OLD SOCORRO MISSION: AN OSTEObIOLOGICAL ANALYSIS OF THE SKELETAL REMAINS FROM THE 1982-1985 FIELD EXCAVATIONS.

A Thesis

by

MICHELLE JEANETTE RAISOR

Submitted to the Office of Graduate Studies of Texas A&M University in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

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Major Subject: Anthropology
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ABSTRACT


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The skeletal remains of 51 individuals from the Old Socorro Mission (OSM) were analyzed to provide both a demographic profile and an assessment of their health. According to Spanish documents, the mission, which was in use from 1684 to 1829, served the Spanish families and Piro Indians who were living at the settlement.

Of the 51 burials recovered, 23 of the adults were identifiable as to sex: 15 males and 8 females. All age categories were represented: one fetal, 15 infants, five in early childhood, three in late childhood, one adolescent/adult, 19 adults, and seven old adults.

Physical characteristics, such as stature and robusticity were also determined. Stature estimates of the OSM sample did not differ significantly from other Indian groups from the region. Visual observation of the OSM sample indicated that the population appeared to be sexually robust. The males and females displayed a pronounced degree of skeletal dimorphism both in stature and other discrete traits.

Examination of the dentition revealed numerous pathological conditions. The OSM population displayed a high frequency of cariogenic activity, enamel hypoplasia,
abscessing, antemortem tooth loss, alveolar resorption, and periodontal infection. Dental anomalies, shoveling and enamel wrinkling, were also present.

The OSM sample revealed numerous skeletal pathological conditions. Degenerative joint disease, infectious disease, neoplasias, traumatic injuries, and skeletal dysplasias were evident in both sexes. Anomalous features were also identified, such as developmental and cultural modifications. The high frequency of developmental variations is suggestive of a small breeding population with restricted gene flow.

The lack of skeletal lesions with dietary imbalances suggests that the OSM people were well nourished. However, the high incidence of degenerative joint disease suggests that the Piro Indians suffered a great amount of physical stress.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>v</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td><strong>CHAPTER</strong></td>
<td></td>
</tr>
<tr>
<td>I  INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>- Archaeological History</td>
<td>5</td>
</tr>
<tr>
<td>- Site Description</td>
<td>9</td>
</tr>
<tr>
<td>- Research Objective</td>
<td>17</td>
</tr>
<tr>
<td>- Materials and Methods</td>
<td>17</td>
</tr>
<tr>
<td>II  DEMOGRAPHIC ANALYSIS</td>
<td>19</td>
</tr>
<tr>
<td>- Age</td>
<td>19</td>
</tr>
<tr>
<td>- Sex</td>
<td>28</td>
</tr>
<tr>
<td>III  STATURE AND ROBUSTICITY</td>
<td>36</td>
</tr>
<tr>
<td>- Stature</td>
<td>36</td>
</tr>
<tr>
<td>- Sexual Robusticity</td>
<td>50</td>
</tr>
<tr>
<td>IV  DENTAL PATHOLOGY AND ANOMALIES</td>
<td>67</td>
</tr>
<tr>
<td>- Caries</td>
<td>67</td>
</tr>
<tr>
<td>- Antemortem Tooth Loss</td>
<td>72</td>
</tr>
<tr>
<td>- Abscesses</td>
<td>73</td>
</tr>
<tr>
<td>- Periodontal Disease</td>
<td>75</td>
</tr>
<tr>
<td>- Enamel Hypoplasia</td>
<td>80</td>
</tr>
<tr>
<td>- Dental Attrition</td>
<td>82</td>
</tr>
<tr>
<td>- Shoveling</td>
<td>84</td>
</tr>
<tr>
<td>- Anomalies</td>
<td>85</td>
</tr>
<tr>
<td>- Comparison</td>
<td>86</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>Page</td>
</tr>
<tr>
<td>------------------</td>
<td>------</td>
</tr>
<tr>
<td>V SKELETAL PATHOLOGY</td>
<td>89</td>
</tr>
<tr>
<td>Degenerative Disease</td>
<td>90</td>
</tr>
<tr>
<td>Infections Disease</td>
<td>94</td>
</tr>
<tr>
<td>Neoplasia</td>
<td>110</td>
</tr>
<tr>
<td>Traumatic Injuries</td>
<td>112</td>
</tr>
<tr>
<td>Skeletal Dysplasia</td>
<td>113</td>
</tr>
<tr>
<td>Suture Anomalies</td>
<td>120</td>
</tr>
<tr>
<td>Cultural Modifications</td>
<td>123</td>
</tr>
<tr>
<td>Developmental Anomalies</td>
<td>127</td>
</tr>
<tr>
<td>Comparison of Pathological Findings to Mission San Juan Capistrano and Mission San Xavier</td>
<td>133</td>
</tr>
<tr>
<td>VI SUMMARY</td>
<td>139</td>
</tr>
<tr>
<td>LITERATURE CITED</td>
<td>147</td>
</tr>
<tr>
<td>APPENDIX A: DESCRIPTION OF SKELETAL REMAINS OLD SOCORRO MISSION (E.P.C.M. 31:106:7:23)</td>
<td>163</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>164</td>
</tr>
<tr>
<td>APPENDIX B: DESCRIPTION OF MEASUREMENTS</td>
<td>203</td>
</tr>
<tr>
<td>APPENDIX C: LIST OF PATHOLOGICAL DISORDERS AND AFFECTED BURIALS</td>
<td>207</td>
</tr>
<tr>
<td>VITA</td>
<td>211</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distribution of individuals by age.</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Comparison of the number of individuals by age.</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>Comparison of the number of individuals by sex.</td>
<td>35</td>
</tr>
<tr>
<td>4</td>
<td>Age distribution by sex.</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
<td>Mean stature at Old Socorro Mission site (cm).</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Estimation of stature (cm).</td>
<td>41</td>
</tr>
<tr>
<td>7</td>
<td>Comparison of femur lengths (cm) to other cultural areas.</td>
<td>46</td>
</tr>
<tr>
<td>8</td>
<td>Comparison of mean tibia lengths (cm) to other cultural areas.</td>
<td>47</td>
</tr>
<tr>
<td>9</td>
<td>Comparison of stature (based on femur lengths) to other cultural areas (cm).</td>
<td>48</td>
</tr>
<tr>
<td>10</td>
<td>Comparison of stature (based on tibia lengths) to other cultural areas (cm).</td>
<td>49</td>
</tr>
<tr>
<td>11</td>
<td>Comparison of mean humerus lengths (mm) to other cultural areas.</td>
<td>51</td>
</tr>
<tr>
<td>12</td>
<td>Mean measurements of the humerus (mm).</td>
<td>54</td>
</tr>
<tr>
<td>13</td>
<td>Mean measurements of the radius (mm).</td>
<td>55</td>
</tr>
<tr>
<td>14</td>
<td>Mean measurements of the ulna (mm).</td>
<td>56</td>
</tr>
<tr>
<td>15</td>
<td>Mean measurements of the femur (mm).</td>
<td>57</td>
</tr>
<tr>
<td>16</td>
<td>Mean measurements of the tibia (mm).</td>
<td>58</td>
</tr>
<tr>
<td>17</td>
<td>Robusticity index (cm).</td>
<td>59</td>
</tr>
<tr>
<td>18</td>
<td>Comparison of the mid-shaft circumference of the femur by sex (mm).</td>
<td>66</td>
</tr>
<tr>
<td>TABLE</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Number of caries per individual.</td>
<td>69</td>
</tr>
<tr>
<td>20</td>
<td>Number of caries per tooth type.</td>
<td>70</td>
</tr>
<tr>
<td>21</td>
<td>Number of caries by sex (adults only).</td>
<td>71</td>
</tr>
<tr>
<td>22</td>
<td>Number of adults exhibiting antemortem tooth loss.</td>
<td>74</td>
</tr>
<tr>
<td>23</td>
<td>Number of abscesses per individual.</td>
<td>74</td>
</tr>
<tr>
<td>24</td>
<td>Comparison of percentage of dental pathological conditions.</td>
<td>76</td>
</tr>
<tr>
<td>25</td>
<td>Number of abscesses per tooth type.</td>
<td>77</td>
</tr>
<tr>
<td>26</td>
<td>Presence of dental pathological conditions in individual burials.</td>
<td>79</td>
</tr>
<tr>
<td>27</td>
<td>Comparison of percentage of skeletal pathological conditions observed.</td>
<td>137</td>
</tr>
</tbody>
</table>
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURES</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regional map showing the relative location the Old Socorro Mission site, S.E. of El Paso.</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Side-by-side burial positioning at the Old Socorro Mission site.</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Adult male burial (Burial 36).</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Two subadult burials (Burial 8 and 12).</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>Age categories at Old Socorro Mission site.</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>Comparison of age groups between mission sites.</td>
<td>31</td>
</tr>
<tr>
<td>7</td>
<td>Estimate of stature based on the femur by sex (cm).</td>
<td>43</td>
</tr>
<tr>
<td>8</td>
<td>Estimate of stature based on the tibia by sex (cm).</td>
<td>45</td>
</tr>
<tr>
<td>9</td>
<td>Robusticity index of the humerus by sex (cm).</td>
<td>62</td>
</tr>
<tr>
<td>10</td>
<td>Robusticity index of the femur by sex (cm).</td>
<td>64</td>
</tr>
<tr>
<td>11</td>
<td>Periostitis of the cervical vertebrae with subsequent fusion of the vertebrae to the skull (Burial 36).</td>
<td>102</td>
</tr>
<tr>
<td>12</td>
<td>Severe periostitis of the sternum, lateral view (Burial 36).</td>
<td>104</td>
</tr>
<tr>
<td>13</td>
<td>Periostitis of the ribs (Burial 36).</td>
<td>106</td>
</tr>
<tr>
<td>14</td>
<td>Radiograph of ribs showing severe widespread periosteal infection (Burial 36).</td>
<td>108</td>
</tr>
<tr>
<td>15</td>
<td>Un-united fracture of right ulna of Burial 32.</td>
<td>115</td>
</tr>
<tr>
<td>16</td>
<td>Torsion of femoral head of Burial 18.</td>
<td>117</td>
</tr>
<tr>
<td>17</td>
<td>Shortening of the right femur and left fibula of Burial 18.</td>
<td>119</td>
</tr>
<tr>
<td>18</td>
<td>Skull 38 exhibiting &quot;saddle nose&quot;.</td>
<td>122</td>
</tr>
<tr>
<td>FIGURE</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>19</td>
<td>Cranial deformation of Burial 18.</td>
<td>126</td>
</tr>
<tr>
<td>20</td>
<td>Bifid sacral hiatus of Burial 36.</td>
<td>129</td>
</tr>
<tr>
<td>21</td>
<td>Asymmetry of mandibular condyles (Burial 20).</td>
<td>132</td>
</tr>
<tr>
<td>22</td>
<td>Congenital absence of the left transverse process (Burial 32).</td>
<td>135</td>
</tr>
</tbody>
</table>
CHAPTER 1
INTRODUCTION

The Old Socorro Mission, also known as La Purísima Concepción Nuestra Señora de Socorro, was established by Franciscan missionaries in A.D. 1684 in the El Paso del Norte area of Texas. Located on the Rio Grande River, it remained in constant use until A.D. 1829 when the church was severely damaged by flood waters and abandoned (Figure 1). Originally the small mission was built to administer to the Spanish families and the Piro Indians that accompanied the Spanish from New Mexico following a failed reconquest of that region during the years of 1681–1682 (Hackett and Shelby, 1942). Following the European custom of using the church as a cemetery, the floor of the Old Socorro Mission (OSM) also served as an interment site.

