twin, Bolsa Chica, White, Mud, and Black Lakes. A canyon leads west from Black Lake up into the Mesa and may have been a source of water in past days, much as Los Osos Creek feeds Morro Bay from the southeast.

The sand dunes on the west are a constant threat to the lakes. These dunes show a general drifting to the southeast that will probably fill the lakes and reach the mesa after a long time. Big Pocket Lake is already gone. The dunes reach a maximum elevation of about 100 feet.

There are about 35 sites around Cienega Valley, but there are no known sites at present in Cienega Valley. About half of the sites follow the 40 foot contour. Another quarter of them follow Arroyo Grande and Los Berros Creeks. Most of the last quarter are within about 200 feet of the 40 foot contour. Those that are below 40 feet are on the windward side of the dunes, either north or south of the creek mouth. One site (CA-SLO-406) was the subject of a small salvage excavation which suggested a date of 1500-2500 B.P. (Tainter 1971).
Archaeological Site Locations Have Been Altered
Archaeological Site Locations Have Been Altered
If one emphasizes the 40 foot contour on the USGS quad map of the area, a remarkable similarity to Morro Bay appears. This is evident on the tracings of the sections of the Morro Bay South and Oceano quads. The site locations have been altered to protect their security, but their general location is close enough to give the proper picture. I believe the resemblance implies that Cienega Valley was an estuary less than 1,500 years ago, and quite possibly much more recently. I propose that this extinct estuary be called Halcyon Bay. I believe no aboriginal sites will be found within the area of the bay, but this does not relieve us of the responsibility of looking. Rather, it intensifies our need to search this area closely.

It is hoped that local geologists might become interested in this suggestion and look for geological clues to confirm or disprove the existence of "Halcyon Bay." I have no explanation for the significance of the 40 foot contour line other than it might represent the ancient water line. It may indicate that the level of the land has risen 10 or 20 feet, relative to the water level, over the past one or two millennia.

We should be alert for information such as this which may be of use in other fields. Pollen should give a great deal of information about past food resources, flora, fauna, and weather. To make such information useful and reliable, however, it should be gathered from the different sites with some kind of statistically-oriented uniformity. The San Luis Obispo County Archaeological Society has been attempting to unify the basic descriptive language for archaeological reports in this county. We would like to set up an excavation plan that is a statistical minimum to allow intersite correlations. It would be hoped that all excavations in this county would collect this minimum data as a part of their larger research designs. If this has been accomplished elsewhere, we would appreciate hearing how it was done.

REFERENCE

COCCIDIOIDOMYCOSIS
AN OCCUPATIONAL HAZARD FOR ARCHAEOLOGISTS

by John C. Loofbourow, M.D. and Demosthenes Pappagianis, M.D.

Revised 1980 by Demosthenes Pappagianis, M.D.

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AREAS IN WHICH COCCIDIOIDOMYCOSIS IS ENDEMIC

FIGURE 1. UNCERTAIN BOUNDARIES
DESCRIPTION OF THE DISEASE

Coccidioidomycosis, often called San Joaquin or Valley Fever, is an infection that usually begins in the lung, caused by the fungus (mold) Coccidioides immitis. The infectious organism which grows in the soil forms tiny spores which lodge and then grow in the finer bronchioles or alveoli of the lung. This organism is found where the climate is characterized by hot dry summers and mild winters with modest or little rainfall. While the name Valley Fever suggests usual presence of the organism at low elevations, the fungus exists and infections have been acquired at elevations as high as 3,200 feet (Inyokern, California).

In most cases the disease is mild and recovery occurs spontaneously. It may be so mild as to be undetected, but indicated by reaction to a skin test (see below). Occasionally it spreads (disseminates) from the lungs to other parts of the body leading to severe illness or death. At times it may yield chronic disease of the lung, often benign, sometimes severe.

The typical mild symptomatic case is like a chest cold with fever, chest pain, especially with deep breathing, cough, generalized aching, sore throat, and headaches. Pneumonia is often detected by chest X-ray. These complaints usually occur one to two weeks after exposure to the dust-borne fungus. Infrequently the illness does not become apparent until some months later, or an abnormality may be detected on a chest X-ray in the course of a routine physical examination.

In 5 to 10 percent of the cases, skin rashes occur. These vary from a measles-like rash to a series of tender, red itchy swellings on the shins, or patchy red itching areas on the upper body. Occasionally arthritis of the ankles, knees, hips or other joints occurs with the rash. Although these rashes are not usually serious, they provide a clue to the presence of Valley Fever.

The disease picture described above usually resolves by itself in one or two weeks. Care by a physician is important, first, to confirm the nature of the infection, and second, to discover complications or progression so that more aggressive treatment can be initiated when indicated. Among Blacks, Filipinos, and Asians, the risk of fatal disease is greater than among Caucasians.

Conversion of a skin test from negative (no significant reaction) to positive (5mm induration or more) and conversion of serologic tests from negative to positive confirm infection. In very mild cases the skin test conversion from negative to positive may be the only proof of infection. In more severe cases, conversion of the serologic tests provides further confirmation of disease. Subsequent blood tests also measure the degree and rapidity of recovery and are very helpful in determining progression of the disease or of relapse. Once an infected individual has recovered completely, reinfection from natural exposure is very rare. Indeed, recovery from infection provides resistance to reinfection—which is important in permitting archaeologists who have been previously infected to return to work in endemic areas.