In 1981, the University of Texas at El Paso (UTEP) examined the site following a report by Schuetz (1980) that evidence of a pre-1829 mission had existed there (Gerald, 1990). Excavations were conducted during the summers of 1982 through 1985 by students of the UTEP archaeological field school under the direction of Dr. Rex Gerald. Following the investigation, the Old Socorro site (E.P.C.M. 31:106: 7:23) was determined to be the oldest mission site in Texas for which the location is known.

This thesis follows the style and format of the American Journal of Physical Anthropology.
Figure 1.

Regional map showing the relative location

of the Old Socorro Mission site, S.E. of El Paso.
The Dunes of White Sands National Monument are composed of fine white gypsum crystals. In extreme summer heat, the highly reflective sand feels cool, inviting a paradox of temperature extremes.

In the Rockhound State Park, which clings to the slopes of the Sandia Mountains, visitors are allowed to remove samples such as quartz, petrite, jasper, and agate.

Albers Conical Equal-Area Projection: Standard Parallels 29°30' and 45°30'

SCALE 1:23,820,000 OR 1 INCH = 37.6 MILES
At the conclusion of the 1985 field school, thirty-two discrete burials and hundreds of miscellaneous bone fragments had been recovered. Both sexes and all age categories, including fetal remains, were represented. For the most part, the burials were nearly complete and the preservation was excellent. Initially the skeletal material was examined and inventoried by the Department of Anthropology at UTEP. During the summer of 1991, the burials were transferred to Texas A&M University, Department of Anthropology, for further analysis and study. Upon further examination, the OSM sample revealed a wealth of pathological disorders and demographic information.

Identification of pathological conditions supplies an important assessment of overall health and the role that disease plays in human adaptation. Estimates of stature, age at the time of mortality, sex and robusticity contribute a vital dimension in appraising the subsistence strategy and even the amount of gene flow within the population. Mission Indian groups are of particular interest because they represent a people in transition. Following European contact and colonization, many of the Pueblo Indians experienced a large population decrease. Restricted to the mission sites, the native populations became substantially decimated by the introduction of smallpox and other European diseases, malnutrition, and warfare (Marshall, 1987).

The Old Socorro Mission skeletal sample represent such a group. The Piro Indians who resided at the Mission were once a large Pueblo population that not only exploited the diverse wildlife and vegetative products of New Mexico, but also raised maize, beans, squash, cotton, and turkeys. After fleeing with the Spanish to Texas, the Piro Indians were forced to adapt not only to a new land, but also to a new lifestyle.
The skeletal material recovered from the OSM site provides a unique opportunity to evaluate the health and general quality of life that the Piro Indians endured following Spanish colonization and how they compared to other groups of similar lifeways.

ARCHAEOLOGICAL HISTORY

SPANISH COLONIZATION: The Spanish colonization of the American Southwest is a fascinating history of the "civilizing" of a native people. Following the conquest of Mexico, the Spanish became interested in the Pueblo region of New Mexico upon hearing tales of cities lying to the north filled with riches. Hoping to find another culture as advanced as the Aztecs, in 1540 the viceroy of Mexico proceeded to send Francisco Vasquez de Coronado on an expedition to explore the new land. Coronado traveled north and spent the next two years traveling throughout the region. Disappointed in what he discovered, he went back to Mexico with an unfavorable report. However, interest in the new territory built as soldiers and priests envisioned new opportunities for fortunes to be made and souls to be saved.

The task of colonizing New Mexico was given to Don Juan de Oñate in 1595, with his primary focus being the establishment of the missionary program in the new territory. As more and more missionaries, soldiers and settlers poured into New Mexico, many Indians quickly lost both their culture and religion. The Spanish required strict obedience to their rule. Failure to do so was met with brutal punishment. When de Oñate was met with resistance to his "civilizing" program, he proceeded to amputate one foot from every male over twenty-five years of age. The Spanish, insisting that the
Indians abandon their own religious beliefs and replace them with Catholicism, ensured this would happen by killing their religious leaders. The Indians were used as forced labor to build their churches, mine salt, collect pinon nuts, and weave blankets to be sold in Mexico. Although subjected to inhumane treatment at the hands of the Spanish, the Indians in secret practiced their religion, and eventually plotted to force the missionaries and settlers out of the area.

After years of oppression and terrible suffering, the Pueblos united to overthrow Spanish rule. In 1680, under the leadership of a Tewa medicine man by the name of Popé, a Pueblo revolt ensued. The Indians swept through the land, killing friars and settlers, destroying the churches, and laying waste to the settlements. A large number of Spanish settlers, a few missionaries, and Indians from the Isleta and Piro pueblos fled southward along the Rio Grande. The revolt was short-lived however, and within a few years the unity of the pueblos dissolved providing an opportunity for the Spanish to regain the pueblo areas (Dozier, 1970).

THE PIRO: Originally, the Piro Indians of Old Socorro Mission were one of the Pueblo groups which inhabited the Rio Grande region of central New Mexico. The Piro villages have been reported to be much smaller than the surrounding Tiqua villages, with their size ranging from 14 to 123 houses (Hammond and Rey, 1966). Typical of pueblo architecture, the Piro villages consisted of multi-level adobe houses, with separate rooms for sleeping, storage, and food preparation. The Spanish reported that, unlike other Indian villages, the Piro communities were clean and tidy with the mud walls of their dwellings frequently white-washed and artfully decorated with motifs of animals, monsters, and human figures (Hammond and Rey, 1966).
Refuse excavated from historic Piro settlements indicates that the Piro enjoyed a varied diet. Bones of sheep, goat, rabbit, turkey, dog, pronghorn antelope, and mule deer, along with some bison, have been recovered from sites throughout the Piro providence (Ayer et al., 1916; Toulouse and Stephenson, 1960). Spanish documents reported that the Piro were also proficient at farming, using both irrigation and dryland farming methods (Hammond and Rey, 1929). The crops usually consisted of maize, squash, tobacco, beans, and herbs that were preserved for winter (Hackett, 1937; Hammond and Rey, 1953). Cotton was also grown, and was later woven into blankets that were traded in exchange for buffalo skins from the Apaches (Hackett, 1937). Apparently, from Spanish descriptions, food supplies were abundant (Hammond and Rey, 1966).

The Piro eventually became thoroughly integrated into the Spanish culture as they were brought into the mission system. Although the Spanish conquered the Puebloan people in the name of Christianity with plans to teach "customs and habits of a civilized life," it was soon apparent that this practice also included enslaving the natives to care for the Spaniard's livestock, labor in the mines, work as household servants, and act as an intermediate between themselves and the more hostile northern tribes (Persons, 1958; Newcomb, 1986). Upon entering the Rio Grande area the Spanish first enticed the Piro into friendship by promising protection against the Apaches (Hammond and Rey, 1928). Although the Piros and Apaches regarded each other as enemies, this did not prevent them from establishing a trade relationship. According to Earls (1985) the Apaches "came to their Pueblos with articles of barter, such as deerskins and cattle-hides for making footwear, and with a large amount of meat in exchange for corn and blankets." Eventually the Spanish attempted to control
the trade and food distribution between the two groups by forbidding the Apaches access into the Pueblos, forcing the Piro to rely upon the Spaniards as go-betweens (Earls, 1987).

The interference of the Spaniards caused increased hostilities with the nomadic tribes. In 1680 a Pueblo revolt occurred, a revolt the Piro were not asked to participate in. Their numbers decimated by disease, and fearing retribution from the Apaches, the Piro chose to flee with the Spaniards. Eventually the Piro and some of the Spanish settled in the El Paso del Norte area. Included among the Piro at this time were also some Tiqua, Tampiro, Mansos, and Suma Indians. Because of the large number of refugees migrating into the area following the revolt, most of the Indians were immediately dispersed downriver.

Following the revolt, sometime between 1684 and 1690, the Old Socorro Mission was established, bearing the name of the old Pueblo in New Mexico (Morrow, 1981). By 1778, reports written by the minister of Socorro stated that predominantly Spanish families and Piro Indians, along with a few Janos and Jamez, were living at the settlement (Evans, 1989). Eventually the Indian groups were thoroughly assimilated into the Spanish culture. The Old Socorro Mission by 1800, no longer had any Piro families living there. By the time the church fell to ruin in 1829, the majority of the population consisted of criollo (those individuals of Spanish descent born in America) and mestizo (those individuals of Spanish and Indian admixture) (Evans, 1989). Although descendants of these early groups live in the valley towns today, culturally the Piro became extinct.
SITE DESCRIPTION

Descriptions of the OSM site have been previously published by Dr. Rex Gerald and Consuelo T. Evans, the principal investigators of the excavation. The following narrative is a brief, combined summary of the visual descriptions of the site as previously reported (Evans, 1989; Gerald, 1990).

In the fall of 1981, the University of Texas at El Paso examined a large cultivated field in El Paso county reported to have once displayed evidence of adobe dunes. Following interviews conducted of elderly residents in the area, a specific location was determined. Surface examination of the site yielded bits and pieces of early eighteenth century glazed Spanish potsherds, adobe walls, and human bone fragments. Test trenches dug revealed further evidence of walls and painted plaster.

Under the direction of Dr. Rex Gerald, Associate Professor of Anthropology, field schools were conducted during the summers of 1982–1985. The site was excavated by controlled surface collections, mechanical trenching, and hand excavation. In 1982, evidence of skeletal fragments and the mandible of a child were recovered; however, the first complete burial was not excavated until 1983. It was not until the 1984 and 1985 field schools that removal of skeletal fragments and intact burials was actually accomplished (Evans, 1989).

Architecturally, the OSM site consisted of a five-room adobe structure and a separate bell tower. Room 1 was assumed to be a convent room. A smaller room located adjacent to Room 1 was designated Room 2, whose purpose was unknown. Room 3 was probably a large uncovered courtyard or garden area, with Room 4
probably serving as a baptistry. The majority of the burials were recovered from beneath the floor in what would have been the nave of the church (Room 5). Using the church as a cemetery is typical of the European tradition of interment, and has been documented at the Spanish missions of San Juan Capistrano and San Xavier, both in Texas, and Santa Catalina de Guale in Georgia.

The field school excavated thirty-two discrete burials during the summers of 1984 and 1985 (Figures 2, 3, and 4). Numerous separate bone fragments were also removed, along with one burial containing five skulls only. Very few artifacts were recovered along with the burials. Numerous beads of varying sizes and colors, fabric remnants, and some religious medallions were discovered.

The majority of the OSM burials were positioned side-by-side (Figure 2). The heads were positioned to the east, with the feet pointed toward the west. This positioning is atypical of the Christian burials commonly seen. Normally, in the Christian religion, burials are placed with the head toward the west so that the deceased can view the second coming of Christ, which is supposed to occur at dawn (Shafer, 1993).

Examination and analysis of the burials was initially done by UTEP. Dietary isotope analysis was also attempted on thirteen adult skeletons using 50mm segments of the right humerus (Evans, 1989). In the summer of 1991, the Department of Anthropology of Texas A&M University received the skeletal material for further study.
Figure 2.

Side-by-side burial positioning

at the Old Socorro Mission site.
Figure 3.

Adult male burial (Burial 36).
Two subadult burials (Burials 8 and 12).
RESEARCH OBJECTIVE

The first objective of this study was to provide a generalized description of the structural features of the individuals recovered from beneath the church floor at the OSM site. All discrete skeletal remains that were sufficient for analysis were used to obtain the maximum amount of information. Descriptions and differential diagnoses of pathological conditions, as well as demographic data, were collected to ascertain the overall health profile of this historic population.

The second objective was to conduct a comparison between the OSM sample and other similar mission Indian groups. This was done to evaluate possible differences of physical features, mortality rates, subsistence strategies, and the quality of life between the various Spanish settlements.

MATERIALS AND METHODS

Analysis of the OSM population was accomplished by using both qualitative and quantitative methods. Estimates of stature and robusticity were achieved using standard anthropometric techniques as previously described by Bass (1971), France (1983), Montague (1960), Olivier (1970), Steele and Bramblett (1988), and Stewart (1952). Skeletal pathological conditions were identified primarily using Ortner and Putschar (1981), Steele and Bramblett (1988), and Steinbock (1976). Descriptions of dental disorders, patterns of tooth eruption, and anomalies were recorded following the techniques of Bhaskar (1986), Clarke and Hirsch (1991), El-Najjar and McWilliams (1978),
Hildebolt and Molnar (1991), Hrdlicka (1920), Pindborg (1970), Schour and Massler (1940), Steele and Bramblett (1988), and Ubelaker (1978).

A demographic profile was deemed essential for evaluating the OSM sample. Demographics provide an inference as to whether or not there was any undue stress acting upon any particular age category or sex. Determination of sex and assessment of age was accomplished by using observations of non-metric features, as well as by using metric analysis. This information was used as a basis for demographic comparison with two other mission skeletal populations, Mission San Juan Capistrano and Mission San Xavier.

All skeletal material was assessed for the following characteristics: age, sex, stature, robusticity, dental pathology, skeletal pathology, and skeletal anomalies. A thorough and detailed account of the methodology used in evaluating each burial for the above characteristics is provided in each descriptive Chapter and Appendix B.
CHAPTER II

DEMOGRAPHIC ANALYSIS

Determining the age and sex of skeletal material provides insight as to the mortality distribution with a population, and this demographic data can be helpful in drawing conclusions about the possible stresses acting on a population. Age at the time of mortality can be used to assess the decline of a population from environmental factors, such as disease or starvation, cultural pressures as in intertribal warfare, or even genetic factors and familial variation in genes relating to the length of life generally (Owsley and Bass, 1979; Ubelaker, 1974; Weiss, 1976; Weiss and Chakraborty, 1982). Determining sex ratios helps to establish whether or not both sexes were under equal stresses. For instance, if a sex ratio was markedly skewed in favor of one sex or the other, this difference could be linked to childbirth or warfare (Owsley and Bass, 1979). Although, unequal proportions in the sex ratio is not uncommon since many factors can act upon individuals from generation to generation (Berry, 1985; Patrick, 1988).

AGE

There are many techniques currently being utilized to assign age categories. The pattern of tooth development in humans is predictable and varies only slightly between individuals (Schour and Massler, 1940; Ubelaker, 1978). However, once tooth eruption has been completed during the late teens or early twenties, the estimation of age depends upon the degree of dental attrition, epiphyseal closure and degenerative changes of the skeleton (Bass, 1987).
In the case of subadults, odontogenesis of the deciduous and part of the permanent dentition begins in utero (Schour and Massler, 1940). Development of the enamel, dentin, crown and root occurs in stages (Logan and Kronfeld, 1933). Tooth formation appears to be relatively resistant to most physiological problems such as chromosomal defects, endocrine insults and nutritional effects than other tissues (Smith, 1991). Although dental eruption can be affected by such factors as malnutrition it is usually assumed that dental age and chronological age are closely comparable (Garn et al., 1959; Garn et al., 1965; Kronfeld, 1935; Ubelaker, 1978).

The permanent dentition begins to erupt approximately at six years of age and continues until the third molars (wisdom teeth) erupt between the ages of 17–25 years (Schour and Massler, 1940; Ubelaker, 1978). Of all the teeth, the third molars are truly the most unpredictable in their eruption which in a few cases can occur as late as 35 years (McKern, 1957). Often, they are impacted in the bone and may never erupt or may be congenitally absent. Dental attrition of the permanent teeth has also been used in correlation with chronological age (Walker et al., 1991). However, it is clearly evident that there is a relationship between diet and attrition with much variation occurring between populations. Therefore, it is necessary to consider this dietary factor in order to obtain accurate age estimates. The degree of occlusal wear can not be used alone in determining age, but can be helpful in providing an estimate of longevity (Brothwell, 1965; Miles, 1963).

Age estimations using diaphyseal lengths in individuals under the age of twelve years have been developed based on radiographic studies using live subjects (Hoffman,
This technique was done by taking radiographs of long bones, measuring the diaphyseal lengths, then plotting the lengths against chronological age. However, Hoffman concluded that although this technique was only reasonably accurate it should only be used as a last result on fragmentary subadults when dentition and epiphyses are not available. With older subadults from the age of puberty to about the age of thirty years, epiphyseal union can be used (McKern, 1957; McKern and Stewart, 1957). Although, union of the epiphyses can undergo union intervals which may last as long as six to seven years (McKern and Stewart, 1957). McKern states that the most reliable age estimates can be made if the critical areas of epiphyseal union are scored and the scores are added. The sum will give an estimate of maturity and predicted age. However, abnormal or premature union of the epiphyses can occur. It also must be remembered that ossification begins earlier in females than males with complete unification occurring up to three years soon (Bass, 1987).

The cranium has been infrequently used for estimation of age. Meindl and Lovejoy (1985) developed a scoring method for ectocranial suture closure. Using ten sites at which the suture closure is rated, four degrees of closure were assigned. Their results showed that sites at the sphenofrontal and sphenotemporal region were the most useful in young adults. However, Meindl and Lovejoy concluded that this method only provides a general age assessment but when compared to pubic component aging systems, it was more accurate. Kerley (1970) states, however, that the only reasonable method of cranial aging techniques is the presence of parietal thinning. This condition,
called senile osteoporosis, is an indicator of advanced age occurring in individuals usually over 60 years old.

The most frequently used bone in age estimation is the pubic symphysis of the pelvis. Since Todd's study in the 1920's, the technique of scoring the maturation changes on the symphyseal surface is still one of the most accurate methods for estimating age. Modifications and refinement of Todd's method have been attempted over the years but his initial work still remains surprisingly consistent (Gilbert and McKern, 1973; McKern, 1957; McKern and Stewart, 1957; Meindl et al., 1985; Phenice, 1969; Suchley et al., 1986). Three areas of the pubic symphysis are used for age determination: dorsal plateau, ventral rampart, symphyseal rim. Each area is scored from stages 0–5. Each stage of the three components are characterized by distinctive developmental modifications of the pubic symphyseal facet. The biggest problem with using the pubis for age determination is that it is frequently missing from skeletal material. It lacks the preservation quality of other bones and this area of the pelvis is commonly broken.

Degenerative changes in the skeleton are often seen in old adults. Osteoarthritis of the articular joints can result from fractures that cause unnatural stress on the joints or from physiological wear and tear as a result of the aging process (Ortner and Putschar, 1985). Osteoarthritis causes destruction of the joint surface with abnormal production of bone around the rim of the articular surface (Kerley, 1970; Steele and Bramblett, 1988). Bone changes in the rim can be exhibited by only marginal lipping, eburnation, pitting, and osteophytes. Vertebral osteophytosis according to Ortner and
Puschar is not technically arthritis but because this regenerative change is similar to that seen in the joints, it is often classified in the osteoarthritis category. Osteophytosis of the vertebral column is seen as lipping on the vertebral bodies and has been associated with changes in the intervertebral disc (Goodman et al., 1984). Osteophytosis first occurs in the thirties but is seen in almost all individuals by the age of 60 (Steinbock, 1976). Goodman states that the lipping can range from marginal to severe with complete fusion of the vertebral bodies. Degenerative changes of the skeleton are usually associated with increasing age and are good indicators of cultural activity.

The OSM sample was divided into eight age categories: fetal (conception to birth), infant (0–2 years), early childhood (3–5 years), late childhood (6–12 years), adolescence (13–20 years), adult (21–49 years), old adult (50 + years) (El-Najjar and McWilliams, 1978; Steele and Bramblett, 1988). Another category was added, that of adolescence/adult. This particular age group was used when individuals possessed physical traits characteristic of both late adolescence and early adulthood. Fifty-one individuals in the OSM population were assigned to age categories (Table 1 and Figure 5). Subadult mortality rate was estimated to be 47%. Old adults represented only 13% of the population. The combined mortality distribution of all individuals other than old adults was 86%. The two categories which displayed the highest mortality rate was infant (29.4%) and adult (37.2%). Mortality decreased after infancy (early childhood 9.8%; late childhood 5.9%; adolescence/adult 1.96%) then sharply increased upon reaching adulthood. Infancy is a particularly stressful period with infants being highly
Table 1. Distribution of individuals by age.

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Number of Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetal</td>
<td>1</td>
</tr>
<tr>
<td>Infant</td>
<td>15</td>
</tr>
<tr>
<td>Early Childhood</td>
<td>5</td>
</tr>
<tr>
<td>Late Childhood</td>
<td>3</td>
</tr>
<tr>
<td>Adolescence</td>
<td>0</td>
</tr>
<tr>
<td>Adolescence/Adult</td>
<td>1</td>
</tr>
<tr>
<td>Adult</td>
<td>19</td>
</tr>
<tr>
<td>Old Adult</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>
Figure 5.

Age categories at Old Socorro Mission site.
susceptible to diseases resulting from weaning, poor sanitation, malnutrition or childhood diseases such as smallpox. Humphreys (1971) states that at the San Juan Capistrano Mission a common and recurrent mission epidemic was smallpox and syphilis (Castaneda, 1936; Schuetz, 1968).

The high mortality of the adult population can most likely be explained as the result of several factors. First, there is evidence of Pueblo Indian resistance to Catholic practices and the outbreak of hostilities as a result of the clash of religions (Jones, 1989). The Spaniards used the Piro and Tompiro warriors in campaigns to crush rebellions against the Athabaskans, causing the Athabaskans to regard their former allies as traitors and enemies to be destroyed with the Europeans (Earls, 1987; Forbes, 1960). There is also evidence that following European contact, Piro populations showed a substantial depopulation due to disease following epidemics that were recorded during the 17th and 18th centuries (Marshall, 1987). Father Juan de Prada recorded that the number of baptisms had decreased because of the prevalence of smallpox and a sickness called cocolitzli (Earls, 1987; Hackett, 1937). Another possibility for the high mortality of adults might be attributable to the increase of Apache predation on the Piro. Although the Piro maintained a trading relationship with the Plains tribes, there is some evidence that as a result of the Spaniards attempts to control the trade relationship between these two groups, the Apaches became increasingly hostile and created food shortages (Earls, 1987; Forbes, 1960; Marshall, 1987).

The OSM population displays almost an equal distribution of subadult and adult mortality rates. This distribution is significantly different than the demographic data
compiled on Mission San Juan Capistrano and Mission San Xavier (Table 2 and Figure 6). Both these missions displayed a much greater representation of adult interments. It should be pointed out that church internments may not be reflective of the total population, and this appears to be true of the OSM population. Given the fact that historical records document the high incidence of epidemics, such as smallpox, within the Indian population, a large number of subadult burials would not be unexpected. Also, the complete lack of adolescent burials would seem not to be representative of the various age categories expected in the OSM community.

SEX

Determination of sex provides important paleodemographic information about a population. If a population is biased towards one sex or the other it can be indicative of environmental or physiological stresses acting upon the group.