ENDEMIC AREAS

Infection usually occurs in the dry seasons of the year and a high incidence may follow an especially wet rainy season. C. immitis occurs only within roughly defined geographic regions of the Western Hemisphere (California, Arizona, New Mexico, southern Nevada, southwestern Utah, southwestern Texas, northern
Mexico, including Baja California, Argentina, Paraguay, Columbia, Venezuela, Guatemala, Honduras and possibly Bolivia (Figure 1). Actual recovery of *C. immitis* from the soil has been achieved in many but not all of these areas. Within endemic areas *coccidioidomycosis* may occur in humans, dogs, cattle and other animals.

Drainage areas of the San Joaquin, Colorado, Salt and Rio Grande Rivers roughly define the known endemic regions of the Southwestern United States. Fiese (1958) has provided a map of endemic areas and additional details may be found in the proceedings of the Second and Third symposia on *coccidioidomycosis* (Ajello 1967, 1977). Unfortunately, the risk of infection at any one site is not predictable except in a general way. Infection appears to be most likely in certain "pockets," but the conditions which allow the growth of the fungus in the soil remain poorly defined. We do know that dispersion of dry soil and inhalation of spores are necessary for the usual pulmonary infection. (Infrequently infection has occurred through trauma to the skin.)

Because of these variables, an accurate description of endemic or high risk areas is not possible. It is recommended that archaeologists working in the above mentioned geographic regions in the dry season be aware of the possibility of contracting Valley Fever, even when their sites have not previously been proven to be infected. Figure 2 shows the general and the specific archaeological regions where *coccidioidomycosis* has been reported in California.

Areas of Northern California are now known to be endemic largely as a result of infections among archaeologists. The first of these occurred in 1968 among a crew excavating near Brooks, in Yolo County (Loofbourow, Pappagianis and Cooper 1969). During the summer of 1970 some 60 out of 100 students from New York developed Valley Fever after exposure at an excavation at Richardson Springs (Chico), in Butte County (Werner et al. 1970). The northernmost occurrence was at Mill Creek, Tehama County in 1972 (Werner and Pappagianis 1973).

Several other episodes of *coccidioidomycosis* among archaeological, anthropological and zoological groups in California have been reported in recent years (Huberty 1963, King 1968, Plunkett 1955, Plunkett and Swatek 1957, Schmidt and Howard 1968, Swatek 1967). Unfortunately, *coccidioidomycosis* among archaeologists usually has not been widely published or documented completely.

### THE YOLO COUNTY OUTBREAK

As an example of this illness in an archaeological crew, the Yolo County outbreak of 1968 is described briefly below. (See also Loofbourow, Pappagianis and Cooper 1968.)

An archaeological class from the University of California at Davis explored an Indian burial site near Brooks, California, in the period 16 June 1968 through 26 July 1968. On 9 July, a student member of the class reported pleuritic pain, fever, malaise and cough, and was found to have middle lobe pneumonia. *Coccidioidomycosis* was suspected on the basis of clinical manifestations and a positive skin test response to 1:10 coccidioidin. The entire archaeological group was then tested with 1:100 coccidioidin. Those who did not react to the first test were retested with a 1:10 dilution. Surveillance was maintained for the duration of the archaeology course, and, where possible, continued by mail with cooperating physicians thereafter. Eleven cases of clinically apparent *coccidioidomycosis* occurred among the group of 23 archaeology students. Eight of the cases were confirmed serologically and three by skin test conversion alone.
Four case descriptions may help to illustrate the typical mild infection.

Case 1.--A 21-year-old Caucasian man was first seen at the Student Health Center 9 July 1968 with a two-day history of cough with painful breathing, fever, chills, and malaise. He had had heavy exposure to dust in the above described archaeological effort since 19 June. An X-ray film showed segmental right middle lobe pneumonia. A skin test with 1:100 coccidioidin was read at 48 hours as equivocal (4 to 5 mm induration and very faint erythema). The patient's symptoms lessened decidedly by 11 July, but a repeat skin test with 1:10 coccidioidin resulted in a reaction 40 mm x 25 mm. On 16 July precipitins (antibodies) were detectable. The patient recovered uneventfully and by November 1968 was asymptomatic and an X-ray showed the chest had cleared completely.

Case 2.--A 20-year-old Caucasian woman was seen on 16 July with pleuritic pain of five days duration which had been preceded by a sore throat occurring about one week earlier. A skin test (1:100 coccidioidin) was negative at this time but an X-ray film showed pneumonia in the superior segment of the left lower lobe, and she was admitted to the hospital. A repeat coccidioidin skin test with a 1:10 dilution on 17 July was positive with 14 mm x 15 mm of induration. This patient had a previous history of acute glomerulonephritis (inflammation of the kidneys), and with the current illness albuminuria (protein in urine) and hematuria (blood in urine) developed. These conditions cleared completely by 13 August 1968. A residual X-ray density in the area of the previous pleumonitis remained for at least 3 years, but the patient was in good health.

Case 3.--A 20-year-old Caucasian woman was found to be skin test negative in the original survey, had a clear X-ray of the chest, and showed a negative serological test on 19 July. She finished her course of study on 26 July, and was provided information on coccidioidomycosis and was given a letter of instruction for her physician in case of illness. She was also requested to have serologic and skin tests repeated in August. On 28 July pleuritic pain developed on the right side. She was seen by a physician and a "spot" was noted on an X-ray film of her chest. Penicillin was given, but chills, cough, fever and more severe pleuritic pain and erythema nodosum (red skin rash) developed. The patient returned to her home and was seen there by her personal physician, who made a tentative diagnosis of coccidioidomycosis. Because it was felt necessary that she be isolated (incorrectly, inasmuch as coccidioidomycosis is not transmitted from human to human or from other animals to human), and no private isolation room was available, she returned to the Student Health Center at U.C. Davis and was admitted on 5 August after a chest X-ray showed a pneumonia of the right upper lung region. Coccidioidin skin test (1:100 dilution) produced 5 mm of induration and erythema, while the 1:10 dilution yielded a 10 mm reaction. She recovered uneventfully in the following week and was returned to the care of her physician.

Case 4.--A 19-year-old Caucasian male student had no reaction to 1:100 coccidioidin when originally skin tested on 16 July 1968. He was retested on 18 October with 1:100 coccidioidin and showed a 15 mm reaction. In the interim he had had a chronic rash lasting about one month and presumed to be caused by poison oak. The rash was treated with cortisone and he subsequently became asymptomatic. Coccidioidal serologic tests remained negative through 18 October 1968. He apparently had a mild case of coccidioidomycosis with rash and recovered quickly.

In archaeological excavations, infection rates are high, probably because of the heavy dust exposure and the susceptibility of the crews. Outbreaks are dramatic where students are involved, since they are less likely to have had previous exposure than more experienced archaeologists. Museum personnel have occasionally been infected through handling bones or artifacts, although this is
PREVENTION

Prior infection confers protection, and reinfection after recovery is rare. A vaccine using killed cells of *C. immitis* has provided protection against progression of infection in experimental animals (Levine et al 1960). This vaccine has been safe in humans, but its protective efficacy in man has not been evaluated (Pappagianis and Levine 1975). Preventative measures still center on dust control, which is difficult; operating in slightly damp soil or moistening of soil is effective. Protective masks may reduce exposure if used properly, though experience is limited. The quality of the masks is important, and filters should be changed often in heavy dust conditions. A washable mask with disposable filters (such as the American Optical Company mask, catalogue #R 2900 or its equivalent), costs less than $3.00, filters less than 10¢ each. This mask, however, is ineffective if the fit of the mask against the face is obstructed by a beard. Museum personnel should avoid working with possibly infected material in poorly ventilated rooms and should employ modifications of dust control measures outlined above. A hygroscopic agent such as calcium chloride has been used in the eastern United States for control of dust on roads, and although no use in archaeology is known to the authors, this might be practical in some soil conditions. The material should be applied each evening in an amount adequate to keep soil slightly moist. Another suggested, experimentally effective measure is the use of the fumigant-fungicide 1-chloro-2-nitropropane (Elconin et al 1967). Under laboratory conditions this was effective as a surface spray killing *C. immitis* to a depth of 1/4 inch, but only partially effective in soil 1/2 inch deep and thus of limited practical use.

TREATMENT

Treatment is carried out in certain forms of the disease. Treatment may involve administration of a medication, amphotericin B, which usually is given only in more severe infections. A new oral medication, ketoconazole, is currently being evaluated. Surgical removal of diseased tissue, including part of the lung may be necessary.

Suggested Procedure.—For individuals working in endemic areas or suspected endemic areas, the following measures are recommended:

1. Arrange for medical care and skin testing ahead of time. This is best done by the director of the excavation through a local physician. Skin testing should be done before exposure if funds are available. Generally if testing is done in a group and those tested take care to come in for testing or reading in a group the physician will be able to reduce the cost considerably. In making the original contact with the physician, this publication may be useful. The skin test may be available through the student health service of a college or university.

   The skin test should be carried out using the 1:100 dilution of coccidioidin or "usual test strength" of spherulin. Readings must be made at 24 and 48 hours if possible. The tests are read in millimeters of induration, greater than 5mm being read as positive. If the test is negative, it should be repeated with 1:10 coccidioidin or "high test" spherulin.

2. If working in an area where risks are known to be high, select a crew of skin test-positive individuals (perhaps from the local area).

3. When digging, exercise dust control through means outlined under the preceding section and by other simple means such as not working down wind or in adverse conditions. Sleeping away from the excavation site in relatively dust free surroundings is desirable.
4. If symptoms develop, stop exposure and contact a physician familiar with coccidioidomycosis. Depending upon symptoms the doctor may:
   a. Repeat skin tests.
   b. Take chest X-rays.
   c. Draw blood for serum specimens. (He may wish to use a series of forms available from the Society for California Archaeology.)

5. If you have had Valley Fever in the past or if you contract it in the future, please fill out and return a report form (available from the SCA). It is part of a reporting procedure that has been set up with the help of the Davis Center for Archaeological Research in an effort to keep informed about coccidioidomycosis in archaeologists. When new areas of infection are discovered, information will be disseminated through the SCA Newsletter.

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Werner, S.B., D. Pappagianis, I. Heindl and A. Mickel

Werner, S.B. and D. Pappagianis
INTRODUCTION

The La Brea Woman was recovered in 1914 by the Los Angeles County Museum of Natural History at Rancho La Brea (now Hancock Park). Since the La Brea Woman's discovery almost 75 years ago, no other human skeletal material has been found in the asphalt deposits located there. Curiously enough, the skull and associated postcranial remains have had little attention in the literature.

What attention has been paid to the La Brea Woman has been mainly concerned with determining its geological age. Merriam (1914) was the first to recognize the significance of the human remains. His investigation consisted of an attempt to elucidate the age either through sedimentary deposits or faunal association. Merriam concludes, however, that "from whatever point of view this specimen is considered, it is well worth exhaustive scientific investigation" (Merriam 1914:203). Howard and Miller (1939) also investigated the age of the specimen through faunal associations and concluded that it was of recent origin. The latest summary of the human remains (Stock 1956) is also primarily concerned with the age, and cites both of the earlier papers to conclude that it is more recent than deposits found in other pits.