Various techniques have been designed to sex skeletal remains. The most popular of these techniques is based on observations of the morphology of the os pubis (Phenice, 1969). Other techniques include sexual differentiation of the skull (Keen, 1950), dentition (Ditch and Rose, 1972; Harris, 1980), tibia (Iscan and Miller-Shavitz, 1984), talus and calcaneus (Steele, 1976), femora (Black, 1978; MacLaughlin and Bruce, 1985), fragmentary skeletal remains (Kelley, 1979) and numerous others. These methods have been well documented in textbooks and there is no need to go into great detail except for those methods which were used for sexing the OSM population.
Table 2. Comparison of the number of individuals by age.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Adult</th>
<th>% of Adult</th>
<th>Subadult</th>
<th>% of Subadult</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Socorro Mission</td>
<td>27</td>
<td>53%</td>
<td>24</td>
<td>47%</td>
<td>51</td>
</tr>
<tr>
<td>Mission San Juan Capistrano</td>
<td>75</td>
<td>82%</td>
<td>17</td>
<td>18%</td>
<td>92</td>
</tr>
<tr>
<td>Mission San Xavier</td>
<td>11</td>
<td>85%</td>
<td>2</td>
<td>15%</td>
<td>13</td>
</tr>
</tbody>
</table>
Figure 6.
Comparison of age groups between mission sites.

Legend:

1 = Old Socorro Mission

2 = Mission San Juan Capistrano

3 = Mission San Xavier
Sex estimation of the OSM sample was based on the following criteria: 1) visual observations of the pelvis, 2) cranial features characteristic of the male and female skull, and 3) musculo-skeletal development of the long bones. These broad categories estimate sex by assessing the varying degrees of maleness and femaleness when comparing the same bone.

Nonmetrical methods based on visual inspection of the pelvis were used in the analysis of the OSM sample. Sex was assigned based on the following nonmetric criteria used by Krogman (1973), Phenice (1969) and Stewart (1979): 1) differences in the greater sciatic notch, 2) width of the pelvis, 3) presence of the ventral arc, 4) presence of a subpubic concavity, 5) width of the medial aspect of the ischio-pubic ramus, 6) width of the subpubic angle, 7) shape of the obturator foramen, and 8) the size and shape of the pelvic inlet.

Similar broad categories were used in evaluating the cranial features. The crania were examined for the presence of morphological traits characteristic of sexual dimorphism. Sex was assigned based upon the visual observation of the following traits which have been utilized by Bass (1987), Krogman (1973), Steele and Bramblett (1988), Stewart (1979), Ubelaker (1978): 1) supraorbital tori, 2) shape of the upper eye orbit edge, 3) size of the mastoids, 4) size of the zygomatics, 5) sites of muscle attachment on the occipital bone, 6) shape of the chin, 7) shape of the gonial angles of the mandible, and 8) the overall appearance of gracelessness or masculinity of the skull.

Long bones were also considered in the diagnosis of sex. Both visual evaluation and measurements were used in this assessment. Comparisons were made using
the width, circumference and lengths of the long bones. Sites of musculo-skeletal attachment were appraised for size differences. Also taken into consideration was the overall robustness of the bones. Sex was assigned based on methods utilized by Bass (1987), Black (1978), MacLaughlin and Bruce (1985), and Iscan and Miller-Shaivitz (1984). However, because there was a great deal of overlap between the sexes in regards to long bone measurements, this particular criteria was not used alone in assessing sex.

Whenever possible a combination of the three above criteria were used in determining sex. Not one particular method was found to be entirely accurate. Measurements taken on twelve individuals which possessed both cranial and pelvic elements displayed a disproportionally large number of males which overlapped with the female measurements. It was then determined that measurements alone were not sufficient for sexing this population. In order to get a more precise assessment determination of sex, it was necessary to use a composite of all skeletal features since a numerical cutoff point could not be derived.

It is necessary to point out a few possible explanations for the excess number of males versus females sexed in the OSM skeletal material. Weiss (1972) states that there is a significant excess of males sexed in worldwide archaeological skeletal samples. He states that one possible explanations for this bias could be a result of differential burial customs, unrepresentative sampling, or poorer preservation of female material. Bennike (1985) and Raisz (1982) suspect that female skeletons disintegrate more rapidly because of their slighter build and as a result of skeletal deterioration due
to osteoporosis occurring in postmenopausal women. Another possible explanations for sexing bias is that there is a tendency to assign the sex of male in various "racial" groups based on certain typological characteristics (Hooton, 1930; Walker et al., 1988; Weiss, 1972). Weiss points out that most sexing techniques are based on the "larger-smaller" characteristics. Therefore, the larger or more pronounced a trait is the more likely it is male. He claims that there is a temptation to call a skeleton male if the traits displayed are intermediate in nature. So, if this is the case, mortality profiles of skeletal remains would be distorted as a result of the number of excess males sexed. Thirdly, the church sample may not be reflective of the proportion of sexes present in the OSM population given that the age category data seems to differ greatly from other similar mission groups.

In the OSM population of the 23 adults assigned sex, 65% were males and 34.7% were females (Table 3 and Table 4). These numbers are similar to Hooton's findings in his study of Pecos Pueblo Indians in which 60% of 617 specimens were determined to be male. It is therefore necessary to suspect a certain amount inaccuracy in sexing those skeletal remains where measurements, cranial characteristics, and pelvic traits were not possible to obtain.
Table 3. Comparison of the number of individuals by sex.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Male</th>
<th>% of Males</th>
<th>Female</th>
<th>% of Females</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Socorro Mission</td>
<td>15</td>
<td>65%</td>
<td>8</td>
<td>35%</td>
<td>23</td>
</tr>
<tr>
<td>Mission San Juan Capistrano</td>
<td>25</td>
<td>65%</td>
<td>13</td>
<td>35%</td>
<td>38</td>
</tr>
<tr>
<td>Mission San Xavier</td>
<td>5</td>
<td>50%</td>
<td>5</td>
<td>50%</td>
<td>10</td>
</tr>
</tbody>
</table>

* Total sample based on adults whose sex could be estimated. Subadults not included.

Table 4. Age distribution by sex (only sexually mature individuals).

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescence</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adolescence/Adult</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Adult</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Old Adult</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>15</td>
</tr>
</tbody>
</table>
CHAPTER III
STATURE AND ROBUSTICITY

Two important assessments that can be made from skeletal remains are those of stature and robustness. Stature is considered an inheritable characteristic that is indicative of biological affinity. Robusticity is also linked to the degree of sexual dimorphism (biological differences) within a population. Both stature and robusticity have been shown to be indicative of nutritional health and environment stress acting upon a population.

STATURE

According to Trotter (1970), "Stature is quite as marked a racial character as a cephalic index." In studies of living populations made over two generations, it was determined that there is an extremely high genetic correlation between parental size and size of offspring (Garn, 1962). Conversely, the same way body size can be increased by stepping up the caloric surplus, it can also be adversely affected when there are insufficient amounts of protein and calories necessary for growth. The effects of protein-caloric malnutrition on bone growth is most clearly seen in the growth of tubular bones (Himes, 1978). Himes states that growth in length of tubular bones is depressed with prolonged fasting or starvation, chronic deficiencies in protein and calories, caloric deficiency, or protein deficiency. Stini's (1969) study of residents of Heliconia, Columbia also reflects the affect poor nutrition has on human growth and development. Stini reports that in addition to a diet inadequate in protein, a high
carbohydrate diet can produce frequent and extended periods of diarrhea. As a result of this prolonged physiological stress, an individual can be in a perpetual state of malnourishment which depresses growth. It has also been reported that individuals which are severely malnourished while young will not attain normal bone length even when protein-caloric intake is increased (Himes, 1978). Parasitic infection and vitamin D deficiency has also been found to retard normal long bone growth (Engfeldt and Hjertquist, 1961; Stini 1969).

Nutritional disturbances, as well as high fevers, can cause transverse lines (also called Harris lines) in the diaphysis of the long bones. These lines, or scars, are a result of growth being arrested. They are particularly important because their presence might indicate morbidity and the frequency of nutritional trauma of a population (McHenry, 1968). Park (1964) also reports that the appearance of transverse lines can be caused by a multitude of diseases such as: 1) measles, 2) scarlet fever, 3) pneumonia, 4) kwashiorkor, 5) leukemia, 6) vitamin A deficiency, and 7) chronic lead poisoning. Studies have also shown that by restricting protein intake transverse lines will be produced (Dickerson and McCance, 1961; Platt and Stewart, 1962). It is also possible to estimate the age of the individual when the Harris lines are formed by measuring the distance of the line from the growth plate (Ortner and Putschar, 1985). This can be extremely helpful in determining seasonal starvation.

Because stature can be affected by many factors, the accurate estimation of this particular trait can give important anthropological information. Trotter and Gleser (1952) developed one of the best known regression equations for the estimate of stature
in order to determine racial affinity of American Black and White World War II casualties. Later, Trotter expanded on these findings by including data completed from Korean War casualties and the Terry Anatomical Collection (Trotter, 1970). There have been other regression formulae developed for the estimation of stature. Steele and McKern (1969) have developed a method of using fragmentary long bones to calculate the maximum long bone length to predict living stature. Musgrave and Harneja (1978) also used a regression equation using metacarpal bone length and proved that there is a significant correlation coefficient between stature and metacarpal length in both sexes. However, for the purposes of the study on the OSM population, Santiago Genoves (1967) regression formulae will be used. Genoves work is of significant importance as it relates to estimates of stature in the Meso-American population. To insure that the cadavers Genoves measured were biologically affiliated to the native indigenous group, blood samples were taken to identify a homogeneous sample.

Estimations of stature in the OSM sample were reconstructed from intact long bones of mature individuals. Only those individuals which contained cranial elements, os coxae, or both were used so that stature could be correlated with sex. Calculations were done following the Genoves formulae for Meso-American populations. Long bones were measured using established anthropometric procedures.

Stature was estimated for 12 individuals from the OSM. Eight of these individuals were identified as males, four were identified as females. The femora and tibiae were not present in B-33 (male), therefore, estimate of stature was based on Trotter’s and Glessner’s (1958) regression formulae using bones of the upper limbs.
Both femora were sectioned in B-5 (female), therefore, only the tibia was used for estimating stature. The mean stature for both males and females in the OSM sample are provided in Table 5. Stature estimates for the 12 individuals are provided in Table 6 and again in Appendix A. Comparison between male and female stature based on the lengths of the femur and tibia are provided in Figure 7 and Figure 8. Based on the statistical analysis between the male and female statures there appears to be a significant difference between the two. However, it must be noted that females are less represented in the sample than males, and it is possible that there is far more overlap between the sexes than observed. The mean value for measurements of the long bones from OSM were compared to other prehistoric populations from Texas (Comuzzie, 1987; Doran, 1975). The lengths of the femur (Table 7) and tibia (Table 8) are provided for comparison. Males in the OSM sample were used for comparison to Doran's stature data (Table 9 and Table 10). It is also necessary to note that the Trotter and Glesser formulae will calculate a much higher estimate of stature than Genoves' formulae. Even though different formulae were used, it is interesting to note that the OSM sample overlaps the ranges given for Historic and Trans-Pecos stature estimates.

Comparison of femur lengths indicates that there is little significant difference between the OSM male sample and other regional areas of Texas, except for the Blue Bayou and the Trans-Pecos samples which are smaller (Table 7). Because of geographical proximity, it would be expected that both the OSM and Trans-Pecos samples would be the most similar in lengths, although the males do not reflect this.
Table 5. Mean stature at Old Socorro Mission site (cm).
N = Number of bones upon which stature was estimated.

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>16</td>
<td>167.58</td>
<td>3.41</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>156.26</td>
<td>3.87</td>
</tr>
</tbody>
</table>
### Table 6. Estimation of stature (cm).