The present director and staff of the George C. Page Museum in Hancock Park have also shown specific concern to the question of geologic age, and through the use of the UCLA Carbon-14 facility have obtained an estimated date of 9,000 years B.P.

Our primary concern in this paper, however, is the pathology, sex, stature, craniometric and non-metric analysis, none of which has ever been systematically investigated by a trained physical anthropologist. This concern is a reasonable one; for instance, it has been assumed for years that the La Brea Woman died as a consequence of severe paranasal sinus infection. Through our investigation, however, the sinus erosion previously attributed to severe sinus infection appears to be due to pit wear, and the true cause of death was from a heavy blow to the head. We believe we have discovered the oldest known North American homicide.

Sex estimation is performed using typical osteological criteria on the cranium and the innominate. This examination also suggests that the La Brea Woman gave birth to one or more children. Stature estimation included the use of two techniques applied to the femoral length. Both techniques agree quite well with each other, and indicate an individual with quite short stature. In order to provide a complete descriptive analysis, craniometrics and non-metric traits have been included in an appendix. Although the osteometric data are not treated statistically, morphological observations indicate that the La Brea Woman was of local origin.

ESTIMATION OF AGE

The degree of dental attrition may be particularly valuable in assessing the age of the La Brea Woman. Although the system is difficult to apply to individuals with no comparative attrition standards, the La Brea Woman demonstrates third stage dental wear indicating a probable age of about 25-30 years.

Other evidence is consistent with the attrition assessment. All of the permanent dentition has erupted, indicating an age of 14+ (Chagula 1960). Also, the medial epicondyle of the humerus has completely united, which indicates an age of 16+ (Stephenson 1924).
One piece of evidence is in contradiction to the dental attrition assessment. The left innominate shows incomplete epiphyseal union of the iliac crest represented by a short piece of bone (Figure 1). Stephenson (1924) indicates an age for incomplete union at 21 years or less. It is very probable, however, in light of the degree of dental wear, that the incomplete epiphyseal union is an aberrant of the normal closure sequence; the likely cause relating to dietary deficiencies.

ESTIMATION OF SEX

The results of the sex estimation assessment are summarized in Table 1.

The pre-auricular groove is the site of attachment for the ventral sacro-iliac ligament. As explained by Houghton (1974), this ligament and others of the sacro-iliac joint, and the pubic symphysis, undergo an hormonally-mediated softening which leads to an osteoclastic resorption of bone adjacent to the ligamentous attachments during pregnancy. This process leads to the formation of a GP (groove of pregnancy) form of groove as opposed to a GL (groove of ligament) form of groove not indicative of pregnancy. The GP morphology consists of undulating walls and a pitted or scooped-out appearance of the floor of the groove. The GP type occurs in the preserved left innominate of the La Brea Woman.

The site of attachment of the interosseous ligaments (posterior to the auricular surface) also shows extensive pitting and erosion of the bony surface.

Table 1. Sex Estimation Criteria

<table>
<thead>
<tr>
<th>Observation</th>
<th>Observation</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranium:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>upper orbital margin, right</td>
<td>smooth</td>
<td>male</td>
</tr>
<tr>
<td>upper orbital margin, left</td>
<td>sharp</td>
<td>female</td>
</tr>
<tr>
<td>supraorbital torus</td>
<td>absent</td>
<td>female</td>
</tr>
<tr>
<td>line of Keen</td>
<td>absent</td>
<td>female</td>
</tr>
<tr>
<td>malar</td>
<td>smooth</td>
<td>female</td>
</tr>
<tr>
<td>nuchal area</td>
<td>smooth</td>
<td>female</td>
</tr>
<tr>
<td>mastoid length</td>
<td>19.8 mm</td>
<td>female</td>
</tr>
<tr>
<td>Innominant:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>greater sciatic notch</td>
<td>wide</td>
<td>female</td>
</tr>
<tr>
<td>iliac flare</td>
<td>undulating</td>
<td>female</td>
</tr>
<tr>
<td>acetabulum width</td>
<td>44.5 mm</td>
<td>female</td>
</tr>
<tr>
<td>pre-auricular groove</td>
<td>(see text)</td>
<td>female</td>
</tr>
</tbody>
</table>
Erosion has continued around the superior margin of the auricular surface as well, and the effect has been to raise the main portion of the auricular surface above the level of the surrounding bone. According to Houghton (1974) this observation is useful in the confirmation that the groove is of the GP form.

The conclusion is that "GP is the result of the same series of physiological and pathological changes as occur at the pubic symphysis during pregnancy and labor. The pelvis must be of a female who has borne at least one child" (Houghton 1974:383). But see also Holt (1976:91).

ESTIMATION OF STATURE

Two methods of stature reconstruction were employed both of which rely on the dimensions of the femur (as taken from the cast of the original specimen femur). The two methods are 1) the estimation of bone lengths and stature from bone fragments (Steele 1970), and 2) comparative California skeletal material (female femurs) can be measured and put into Genoves' (1967) Mesoamerican formulae to estimate stature.

Femur segments have been measured (on the cast) as described by Steele, and these measurements have been used in regression formulae for determining the femur length and stature. It should be noted that measurement landmarks were difficult to find on the cast and that reasonable estimates had to be made to compensate for lost or damaged bone. For these reasons, results should be looked upon with some caution. Tables 2 and 3 utilize Steele's regressional formulae for White females and Negro females.

A second method of stature reconstruction utilizes comparative California Indian material. A femur was selected which closely resembles the morphological features of the fragmentary cast and has a length of 374 mm. Placing this value into Genoves' Mesoamerican formula, it yields a mean of 144.11 cm ± an SE of 3.82 cm. This gives a mean of 4 foot 8.8 inches, with a range of 4 foot 7.2 to 4 foot 10.2 inches.

---

Figure 2. Tracing of the greater sciatic notch.

Figure 3. Looking from below (inferior to superior at top) the pre-auricular groove can be seen to be quite long. Hatch marks indicate negative relief characteristic of the GP form.
Table 2. Estimation of Femur Length

<table>
<thead>
<tr>
<th>Femur segment</th>
<th>Value (mm)</th>
<th>Estimated femur length (mm) based on white females</th>
<th>Estimated femur length (mm) based on Negro females</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64.0</td>
<td>421.8</td>
<td>434.6</td>
</tr>
<tr>
<td>2</td>
<td>196.5</td>
<td>372.8</td>
<td>384.5</td>
</tr>
<tr>
<td>3</td>
<td>65.0</td>
<td>426.3</td>
<td>421.5</td>
</tr>
<tr>
<td>1+2</td>
<td></td>
<td>358.4</td>
<td>363.1</td>
</tr>
<tr>
<td>2+3</td>
<td></td>
<td>357.0</td>
<td>361.2</td>
</tr>
<tr>
<td>1+2+3</td>
<td></td>
<td>358.5</td>
<td>359.9</td>
</tr>
</tbody>
</table>

Table 3. Estimation of Stature Based on Femur Length

<table>
<thead>
<tr>
<th>Femur segment</th>
<th>Estimated stature (cm) based on white females</th>
<th>Estimated stature (cm) based on Negro females</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+3</td>
<td>141.04</td>
<td>146.93</td>
</tr>
<tr>
<td>1+2+3</td>
<td>141.11</td>
<td>145.09</td>
</tr>
</tbody>
</table>

PALEOPATHOLOGY

When discovered in 1914 in the La Brea Tar Pits, the midfacial bones were detached from the neurocranium. In addition to reconstructing and reattaching the face, an irregular, large portion of the frontal bone and a small part of the left parietal were also reconstructed (Plate 1). The maximum size of the reconstructed vault in an antero-posterior direction is 105 mm, while the reconstructed portion at its greatest width measures 77 mm.

There are several artifactual features in addition to post-recovery damage to the cranium. In as much as the tar matrix effected an abrasive action, the neurocranium displays ablation in several areas: the left parietal (Plate 2) and the area adjacent to glabella (Plate 3). The outer table of the left parietal is, for the most part, absent, presenting smooth diploic bone. Also, the area superior to glabella is eroded exposing portions of the nasal sinus cavities (Plate 3). There are other portions of the neurocranium which are missing through natural destruction: the superior part of the squama of the left temporal (Plate 2) and two areas of the occipital bone lateral and posterior to the foramen magnum (Plate 4).

There is an area about 2 cm anterior to the right coronal suture which has sustained post-recovery damage (Plate 5, A). In the photographs taken shortly after the discovery of the skeletal remains these arc-shaped fracture lines are not illustrated.

There are two other areas of artifactual fracture lines. On the right parietal boss there are four lines radiating from a central point. This appears to be similar to the cracks seen in dessicated and weathered crania where the lines distribute themselves in accordance with the stress patterns reflecting the interaontine ossification pattern (Plate 6). Another fracture line runs superior to the left temporal immediately adjacent to the eroded portion of the left temporal squama (Plate 2, A). The fracture line is considered artifactual as it is
Plate 1. Superior view of cranium. Area reconstructed is a lighter shade than the natural bone. Reconstruction includes a large part of the frontal, part of the left parietal, the right malar, the area about the nasal bridge, and the left post-orbital bar.

Plate 2. Left lateral view of the cranium. Note absence of outer table leaving smooth abraded diploic bone. Squama of the left temporal is weathered away. The fracture line (A) is believed to be artifactual.
Plate 3. Right supraorbital region. The area about glabella (A) shows superficial erosion exposing the frontal sinus cavities. The fracture line (B) extends from the reconstructed portion of the frontal bone to the medial margin of the orbit (arrows).

Plate 4. Basal view of the cranium. Large holes on both sides of the foramen magnum are weathered areas (A). The left third maxillary molar (B) was lost ante-mortem. The alveolar bone shows resorption.
Plate 5. Lateral view of cranium. The fracture lines in the area marked (A with arrows) show post-recovery damage. The fracture lines (B) and (C) radiate from the reconstructed portion of the frontal bone.

Plate 6. Right orbital area. The fracture line (A) radiates from the reconstructed area of the frontal bone and courses near the superior margin of the orbit (B with arrows), and terminates at the reconstructed lateral post-orbital bar (C).
in a thin portion of the parietal in an area of pronounced ablation activity, and is likely the product of warpage stress.

There are several other fracture lines in the frontal bone which are not considered artifactual. For the most part, these fracture lines are illustrated in the original photographs of the La Brea Woman.

There is a fracture line above the right orbit where the bone tissue joins the reconstructed portion of the neurocranium (Plates 3, B and 7, A). This line continues to the medial border of the right orbit, runs posteriorly and inferiorly, and traverses the entire length of the orbital portion of the right frontal bone (Plate 7, B & C). The fracture continues to the lateral margin of the orbit to a point which has been reconstructed.