<table>
<thead>
<tr>
<th>Burial</th>
<th>Sex</th>
<th>Element</th>
<th>Side</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>Male</td>
<td>Femur</td>
<td>Left</td>
<td>166.271 ± 3.417</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Left</td>
<td>163.234 ± 2.815</td>
</tr>
<tr>
<td>37</td>
<td>Male</td>
<td>Femur</td>
<td>Left</td>
<td>165.367 ± 3.417</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Left</td>
<td>163.82 ± 2.815</td>
</tr>
<tr>
<td>31</td>
<td>Male</td>
<td>Femur</td>
<td>Right</td>
<td>168.305 ± 3.417</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Right</td>
<td>166.585 ± 2.815</td>
</tr>
<tr>
<td>34</td>
<td>Male</td>
<td>Femur</td>
<td>Right</td>
<td>170.678 ± 3.417</td>
</tr>
<tr>
<td>22</td>
<td>Female</td>
<td>Femur</td>
<td>Left</td>
<td>162.53 ± 3.816</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Right</td>
<td>158.91 ± 3.513</td>
</tr>
<tr>
<td>20</td>
<td>Female</td>
<td>Femur</td>
<td>Left</td>
<td>150.75 ± 3.816</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Left</td>
<td>155.58 ± 3.513</td>
</tr>
<tr>
<td>18</td>
<td>Female</td>
<td>Femur</td>
<td>Left</td>
<td>153.60 ± 3.816</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Left</td>
<td>154.56 ± 3.513</td>
</tr>
<tr>
<td>17</td>
<td>Male</td>
<td>Femur</td>
<td>Left</td>
<td>165.141 ± 3.417</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Left</td>
<td>162.548 ± 2.815</td>
</tr>
<tr>
<td>5</td>
<td>Female</td>
<td>Tibia</td>
<td>Left</td>
<td>157.89 ± 3.513</td>
</tr>
<tr>
<td>33</td>
<td>Male</td>
<td>Humerus</td>
<td>Left</td>
<td>166.65 ± 4.24*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radius</td>
<td>Left</td>
<td>169.815 ± 4.04*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ulna</td>
<td>Left</td>
<td>172.282 ± 4.05*</td>
</tr>
<tr>
<td>32</td>
<td>Male</td>
<td>Femur</td>
<td>Left</td>
<td>175.085 ± 3.417</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Left</td>
<td>169.996 ± 2.815</td>
</tr>
<tr>
<td>28</td>
<td>Male</td>
<td>Femur</td>
<td>Left</td>
<td>168.757 ± 3.417</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tibia</td>
<td>Left</td>
<td>166.713 ± 2.815</td>
</tr>
</tbody>
</table>

*These estimates were calculated using the method developed by Trotter and Glesser (1958). All other estimates of stature utilized Genove’s (1967) formulae.
Figure 7.

Estimate of stature based on the femur by sex (cm).
Figure 8.

Estimate of stature based on the tibia by sex (cm).
Table 7. Comparison of femur lengths (cm) to other cultural areas.

<table>
<thead>
<tr>
<th>Site or Cultural Area</th>
<th>Sex</th>
<th>N</th>
<th>( \bar{X} )</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Socorro Mission</td>
<td>M</td>
<td>7</td>
<td>45.19</td>
<td>15.57</td>
<td>43.7 - 48.1</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>40.88</td>
<td>23.74</td>
<td>39.0 - 43.55</td>
</tr>
<tr>
<td>Historic(^1)</td>
<td>M</td>
<td>9</td>
<td>46.4</td>
<td>2.1</td>
<td>43.6 - 49.8</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>7</td>
<td>41.5</td>
<td>1.3</td>
<td>39.5 - 42.8</td>
</tr>
<tr>
<td>Trans - Pecos(^1)</td>
<td>M</td>
<td>4</td>
<td>42.2</td>
<td>2.5</td>
<td>39.8 - 45.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>42.4</td>
<td>1.3</td>
<td>40.9 - 43.5</td>
</tr>
<tr>
<td>Central Texas(^1)</td>
<td>M</td>
<td>18</td>
<td>45.7</td>
<td>1.7</td>
<td>43.0 - 49.1</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>7</td>
<td>43.8</td>
<td>1.2</td>
<td>41.2 - 45.2</td>
</tr>
<tr>
<td>Coastal(^1)</td>
<td>M</td>
<td>10</td>
<td>45.7</td>
<td>2.3</td>
<td>42.0 - 49.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>8</td>
<td>43.7</td>
<td>2.0</td>
<td>41.1 - 47.3</td>
</tr>
<tr>
<td>Caddo(^1)</td>
<td>M</td>
<td>15</td>
<td>45.4</td>
<td>2.0</td>
<td>40.8 - 48.3</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>43.0</td>
<td>0.9</td>
<td>42.1 - 43.8</td>
</tr>
<tr>
<td>Blue Bayou(^2)</td>
<td>M</td>
<td>4</td>
<td>42.2</td>
<td>2.40</td>
<td>40.6 - 45.7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1</td>
<td>39.0</td>
<td>-</td>
<td>39.0</td>
</tr>
</tbody>
</table>

\(^1\) These measurements were taken from Doran (1975).
\(^2\) These measurements were taken from Comuzzi (1987).
Table 8. Comparison of mean tibia lengths (cm) to other cultural areas.

<table>
<thead>
<tr>
<th>Site or Cultural Area</th>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Socorro Mission</td>
<td>M</td>
<td>6</td>
<td>36.59</td>
<td>14.41</td>
<td>35.1 - 38.9</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>34.17</td>
<td>7.40</td>
<td>33.4 - 35.0</td>
</tr>
<tr>
<td>Historic(^1)</td>
<td>M</td>
<td>6</td>
<td>37.7</td>
<td>2.8</td>
<td>34.6 - 42.3</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>6</td>
<td>34.9</td>
<td>0.8</td>
<td>33.6 - 35.7</td>
</tr>
<tr>
<td>Trans - Pecos(^1)</td>
<td>M</td>
<td>5</td>
<td>37.4</td>
<td>1.2</td>
<td>35.5 - 38.7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>2</td>
<td>35.6</td>
<td></td>
<td>35.4 - 35.8</td>
</tr>
<tr>
<td>Central Texas(^1)</td>
<td>M</td>
<td>14</td>
<td>39.2</td>
<td>1.7</td>
<td>35.6 - 41.8</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>6</td>
<td>35.8</td>
<td>1.6</td>
<td>33.0 - 37.8</td>
</tr>
<tr>
<td>Coastal(^1)</td>
<td>M</td>
<td>9</td>
<td>37.9</td>
<td>1.4</td>
<td>35.8 - 39.7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>37.0</td>
<td>1.4</td>
<td>35.1 - 38.4</td>
</tr>
<tr>
<td>Caddo(^1)</td>
<td>M</td>
<td>11</td>
<td>38.5</td>
<td>1.9</td>
<td>34.2 - 41.4</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>35.3</td>
<td>1.6</td>
<td>34.2 - 37.1</td>
</tr>
<tr>
<td>Blue Bayou(^2)</td>
<td>M</td>
<td>2</td>
<td>38.7</td>
<td>1.9</td>
<td>37.3 - 40.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1</td>
<td>34.5</td>
<td></td>
<td>34.5</td>
</tr>
</tbody>
</table>

\(^1\) These measurements were taken from Doran (1975).

\(^2\) These measurements were taken from Comuzzie (1987).
Table 9. Comparison of stature (based on femur lengths) to other cultural areas (cm).

<table>
<thead>
<tr>
<th>Site or Cultural Area</th>
<th>N</th>
<th>X</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Socorro Mission(^1)</td>
<td>6</td>
<td>168.51</td>
<td>3.52</td>
<td>165.14 - 175.09</td>
</tr>
<tr>
<td>Historic(^2)</td>
<td>8</td>
<td>122.45</td>
<td>4.31</td>
<td>166.31 - 179.64</td>
</tr>
<tr>
<td>Trans-Pecos(^2)</td>
<td>7</td>
<td>165.59</td>
<td>2.05</td>
<td>158.14 - 170.39</td>
</tr>
<tr>
<td>Central Texas(^2)</td>
<td>19</td>
<td>170.61</td>
<td>3.67</td>
<td>162.87 - 176.85</td>
</tr>
<tr>
<td>Coastal(^2)</td>
<td>12</td>
<td>171.25</td>
<td>4.69</td>
<td>162.87 - 178.99</td>
</tr>
<tr>
<td>Caddo(^2)</td>
<td>15</td>
<td>169.91</td>
<td>3.81</td>
<td>160.29 - 175.34</td>
</tr>
</tbody>
</table>

\(^1\) Reconstruction of stature based on Genoves formula (1967).
\(^2\) Reconstruction of stature taken from Doran (1975) following Trotter and Gleser reconstruction formula (1958).
Table 10. Comparison of stature (based on tibia lengths) to other cultural areas (cm).

<table>
<thead>
<tr>
<th>Site or Cultural Area</th>
<th>N</th>
<th>X</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Socorro Mission(^1)</td>
<td>6</td>
<td>165.48</td>
<td>2.81</td>
<td>162.55 - 169.99</td>
</tr>
<tr>
<td>Historic(^2)</td>
<td>8</td>
<td>170.75</td>
<td>5.85</td>
<td>164.14 - 182.55</td>
</tr>
<tr>
<td>Trans-Pecos(^2)</td>
<td>7</td>
<td>170.19</td>
<td>3.07</td>
<td>166.06 - 181.35</td>
</tr>
<tr>
<td>Central Texas(^2)</td>
<td>19</td>
<td>175.58</td>
<td>3.63</td>
<td>166.06 - 181.35</td>
</tr>
<tr>
<td>Coastal(^2)</td>
<td>12</td>
<td>172.01</td>
<td>3.01</td>
<td>167.01 - 175.85</td>
</tr>
<tr>
<td>Caddo(^2)</td>
<td>15</td>
<td>173.10</td>
<td>3.96</td>
<td>163.67 - 179.44</td>
</tr>
</tbody>
</table>

\(^1\) Reconstruction of stature based on Genoves formula (1967).
\(^2\) Reconstruction of stature taken from Doran (1975) following Trotter and Gleser reconstruction formula (1958).
A possible explanation for this discrepancy is that the sample size for both areas was relatively small and was probably not an accurate representation of the entire population. Statistical comparison of the mean lengths of the tibia indicates that the OSM sample is slightly smaller than the Historic, Trans-Pecos and Coastal sample sites (Table 8). Comparison of the humerus lengths of the OSM population seems to indicate that there is only a slightly significant difference between OSM and Historic, Trans-Pecos, Central Texas, Coastal and Blue Bayou sample sites (Table 11).

It is important to point out that most of the mean measurements used for comparison exhibited a difference of less than 1–2 centimeters, which is very minimal. In many instances, the sample size was quite small—especially in the case of Blue Bayou. Whether or not the few individuals used for statistical comparison were actually representative of their population is not known. Rather than concentrate on the mean for comparison, I believe it is more informative to look at the range as a base for comparison of stature estimates. When range is considered, a more reflective conservative estimator of variability within a population can be observed.

SEXUAL ROBUSTICITY

As in stature, the overall robusticity of a population is an important indicator of nutritional status and racial affinity. The degree of robustness is often synonymous with sexual dimorphism. In determining sexual robustness differences, males are characterized, on the average, by greater values than females (Jolicoeur, 1963). However, in
Table 11. Comparison of mean humerus lengths (mm) to other cultural areas. Doran's and Commuzzie's data carried to 1 mm only.

<table>
<thead>
<tr>
<th>Site or Cultural Area</th>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Socorro Mission</td>
<td>M</td>
<td>7</td>
<td>314.5</td>
<td>11.98</td>
<td>302.0 - 317.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>283.1</td>
<td>13.07</td>
<td>271.7 - 302.0</td>
</tr>
<tr>
<td>Historic(^1)</td>
<td>M</td>
<td>6</td>
<td>314.0</td>
<td>19.0</td>
<td>291.0 - 341.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>9</td>
<td>301.0</td>
<td>11.0</td>
<td>287.0 - 323.0</td>
</tr>
<tr>
<td>Trans - Pecos(^1)</td>
<td>M</td>
<td>4</td>
<td>297.0</td>
<td>22.0</td>
<td>269.0 - 322.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>291.0</td>
<td>9.0</td>
<td>283.0 - 301.0</td>
</tr>
<tr>
<td>Central Texas(^1)</td>
<td>M</td>
<td>21</td>
<td>325.0</td>
<td>16.0</td>
<td>293.0 - 362.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>8</td>
<td>304.0</td>
<td>13.0</td>
<td>290.0 - 330.0</td>
</tr>
<tr>
<td>Coastal(^1)</td>
<td>M</td>
<td>9</td>
<td>328.0</td>
<td>22.0</td>
<td>297.0 - 368.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>300.0</td>
<td>2.0</td>
<td>299.0 - 303.0</td>
</tr>
<tr>
<td>Caddo(^1)</td>
<td>M</td>
<td>10</td>
<td>331.0</td>
<td>11.0</td>
<td>313.0 - 349.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>6</td>
<td>304.0</td>
<td>20.0</td>
<td>278.0 - 333.0</td>
</tr>
<tr>
<td>Blue Bayou(^2)</td>
<td>M</td>
<td>2</td>
<td>316.0</td>
<td>8.0</td>
<td>312.0 - 320.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>2</td>
<td>296.0</td>
<td>10.2</td>
<td>288.0 - 303.0</td>
</tr>
</tbody>
</table>

\(^1\) These measurements were taken from Doran (1975).

\(^2\) These measurements were taken from Comuzzie (1987).
populations where malnutrition is severe and there is a significant lack of protein in the diet, the long-term effects will be more pronounced in the males (Stini, 1969). Therefore, in populations under-going nutritional stresses, the males will tend to be less sexually dimorphic than females. This is probably due to the role that sex hormones play in development. Stini cites, for example, that malnourished mothers will give birth to normal sized infants, thus supporting the theory that tissue resorption is under hormonal control.

In determining sexual dimorphism, many of the same criteria used in sexing skeletal material are the same criteria used for denoting robusticity. The degree of gracileness or robustness of certain skeletal features is frequently used in assessing sex. Since the previous chapter on sexing techniques went into great detail on the visual methods used to identify the varying degrees of maleness and femaleness, only a brief review will be discussed here.

Sexual robusticity can in part be determined by visual observation of skeletal features. One area frequently used in studies of sexual dimorphism is the skull. Cranial features denoted as male are increased chin depth, prominence of the brow, large mastoid processes, prominent nuchal crest and flaring of the gonial angles (Anderson et al., 1977; Krogman, 1973).

Studies of sexual robusticity have also focused on the long bones. Research using the humerus for studies of sexual dimorphism have shown that the maximum length and the vertical diameter of the humeral head are the most diagnostic of robusticity (Bass, 1987; Krogman, 1973; Stewart, 1979; Steele and Bramblett, 1988;
Trotter and Gleser, 1952). Less frequently used for robusticity estimates is the tibia. Iscan and Miller-Shavitz (1984) have developed a method for using the circumference at the nutrient foremen to assess sexual dimorphism of the tibia. In their study, the results indicated that sexual dimorphism was better assessed from the circumference in Whites, while length was a more accurate prediction in Blacks and American Indians.

Visual observation of the OSM sample indicates that the population appears to be sexually robust. The males upon examination displayed squared chins, prominent browridges, flaring gonial angles and muscle ridges on the occipital bone of the skull. The long bones appeared too relatively thick with well-defined areas of muscle attachment. Their overall appearance was rugged in comparison to the females. The females in the OSM population were definitely gracile in appearance. The skulls were smooth and small when compared to the males of this group. The long bones also appeared to be smaller with the sites of muscle attachment being less obvious.

Metrical analysis was also used to assess the robusticity of the OSM sample. Mean measurements and sexual comparisons tabulated from the humerus, radius, ulna, femur, and tibia appear in Tables 12–16. Comparison of humerus lengths to other cultural areas in Texas is provided in Table 11. Following Bass (1987), a robusticity index was calculated for both the humerus and femur (Table 17). The robusticity index provides an assessment of the relative size of the shaft. Comparison of the robusticity index of both the humerus and femur by sex are provided in Figure 9 and Figure 10. Examination of the data compiled in the robusticity index was less informative in determining the degree of sexual dimorphism. Although the sample size was small, the
Table 12. Mean measurements of the humerus (mm).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Length</td>
<td>M</td>
<td>7</td>
<td>314.6</td>
<td>11.9</td>
<td>302.0 - 317.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>283.2</td>
<td>13.0</td>
<td>271.7 - 302.0</td>
</tr>
<tr>
<td>Minimum Circumference</td>
<td>M</td>
<td>7</td>
<td>61.6</td>
<td>1.9</td>
<td>58.7 - 65.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>57.8</td>
<td>2.2</td>
<td>54.7 - 60.2</td>
</tr>
<tr>
<td>Minimum Diameter</td>
<td>M</td>
<td>7</td>
<td>18.7</td>
<td>1.4</td>
<td>17.0 - 20.7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>18.3</td>
<td>1.0</td>
<td>17.5 - 19.7</td>
</tr>
<tr>
<td>Vertical Maximum</td>
<td>M</td>
<td>7</td>
<td>44.5</td>
<td>2.2</td>
<td>42.2 - 47.5</td>
</tr>
<tr>
<td>Diameter</td>
<td>F</td>
<td>4</td>
<td>38.1</td>
<td>3.0</td>
<td>36.0 - 42.5</td>
</tr>
<tr>
<td>Biepicondylar Width</td>
<td>M</td>
<td>6</td>
<td>59.9</td>
<td>2.8</td>
<td>56.2 - 63.5</td>
</tr>
<tr>
<td>Articular Surface</td>
<td>F</td>
<td>4</td>
<td>51.8</td>
<td>1.2</td>
<td>50.5 - 53.5</td>
</tr>
<tr>
<td>Transverse Diameter</td>
<td>M</td>
<td>6</td>
<td>41.0</td>
<td>1.9</td>
<td>38.7 - 43.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>36.7</td>
<td>2.7</td>
<td>34.7 - 40.0</td>
</tr>
</tbody>
</table>
Table 13. Mean measurements of the radius (mm).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Length</td>
<td>M</td>
<td>8</td>
<td>244.2</td>
<td>10.9</td>
<td>227.5 - 254.7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>217.7</td>
<td>7.6</td>
<td>211.5 - 228.5</td>
</tr>
<tr>
<td>Minimum Circumference</td>
<td>M</td>
<td>8</td>
<td>39.2</td>
<td>1.1</td>
<td>37.5 - 41.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>34.7</td>
<td>.4</td>
<td>34.5 - 35.2</td>
</tr>
<tr>
<td>Minimum Diameter</td>
<td>M</td>
<td>8</td>
<td>12.7</td>
<td>.6</td>
<td>12.0 - 13.7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>11.7</td>
<td>.5</td>
<td>11.0 - 12.0</td>
</tr>
</tbody>
</table>
Table 14. Mean measurements of the ulna (mm).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Length</td>
<td>M</td>
<td>7</td>
<td>264.6</td>
<td>11.6</td>
<td>249.5 - 278.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>234.7</td>
<td>7.8</td>
<td>229.0 - 245.7</td>
</tr>
<tr>
<td>Physiological Length</td>
<td>M</td>
<td>8</td>
<td>237.2</td>
<td>10.2</td>
<td>223.2 - 249.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>208.8</td>
<td>7.1</td>
<td>202.5 - 218.0</td>
</tr>
<tr>
<td>Minimum Circumference</td>
<td>M</td>
<td>8</td>
<td>45.4</td>
<td>1.9</td>
<td>32.0 - 37.2</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>31.8</td>
<td>1.9</td>
<td>30.0 - 34.0</td>
</tr>
<tr>
<td>Minimum Diameter</td>
<td>M</td>
<td>8</td>
<td>10.8</td>
<td>1.2</td>
<td>9.2 - 12.7</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>9.8</td>
<td>1.0</td>
<td>9.0 - 11.0</td>
</tr>
</tbody>
</table>
Table 15. Mean measurements of the femur (mm).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Length</td>
<td>M</td>
<td>7</td>
<td>451.9</td>
<td>15.6</td>
<td>437.0 - 481.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>408.8</td>
<td>23.7</td>
<td>390.0 - 435.5</td>
</tr>
<tr>
<td>Bicondylar Length</td>
<td>M</td>
<td>7</td>
<td>448.4</td>
<td>16.0</td>
<td>434.7 - 480.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>404.9</td>
<td>26.4</td>
<td>385.5 - 435.0</td>
</tr>
<tr>
<td>Midshaft Circumference</td>
<td>M</td>
<td>7</td>
<td>88.6</td>
<td>3.6</td>
<td>84.5 - 93.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>81.6</td>
<td>5.3</td>
<td>76.7 - 87.3</td>
</tr>
<tr>
<td>Interior Diameter</td>
<td>M</td>
<td>7</td>
<td>29.7</td>
<td>1.2</td>
<td>28.2 - 32.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>26.3</td>
<td>1.7</td>
<td>25.2 - 28.2</td>
</tr>
<tr>
<td>Transverse Diameter</td>
<td>M</td>
<td>7</td>
<td>26.7</td>
<td>1.8</td>
<td>24.5 - 30.2</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>25.2</td>
<td>1.7</td>
<td>23.5 - 27.0</td>
</tr>
<tr>
<td>Bicondylar Width</td>
<td>M</td>
<td>7</td>
<td>82.6</td>
<td>4.6</td>
<td>76.0 - 88.6</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>72.9</td>
<td>3.0</td>
<td>70.0 - 76.0</td>
</tr>
<tr>
<td>Head Diameter</td>
<td>M</td>
<td>7</td>
<td>46.2</td>
<td>1.6</td>
<td>43.2 - 48.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>41.2</td>
<td>2.6</td>
<td>39.7 - 44.2</td>
</tr>
<tr>
<td>Anterior Subtrochanter Diameter</td>
<td>M</td>
<td>7</td>
<td>27.4</td>
<td>1.0</td>
<td>26.5 - 29.2</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>23.8</td>
<td>1.5</td>
<td>22.0 - 24.8</td>
</tr>
<tr>
<td>Transverse Subtrochanter Diameter</td>
<td>M</td>
<td>7</td>
<td>31.5</td>
<td>2.1</td>
<td>29.0 - 34.5</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>3</td>
<td>30.2</td>
<td>3.4</td>
<td>26.7 - 33.5</td>
</tr>
</tbody>
</table>
Table 16. Mean measurements of the tibia (mm).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Sex</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Length</td>
<td>M</td>
<td>6</td>
<td>366.0</td>
<td>14.4</td>
<td>351.0 - 389.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>341.7</td>
<td>7.4</td>
<td>333.7 - 349.7</td>
</tr>
<tr>
<td>Midshaft Circumference</td>
<td>M</td>
<td>6</td>
<td>93.0</td>
<td>4.6</td>
<td>88.7 - 99.2</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>81.9</td>
<td>5.6</td>
<td>74.7 - 87.0</td>
</tr>
<tr>
<td>Transverse Diameter</td>
<td>M</td>
<td>6</td>
<td>23.7</td>
<td>1.7</td>
<td>22.0 - 26.0</td>
</tr>
<tr>
<td>Minimum Diameter</td>
<td>F</td>
<td>4</td>
<td>22.4</td>
<td>1.2</td>
<td>21.0 - 24.0</td>
</tr>
<tr>
<td>Anterior/Posterior Diameter</td>
<td>M</td>
<td>6</td>
<td>35.2</td>
<td>.7</td>
<td>34.2 - 36.0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>4</td>
<td>29.8</td>
<td>3.2</td>
<td>26.2 - 32.5</td>
</tr>
</tbody>
</table>
Table 17. Robusticity index (cm).