Immediately posterior to the right post-orbital bar on the right frontal bone at the minimal breadth there are two fracture lines (Plate 5, B & C). The anterior of these has been fixed in place with a wire suture. This fracture line extends from the reconstructed portion of the frontal bone to the sphenofrontal suture. The other fracture line is 20 mm posterior and extends from the right coronal suture through the post-excavation damage to the reconstructed portion of the frontal bone (Plate 5, C). In effect, the frontal portion of the right orbit is almost circumscribed by fracture lines.

There are two fracture lines on the left circum-orbital region. As with the right orbit, there is a post-orbital fracture line 30 mm long extending from the reconstructed part of the frontal bone to the sphenofrontal suture (Plate 8, A). This has also been fixed in place with a wire suture. On the superior margin of the left orbit there is a fracture line extending from the reconstructed portion of the frontal bone to the superior medial margin of the left orbit (Plate 9). It is possible that this line extended further, inferiorly to the nasal bones. This evidence is equivocal because of the weathered condition of the frontal sinus area.

The mandible exhibits a fracture on the right side extending from the gonial angle to the socket of the third molar (Plate 10). It is the belief of Dougherty (personal communication) that this lesion was sustained at the same time as the fractures in the cranium and is an occasional concomitant to severe trauma of the head.

Given the location of the battered portion of the neurocranium and the fracture lines radiating from it in an anterior and lateral direction, the most reasonable conclusion would be that the La Brea Woman was bludgeoned by a heavy, blunt object. Considering the size and location of the lesion, death was likely instantaneous.

A grinding stone, commonly employed by aboriginal women to reduce plant seeds to a powder, was found some 10 cm from the skeletal remains. It is about 13 cm in diameter and about 4 cm thick. Swung with sufficient force and striking the cranium one or more times, this could well account for the traumatic lesions.

Dental pathology is found in both the maxilla and mandible. There are three teeth remaining in the maxilla: the left first molar, and the right first and third molars; all other maxillary teeth (with the exception of the right third molar which was lost before death) were lost post mortem. The alveolar bone of the maxillary left third molar shows pronounced resorption (Plate 4, b). Missing molar teeth in aboriginal populations are common because of severe attrition occasionally accompanied by consequent local infection. As the wear of the remaining molar teeth show advanced attrition, it is reasonable to believe
Plate 7. Left lateral view of the cranium. Wire-sutured fracture line (A) radiates from the reconstructed frontal bone to the sphenoid-frontal suture. The fracture line (B with arrows) joins (A) at the reconstructed frontal bone and runs inferiorly and medially.

Plate 8. Frontal view of the cranium. Arrows point to the fracture line from the reconstructed portion of the frontal bone. The line runs medial to the margin of the left orbit. See also Plate 7, B. Chalk lines on the reconstructed frontal bone mark the hypothetical extensions of ad-mortem fracture lines.
that the ante-mortem loss of the maxillary left third molar follows this pattern. The molar teeth in place in their sockets show two to three mm recession of the alveolar bone from the neck of the teeth. This is within the normal range.

On the right maxilla above the cheek teeth root sockets and below the infraorbital foramen there is a shallow horizontal excavation 11 mm in length (Plate 11). Since there is no normal socket for the canine tooth within the right dental arcade, it is the belief of Daugherty (personal communication) that this shallow fossa represents an ectopic horizontal eruption of the canine. Its present appearance is the consequence of the loss of the superior buccal plate in addition to some slight general abrasion.

There is but a single tooth left in the mandible, a left third molar; all but this tooth and the right third molar were lost post-mortem. The remaining molar is impacted, having erupted at about a 45 degree angle at the junction of the horizontal and ascending ramus. The cusp pattern is highly irregular, with a triradiate deep fovea which is carious (Plate 9). There is a small facet of occlusion on the distal surface.

The carious lesion penetrated to the pulp chamber and hence through the roots to the adjacent alveolar bone. Because of the abrasion of the tar matrix on the lingual cortical surface of the mandible, the lingual roots of this molar are clearly exposed. Both the mesial and distal roots had developed apical abscesses and there is evidence of an additional abscess on the buccal root (Plate 10).

The right third molar of the mandible had been lost through an apparent infection. The socket in the alveolar bone, including a portion of the lingual surface of the right ascending ramus had been resorbed.

No additional pathology could be discerned on the few fragments of the postcranial skeleton.

CONCLUSIONS

The La Brea Woman, located at the La Brea Tar Pits in Los Angeles, has to date been neglected professionally. This is the first analysis by a trained physical anthropologist since she was discovered in 1914.

This particular skeleton, dated at over 9,000 years B.P., gains it importance as one of the oldest homicides, if not the oldest homicide, in the New World. It is likely that she was murdered, evidenced by the fracturing of the cranium, and then her body thrown into the Tar Pits, perhaps to conceal the deed. As the find is the only human skeletal material in a very prolific pit, it is reasonable to conclude that this represents an atypical means of disposition of the dead.

Those traits showing sexual differences have been analysed, and it is concluded that the La Brea Woman is indeed a woman. The morphology of the pre-auricular groove indicates that she had at least one child.

The age of the individual has been estimated at between 25 and 30 years, using epiphyseal union and dental evidence.

Regression formulae utilizing long bone lengths provided a stature estimate. Measurements on the femur cast indicate an individual between 4 foot 5.6 inches and 5 foot 2.2 inches. A second method gives values between 4 foot 7.2 inches and 4 foot 10.2 inches.
Plate 9. Occlusal view of the mandible. The impacted third molar shows a discolored carious lesion in the triradiate fovea. The tooth displays no attrition as it was likely unopposed.