**Burial 36:**

- **Humerus:** Robusticity = \( \frac{6.1 \times 100}{31.2} \) = 19.551
- **Femur:** Robusticity = \( \frac{2.9 + 2.625 \times 100}{43.9} \) = 12.585

**Burial 37:**

- **Humerus:** Robusticity = \( \frac{6.275 \times 100}{30.2} \) = 20.778
- **Femur:** Robusticity = \( \frac{2.925 + 2.6 \times 100}{43.475} \) = 12.708

**Burial 31:**

- **Humerus:** Has been sectioned.
- **Femur:** Robusticity = \( \frac{3.025 + 2.725 \times 100}{44.8} \) = 12.834

**Burial 34:**

- **Humerus:** Robusticity = \( \frac{6.5 \times 100}{32.6} \) = 19.938
- **Femur:** Robusticity = \( \frac{3.2 + 2.7 \times 100}{45.45} \) = 12.981

**Burial 22***:

- **Humerus:** Robusticity = \( \frac{6.025 \times 100}{27.9} \) = 21.594
- **Femur:** Robusticity = \( \frac{2.825 + 2.7 \times 100}{43.5} \) = 12.758

* Burial 22 was categorized as a female based on the gracile nature of the skull. Comparison of the skull and the morphology of the os coxa was not possible since the pelvis was not present.

**Burial 20:**

- **Humerus:** Robusticity = \( \frac{5.475 \times 100}{28.0} \) = 19.553
- **Femur:** Robusticity = \( \frac{2.525 + 2.525 \times 100}{38.55} \) = 13.099
Table 17. Continued.

Burial 18:

Humerus: Robusticity = \( \frac{5.85 \times 100}{27.175} = 21.527 \)

Femur: Robusticity = \( \frac{2.55 + 2.35 \times 100}{39.425} = 12.428 \)

Burial 17:

Humerus: Robusticity = \( \frac{5.875 \times 100}{30.7} = 19.136 \)

Femur: Robusticity = \( \frac{2.9 + 2.45 \times 100}{43.35} = 12.341 \)

Burial 5:

Humerus: Robusticity = \( \frac{5.775 \times 100}{30.2} = 19.122 \)

Femur: Both Femora have been sectioned.

Burial 33:

Humerus: Robusticity = \( \frac{6.2 \times 100}{31.75} = 19.527 \)

Femur: Not present.

Burial 32:

Humerus: Robusticity = \( \frac{6.1 \times 100}{33.4} = 18.263 \)

Femur: Robusticity = \( \frac{3.0 + 3.025 \times 100}{48.0} = 12.552 \)

Burial 28:

Humerus: Robusticity = \( \frac{6.05 \times 100}{30.35} = 19.934 \)

Femur: Robusticity = \( \frac{2.825 + 2.575 \times 100}{44.9} = 12.026 \)
Figure 9.

Robusticity index of the humerus by sex (cm).
Figure 10.
Robusticity index of the femur by sex (cm).
females appear to be equally dispersed within the males in both the femoral and humeral indices. Statistical comparison between the sexes for the femur suggests that only the transverse diameter and transverse subtrochanter diameter were not found to be significantly different, with the midshaft circumference being the most sexually dimorphic (Table 18). Comparison of the mean measurements of the humerus indicates that the minimum diameter appears to be the least sexually dimorphic. Doran (1975) stated that in his Trans-Pecos sample all elements except for the tibia exhibited very little sexual dimorphism. However, analyses of the OSM mean measurements indicate that all elements were equally sexual dimorphic. The mean maximum length of all the long bones appears to be the best indicator of sexual difference.

The overall appearance of the OSM population is one of being sexually robust. This is suggested from both visual observations and metric analysis. Based on this analysis, the males are markedly larger and more rugged than the females. This degree of difference observed in the OSM sample is comparable to other historical groups.
Table 18. Comparison of the mid-shaft circumference of the femur by sex (mm).

<table>
<thead>
<tr>
<th>Burial</th>
<th>Sex</th>
<th>Circumference</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>M</td>
<td>85.0</td>
</tr>
<tr>
<td>28</td>
<td>M</td>
<td>84.5</td>
</tr>
<tr>
<td>31</td>
<td>M</td>
<td>91.5</td>
</tr>
<tr>
<td>32</td>
<td>M</td>
<td>93.5</td>
</tr>
<tr>
<td>34</td>
<td>M</td>
<td>92.0</td>
</tr>
<tr>
<td>36</td>
<td>M</td>
<td>88.25</td>
</tr>
<tr>
<td>37</td>
<td>M</td>
<td>86.0</td>
</tr>
<tr>
<td>18</td>
<td>F</td>
<td>76.75</td>
</tr>
<tr>
<td>20</td>
<td>F</td>
<td>80.75</td>
</tr>
<tr>
<td>22</td>
<td>F</td>
<td>88.0</td>
</tr>
</tbody>
</table>
CHAPTER IV

DENTAL PATHOLOGY AND ANOMALIES

The dentition provides an invaluable historical record of an individual's general health. From childhood to death, the teeth and the associated underlying bone structure act as barometers of dietary specialization, disease, metabolic disturbances, nutrition, age, physical inheritance, food preparation, and cultural development. Additionally, there are anatomical variations between individuals, and this information combined with comparative dental pathology provides significant information about a population.

The purpose of this chapter is to report dental disorders observed in the individuals of Old Socorro Mission that would permit comparisons to other populations. The OSM samples were analyzed for the frequency of: 1) carious activity, 2) antemortem tooth loss, 3) abscesses, 4) periodontal infection, 5) linear enamel hypoplasia, 6) calculus, 7) unusual wear patterns, 8) traumatic injury, 9) anomalies, and 10) shoveling.

CARIES

Bhaskar (1986) and Pindborg (1970) define caries as a destructive process of the tooth structure caused by microbial activity on the surface of the tooth either on the occlusal surface, on the root, or in the interproximal regions. This lytic activity is thought to be initiated by bacterial fermentation which produces organic acids that demineralize the dental hard tissues. This fermentation process is stimulated by dietary factors such as the presence of carbohydrates or sugars (Larson, 1982, 1987; Larson et
al., 1991; Newbrun, 1982). Cariogenic activity can be accelerated if the quality of the enamel is defective or if the enamel is damaged or broken (Ortner and Putshar, 1985). Turner and Cheuiche Machado (1983) observed that there is a strong association between caries frequency and diet type, whereas Barmes (1977) reported that in addition to food, soil and water may also play a role in caries etiology. Caries became a much more widespread human health problem with the development of agriculture and its diet rich in carbohydrates (Turner, 1978, 1979, 1983). In Larson’s (1991) study of preagricultural and agricultural populations, he showed that there was a dramatic increase in the frequency of individuals affected by dental caries after the Spanish establishment of mission outposts in the sixteenth and seventeenth centuries. With the Spanish influence, the native populations began to rely less on native plants and animals, and put greater emphasis on plant cultigens such as maize. Larson’s sample showed a total dental caries increase of 47% after Spanish contact. However, the OSM doesn’t reflect such dramatic numbers.

Thirty-two individuals were examined for dental caries. This sample contained individuals ranging in age from late childhood to adult. A total of eleven (B-5, B-5*, B-18, B-20, B-22, B-32, B-36, B-37, S-20, S-29, S-38) displayed caries (34.37%). The number of caries ranged from one to five per individual (Table 19). However, as in the Larson sample, the OSM population exhibited the majority of the dental caries (Table 20) in the premolars (6.45%) and molars (80.64%).

A comparison was also made between the adult males and females at OSM (Table 21). All four of the female adults (B-22, B-20, B-18, B-5) displayed caries,
Table 19. Number of caries per individual.
Sample of 32 consists of those subadults and adults with more than one permanent tooth available for examination.

<table>
<thead>
<tr>
<th>Number of caries</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
</tr>
</tbody>
</table>
Table 20. Number of caries per tooth type.
$N =$ number of teeth examined.

<table>
<thead>
<tr>
<th>Tooth type</th>
<th>N</th>
<th>Number of caries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>PM</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>32</td>
<td>6</td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>PM</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>M</td>
<td>43</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>202</td>
<td>Total 31</td>
</tr>
<tr>
<td>Sex</td>
<td>Number of individuals</td>
<td>Number of individuals with caries</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
whereas three (B-36, B-34, B-32) out of seven males revealed evidence of carious activity. It is difficult to draw conclusions on the male/female comparison based on such a small sample size of females. Attempts have been made to explain cariogenic activity and gender differences. Physiological differences such as age of dental eruption and the stress of pregnancy have been cited in the literature as possible explanations for the typical higher frequencies of affected females when compared to the male population (Arafat, 1974; Bhaskar, 1986; Deakins, 1943; Larsen et al., 1991; Loe, 1965) although no consistent pattern has been determined. Another possible hypothesis for the discrepancy was proposed that women have a greater accessibility to food as a result of their involvement in plant gathering and food preparation (Dahlbert, 1981; Larsen et al., 1991; Lovejoy, 1981; Murdock, 1965; Swanton, 1946). As a result of this accessibility, females would have the opportunity to eat more frequently, therefore exposing the dentition to a constantly high level of the organic acids which cause carious lesion development (Konig, 1970; Larsen et al., 1991; Weiss and Trithart, 1969).

ANTEMORTEM TOOTH LOSS

Antemortem tooth loss is usually due to trauma or some kind of pathological process. Caries, excessive occlusal attrition which exposes the underlying dentin, abscesses, and periodontal disease all can be contributing factors causing premature loss of teeth (Goldberg et al., 1976; Goodman, 1983; Kennedy, 1983). In the OSM sample fourteen individuals exhibited antemortem tooth loss (B-36, B-37, B-34, B-22, B-20, B-17, B-5, B-33, B-32, S-27, S-38, S-29, S-20, B-30). Twelve of these individuals also
displayed partial or complete alveolar resorption (B-36, B-37, B-34, B-22, B-20, B-17, B-33, B-32, S-27, S-29, S-20, B-30). The burials which showed the most extensive tooth loss were B-32 with 27 teeth missing, S-25 with complete antemortem loss of all teeth of the maxilla (the mandible is not present), S-27 with 30 teeth missing, B-37 with 18 teeth missing and S-29 with the antemortem loss of 16 teeth. Other individuals with one to seven teeth missing are B-36, B-34, B-22, B-20, B-17, B-5, B-33, S-38 and S-20. Overall, out of 19 individuals with permanent dentition present, 14 exhibited varying degrees of antemortem tooth loss (Table 22). Two skulls were questionable as to whether or not the third molars were lost antemortem or not yet erupted (S-20, B-33). However, in the 17 to 25 year age range it is difficult to know without the use of radiography whether or not the third molars are impacted, have not yet erupted, or are congenitally absent (Goldberg et al., 1976).

ABSCESSSES

Abscesses result when the dentin is exposed through fractures, heavy wear or caries, and bacteria invade the pulp resulting in infection (Ortner and Putschar, 1985). This condition commonly causes tooth loss. An apical abscess can be identified by the presence of a fistula on the body of the mandible or maxilla, which in life would have been filled with purulent exudate (Goldberg et al., 1976). The typical location of this fistula is the apex of the root (Clarke et al., 1986). In the OSM sample six burials displayed evidence of abscession (B-36, B-37, B-22, B-32, S-29, S-20). The presence of this pathological condition and comparison to other Mission sites is seen in Table 23.
Table 22. Number of adults exhibiting antemortem tooth loss.