Plate 10. Lingual view of the mandible. The root structure of the tooth in Plate 9 is visible because of the erosion of the cortical surface. The arrows point to apical abscesses.
The craniometrics and non-metric analysis provided in the appendix are an integral part of the description presented here. It is not currently advisable to treat this data statistically, however. The basic problem is the absence of a contemporaneous population(s) to test an historic affiliation. It is possible to perform multiple t-tests to later populations but the possibility of committing a Type I or Type II statistical error is very great. It is also possible to submit the data to a multivariate scheme, perhaps with Legler's (1977) Catalina population, but at present his is an isolated multivariate treatment when other populations need to be treated simultaneously for comparative purposes. Given the appropriate time when sufficient comparative sample populations are available, a comprehensive appendix is prepared with the appropriate data.

Despite the statistical problems concerning population affiliation, morphological evidence indicates a local southern California product. The overall impression of the skull is of a relatively low profile with some broad facial features; and "according to Dr. A.L. Kroeber the racial characteristics do not differ decidedly from those of people whose remains have been excavated on Santa Rosa Island off the coast of southern California" (Merriam 1914:202)

ACKNOWLEDGMENT

We should like very much to thank Mr. William Ackersten of the G.C. Page Museum for his permission to inspect and report on the La Brea Woman. Our appreciation is also extended to the Departmental Associations Council, C.S.U., Fullerton, for partial funding of this project.

Plate 11. Right lateral view of the cranium. The arrows point to the parietal boss with cracks radiating from a central point. These are considered to be artifactual, and the result of differential weathering.
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Stock, C.
APPENDIX

The following cranial measurements (in millimeters) are taken as defined in Howells (1973) with the exception of 7, 22, 23, 24, 27, 55, and 56 which are from Bass (1971), and 45 which has been defined by the authors. Question marks following measurement values refer to the uncertainty of the measurement (as described in Howells 1973). The cranial indices calculated here are interpreted as defined by Bass (1971).

1. Glabella-occipital length, GOL (g-op). Glabella taken approximately 170.2?
   4 mm to the left of the left bore hole.
2. Nasion-occipital length, NOL (na-op).
3. Basion-nasion length, BNL (ba-na). Basion is taken so as to find
   the maximum. This point was marked and used for all other measure­ments using basion.
4. Basion-bregma height, BBH (ba-br). Bregma is taken at the inter­section of lines extrapolated from the sagittal (20 mm anteriorly)
   and coronal (8 mm medially) sutures.
5. Maximum cranial breadth, XCB (eu-eu).
7. Minimum frontal breadth, WFB (ft-ft).
8. Bistephanic breadth, STE. The lower (facial temporal lines
   extrapolated to the coronal suture.
9. Bizygomatic breadth, ZYB (zy-zy). Both zygomatic arches have
   been reconstructed.
10. Biangular breadth, AUB. This is an external basal breadth.
11. Minimum cranial breadth, WCB.
15. Upper facial height, NIH (na-ids).
18. Orbit height, left, OBH.
19. Orbit breadth, left, OBB (ek-da). The position of dacryon had to
   be estimated.
22. Palate breadth, PAB (enm-enm).
23. Maxillo-alveolar length, MAL (pr-alb).
24. Palate length, PAL (or-sta).
25. Mastoid height, right, MDH. The left mastoid process is damaged.
   a. 16.5
   Measurement a is taken with the tip of the process as the bottom
   landmark. Measurement b is taken from the deepest portion of the
   glenoid fossa.
26. Mastoid width, right, MDB.
27. Basion-porion height, BPH (ba-po).
29. Bimaxillary subtense, SSS (ss-zyb).
30. Bifrontal breadth, FMB (fm.a-fm.a). Frontomalaris anterior re­constructed on both sides.
32. Biorbital breadth, EKB (ek-ek).
33. Dacryon subtense, DKS (da-ekb). Dacryon taken as for OBB.

169.2
90.9
169.9??
90.9
113
89
112
119??
65
115
88
62.6
63
44.5
22
35.5
38??
111.8
116.6
55.3
36??
47
39
12
10.5??
34. Interorbital breadth, DKB (da-da). Both dacryons reconstructed. 18???
35. Naso-dacryalsubtense, NDS. Both dacryons and the deepest point in the nasal profile are estimated. 47??
36. Simotic chord (least nasal breadth), WNB. Nasal bones reconstructed. 13.5???
37. Simotic subtense, SIS. Same limitations apply as for WNB. 3.5???
38. Malar length, inferior, IML (zym.a-zym). The zygo-temporal suture is reconstructed. 35??
39. Malar length, maximum, XML (zym-zo). Same measurement limitations apply as for IML. 49??
40. Malar subtense, MLS. Same measurement limitations as IML and XML. 12??
41. Cheek height, WMM. 22
42. Supraorbital projection, SOS. Lateral caliper arms were placed in areas of least abrasion. 5?
43. Glabella projection, GLS. Pit wear (abrasive planing of the bone) may be responsible for the 0 value. 0?
44. Foramen magnum length, FOL (ba-os). 37
45. Foramen magnum width, FOB. A maximum reading taken from the inferior edges of the lateral borders of the foramen magnum. 28.6
46. Nasion-bregma chord (frontal chord), FRC (na-br). 92??
47. Nasion-bregma subtense (frontal subtense), FRB. The tangent to the frontal bone was located by sighting from the right frontal region (where much of the frontal still exists) in the horizontal plane. Extrapolated to the midsagittal plane, this intersection lies over the frontal reconstruction which is poorly formed. The coordinate arm was raised slightly to accommodate. 13???
48. Nasion-subtense fraction, FRF. Same limitations apply as for FRB. 62??
49. Bregma-lambda chord (parietal chord), PAC (br-la). Lambda was taken superiorly to the ossicle located there. 116??
50. Bregma-lambda subtense (parietal subtense), PAS. 34??
51. Bregma-lambda subtense fraction, PAF. 60.5??
52. Lambda-opisthion subtense (occipital subtense), OCC (la-os): 89.8
53. Lambda-opisthion subtense (occipital subtense), OCS. 26.8
54. Lambda-subtense fraction, OFC. 42.5
55. Porion-bregma height, PBH (po-br). Measured from the reconstruction the value is 118.5?? The coordinate arm was raised slightly to accommodate for the depression in the reconstruction. 118.5??
56. Auricular height, AUH (po-v). 111.8
57. Vertex radius, VRR (v-t.a.). 119
58. Nasion radius, NAR (na-t.a.). 83
59. Subspinale radius, SSH (ss-t.a.). 81
60. Prosthion radius, PRR (pr-t.a.). 99
61. Dacryon radius, DKR (da-t.a.). 78??
62. Zygoorbitale radius, ZOR (zo-t.a.). 75
63. Frontomalare radius, FMR (fm.a-t.a.). 69??
64. Ectoconchion radius, EKR (ek-t.a.). Measurement taken just posterior to reconstruction. 66
65. Zygomaxillare radius, ZMR (zm.a-t.a.). 66
66. Molar alveolus radius, AVR (alv-t.a.). 75

INDICES
1. Cranial index, cranial breadth (5) X 100
   _________
   cranial breadth (1)

   Mesocrany (average or medium headed, Bass 1971:63). 78.38

2. Cranial module, (Length (1) + breadth (5) + height (4))

   This is a measurement as described by Legler 1977:81). 141.17
3. Cranial height-length index, \( \frac{\text{height}(4) \times 100}{\text{length}(1)} \)  70.45
Orthocrany (medium, Bass 1971:64).

4. Cranial height-breadth index, \( \frac{\text{height}(4) \times 100}{\text{breadth}(5)} \)  89.88

5. Mean height index, \( \frac{\text{height}(4) \times 100}{\frac{1}{2} (\text{length}(1) + \text{breadth}(5))} \)  78.99
Low (Bass 1971:65).

6. Fronto-parietal index, min. frontal breadth \( \frac{\text{breadth}(7) \times 100}{\text{breadth}(5)} \)  66.72

7. Mean porion-height index, \( \frac{\text{porion-bregma ht.}(55) \times 100}{\frac{1}{2} (\text{length}(1) + \text{breadth}(5))} \)  78.06

8. Index of flatness of cranial base, \( \frac{\text{basion- PORION HT.}(27) \times 100}{\text{height}(4)} \)  12.51
Low (Bass 1971:68).

9. Upper facial index, \( \frac{\text{upper facial height}(15) \times 100}{\text{bizygomatic breadth}(9)} \)  52.94
Meseny (average or medium, Bass 1971:69).

10. Nasal index, \( \frac{\text{nasal breadth}(17) \times 100}{\text{nasal height}(16)} \)  49.44

11. Orbital index, \( \frac{\text{orbital height}(13) \times 100}{\text{orbital breadth}(19)} \)  93.42

12. Maxillo-alveolar index, \( \frac{\text{maxillo-alveolar breadth}(21) \times 100}{\text{maxillo-alveolar length}(23)} \)  117.66

13. Palatal index, \( \frac{\text{palate breadth}(22) \times 100}{\text{palate length}(24)} \)  92.31
Brachystaphyline (broad, Bass 1971:71).

NON-METRIC TRAITS

1. Ossicle at lambda: Wormian bone observed
2. Lambdoid ossicles: Observed
   left: 4 wormian bones
   right: 1 wormian bone
3. Bregmatic ossicle: Cannot be observed (bregma reconstructed)
4. Metopism: Cannot be observed (frontal reconstructed)
5. Coronal ossicles: Absent
6. Palatine torus: Absent
7. Sagittal ossicles: Absent
8. Pharyngeal fossa: Absent
9. Epidermic bone: Present left and right
10. Fronto-temporal articulation: Absent
11. Parietal bone: Parietal notch bone absent
12. Ossicle at asterion: Absent
13. Ossicle in mastoid suture: Absent
14. Auditory torus: Absent
15. Foramen of Huschke: Absent
16. Mastoid foramen exsutural: Absent
17. Mastoid foramen absent: Present on right, absent on left
18. Condylar facet double: Cannot be observed (occipital worn)
19. Precondylar tubercle: Cannot be observed (occipital worn)
20. Anterior condylar canal double: Absent
21. Posterior condylar canal: Absent
22. Foramen spinosum open: Cannot be observed (sphenoid damaged)
23. Foramen ovale continuous: Absent. Although the posterio-lateral wall of the foramen ovale is broken, a slight trace of bone here indicates that it was not continuous (left side).
24. 2+ lesser palatine foramina: Absent
25. Maxillary torus: Absent
26. Mandibular torus: Absent
27. Zygomatic-facial foramen absent: Foramen are present on both sides
28. Supraorbital foramen complete: Absent
29. Frontal notch or foramen: Absent
30. Accessory infraorbital foramen: Absent
31. Os japonicum (bipartite malar): Absent
32. Suture in infraorbital foramen: Present on the left; the right maxilla is reconstructed.
33. Parietal foramen: Absent
34. Anterior ethmoid foramen exsutural: Cannot be observed
35. Posterior ethmoid foramen: Cannot be observed

These traits were taken as described by Berry and Berry (1967:361-379) except for number 26 which is from Brothwell (1973:97). All traits have been scored bilaterally.