<table>
<thead>
<tr>
<th>Number of teeth lost</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>104</strong></td>
</tr>
</tbody>
</table>

|                          | Total 14               |

Table 23. Number of abscesses per individual.

<table>
<thead>
<tr>
<th>Burial</th>
<th>Sex</th>
<th>Number of abscesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-36</td>
<td>M</td>
<td>3</td>
</tr>
<tr>
<td>B-37</td>
<td>M</td>
<td>3</td>
</tr>
<tr>
<td>B-22</td>
<td>F</td>
<td>3</td>
</tr>
<tr>
<td>B-32</td>
<td>M</td>
<td>1</td>
</tr>
<tr>
<td>S-29</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td>S-20</td>
<td>M</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>
and Table 24. The majority of the abscesses were located in the maxilla (86.66%). The teeth most frequently attacked were the maxillary canines (33.33%). Males displayed a higher frequency of abscesses than females (Table 25).

PERIODONTAL DISEASE

According to Hildebolt and Molnar (1991), periodontal disease is the intermittent degeneration of the supporting tissues of the teeth--these tissues being the gingiva, cementum, periodontal ligament, and alveolar bone. This degeneration ultimately causes the wasting of the periodontal structures to the point that teeth are lost due to inadequate surface attachment for the ligaments because of a reduction of bony support. It is the crestal margin of the bone which undergoes this loss of surface cortical bone, thus exposing the porous cancellous structure of the supporting bone, usually with an accompanying change of the contour of the crest (Clarke and Hirsch, 1991). The progression of the disease is initiated by bacterial microbes which inevitably cause an inflammatory process that attacks the periodontal structures (Clarke et al., 1986). Periodontal disease was thought to have been a chronic, continuous disease process, however current research has brought this theory into question. Socransky et al. (1984) proposed a new model for the progression of this disease. They proposed that periodontal disease occurs in random bursts of activity which could occur within a period of a few days to a few months. These same sites either go through periods of remission which may never demonstrate destructive activity again, or may
Table 24. Comparison of percentage of dental pathological conditions.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Old Socorro Mission</th>
<th>Mission San Juan Capistrano</th>
<th>Mission San Xavier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Enamel Hypoplasia</td>
<td>10%</td>
<td>34%</td>
<td>63%</td>
</tr>
<tr>
<td>Caries</td>
<td>22%</td>
<td>28%</td>
<td>50%</td>
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<tr>
<td>Abscesses</td>
<td>12%</td>
<td>34%</td>
<td>63%</td>
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</table>
Table 25. Number of abscesses per tooth type.

<table>
<thead>
<tr>
<th>Tooth type</th>
<th>Number of abscesses</th>
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<tr>
<td>RI₁</td>
<td>2</td>
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<tr>
<td>RI₂</td>
<td>1</td>
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<tr>
<td>RC</td>
<td>3</td>
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<tr>
<td>LC</td>
<td>2</td>
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<tr>
<td>LPM₁</td>
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<tr>
<td>RPM²</td>
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<tr>
<td>RM¹</td>
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<tr>
<td>LM₁</td>
<td>1</td>
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<td>RM²</td>
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<td>R₂</td>
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<td>L₁</td>
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<tr>
<td>Total</td>
<td>15</td>
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be subjected to more periodic bursts of activity at later time periods. They reported that these active sites were predisposed to destruction as a result of the host’s inability to control the pathogen attacking the affected sites. To estimate the amount of alveolar bone loss, the distance from the cemento-enamel junction of the tooth to the crest of the alveolar bone is measured (Davies et al., 1969; Goldberg et al., 1976). Usually, affected areas exhibit a shelf-like margin instead of the normal knife-edged configuration (Clarke et al., 1986). However, in some populations marginal lipping of the crestal alveolar bone could also be a hyperfunctional response of the bone to the buccinator muscle being subjected to heavy functional use, and not a pathological indicator of some disease process (Clarke and Hirsch, 1991; Hirschfeld, 1923). It is necessary to take into account when assessing the dentition for periodontal disease the normal age-related changes of alveolar bone (Hildebolt and Molnar, 1991). There are many causes of periodontal tissue loss such as diet, attrition, hormonal deficiencies, continuing facial growth and environmental factors (Clarke and Hirsch, 1991; Hildebolt et al., 1988; Hildebolt and Molnar, 1991; Leight, 1925b).

In the OSM sample, 13 individuals (B-36, B-37, B-34, B-22, B-20, B-17, B-5, B-33, B-32, S-27, S-29, S-20, B-30) exhibited evidence of periodontal infection (Table 26). Burial 32 and skulls 27, 29 displayed the most extensive tooth loss with alveolar resorption and periodontal disease. Burial 32 has lost 28 teeth antemortem with boney remodeling of the socket region. Skull 27 contains only the right maxillary canine and the left first maxillary premolar with both the maxilla and mandible exhibiting full
Table 26. Presence of dental pathological conditions in individual burials.

<table>
<thead>
<tr>
<th>Burial Number</th>
<th>Caries</th>
<th>Enamel Hypoplasia</th>
<th>Abscessing</th>
<th>Antemortem Tooth Loss</th>
<th>Alveolar Resorption</th>
<th>Periodontal Infection</th>
<th>Shoveling</th>
<th>Wrinkling</th>
<th>Impaction</th>
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<td>36</td>
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<td>Skull 38</td>
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<td>Skull 29</td>
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<td>Skull 20</td>
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<td>Skull 25</td>
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alveolar resorption of all sockets. Skull 29 has lost 16 teeth antemortem with most of the tooth sockets displaying remodeling.

**ENAMEL HYPOPLASIA**

Another method of assessing dental health is the analysis of tooth enamel defects. Enamel forming cells, called ameloblasts, secrete the enamel matrix in a ring-like fashion, starting at the occlusal surface and ending at the bottom of the crown (Goodman and Armelagos, 1985). Any deficiency in the enamel formation is called hypoplasia. All growth occurring in the enamel and dentin formation proceeds regularly and rhythmically on a daily basis (Schour and Massler, 1940). If the ameloblast secretion is disrupted to a degree that they lose their functional ability, less matrix will be formed and the resulting enamel will be reduced (Goodman et al., 1980). Since the enamel formation occurs in a ring-like pattern (similar to tree growth), the enamel defects will be observed as horizontally aligned pits and transverse grooves occurring on the enamel surface (Cook 1981; Goodman et al., 1980; Massler et al., 1941; McHenry and Schulz, 1976; Schour and Massler, 1940; Smith, 1991). These permanent markers of growth disruption provide a record of developmental disturbances during an individual's later life (Cook, 1981). Enamel hypoplasia is a reflection of nutritional inadequacy (such as protein or vitamin deficiency), disease experience, childhood environmental stress, cultural factors (such as age of weaning) and metabolic dysfunction on the growing body (Garn et al., 1965; Keshover, 1960; Rose et al., 1978; Stini, 1969). Stini also reported that poor sanitation resulting in amoebic and helminthic
parasites, as well as a high carbohydrate diet, frequently produced extended periods of
diarrhea that could induce sufficient physiological stress that would affect enamel
development. Sarnat and Schour (1941) report that two-thirds of enamel hypoplasia
occurs during the infancy period (birth–1 year), one-third occurs during early childhood
(13–34 months) and only 2 percent during late childhood (35–80 months). However,
Schutz and McHenry (1975) reported in their California prehistoric hunter gatherer
population, peak enamel disturbance occurred between the ages of four to five.
Typically, the canine is used for analysis since the canines are sensitive to growth
disturbances and have a long developmental period of more than six years from shortly
after birth to approximately the seventh year (McHenry and Schultz, 1976).

In the OSM sample, five individuals exhibited evidence of enamel hypoplasia
(B-36, B-20, B-17, B-32, S-27). Table 24 and Table 26 indicate the frequency of this
condition found in this sample. Burial 36 displays enamel hypoplasia in both canines
and the second left incisor of the maxilla, and on all incisors, left canine, and both right
and left first premolars of the mandible. Burial 17 displays hypoplasia on the incisors
and canines of the mandible. Burial 32 has severe enamel hypoplasia on the mandibular
canines, however, because of the extensive antemortem tooth loss of 27 teeth, additional
information on this individual’s developmental disturbance is not possible. This is also
the case with Skull 27, which has lost 30 teeth antemortem, with only the right
maxillary canine and left first premolar present. The canine exhibits severe enamel
hypoplasia. Although only five individuals in the OSM sample revealed enamel distur-
bances, it must be remembered that the OSM population also had a high degree of tooth
loss. Therefore, it is possible that enamel hypoplasia occurred at a higher frequency than viewed, but was unable to be ascertained because of the extensive tooth loss.

**DENTAL ATTRITION**

Eccles (1982) defines attrition as a physical process whereby the tooth surface is removed through the movement and friction of the teeth against one another. It usually occurs on the occlusal surfaces and incisal edges. During the process of mastication, flattened facets develop parts of tooth-to-tooth contact. Attrition can also occur if food has been contaminated with abrasive substances such as grit or silt, or if the individual has consumed a diet high in abrasive carbohydrates (Dahlberg, 1960; Eccles, 1982; Turner and Machado, 1983). Leigh (1925b) reported attrition also occurring in those populations which masticated narcotics high in silicious alkalies.

Attrition can often be confused with erosion. However, erosion is a chemical process of enamel removal usually as a result of consuming an acidic food such as citrus fruits, or from gastric secretion caused by heartburn or vomiting (Eccles, 1982). In the case of erosion, the teeth will have a rounded, polished and almost translucent appearance.

Tooth wear can also be attributed to tool use. Molnar (1971) reported unique attrition patterns possibly related to basket making or other activities where tough fibrous material was either pulled or held with the teeth. He stated that these technological activities would eventually produce angling wear planes that were clearly not produced by normal dietary mastication. Turner and Machado (1983) reported
similar wear patterns in a Brazilian archaic population as a result of food preparation of the manioc. The Brazilian Indians processed the manioc by peeling or shredding the carbohydrate layer from the woody root with the upper anterior teeth. Comuzzie and Steele (1987) also reported severe attrition in a prehistoric coastal population of Texas.

Dental attrition has also been used to estimate age. However, it is necessary to have reliable information regarding diet and food processing for specific wear patterns to be used in determining age estimates (Walker et al., 1991).

Molnar (1971) rates dental attrition in eight states: 1) cusp pattern unworn, 2) facets with minimal wear, 3) cusp pattern partially obliterated with small dentine patches visible, 4) two or more dentine patches visible in the premolars and three or more dentine patches visible in the molars, 5) extensive dentine visible in the incisors, premolars and molars, 6) secondary dentine visible in the incisors, premolars and molars but tooth still surrounded by enamel, 7) enamel worn away on at least one side of the tooth, and 8) only roots functioning in the occlusal surface. This categorization will be used for description of the OSM samples.

Two OSM samples exhibited minimal wear (B-36, B-17). Burials 33, 34, 37 displayed partially obliterated cusp patterns with small dentine patches exposed. Burial 32 had lost 27 teeth antemortem, but the RC-, LC-, and LPM₂ exhibited extensive wear. Skull 27 also displayed extensive wear on the RC- and LPM₁ (30 teeth lost antemortem). Skull 29 showed extensive wear on the RPM², LM², RPM₁, LPM₁ and LM₁, with the LM₁ having a cupped-shape appearance and extensive secondary dentine exposure. Unusual wear patterns were evident in S-20 and B-28. These two samples presented
a unique pattern of wear which angled labially on the mandibular and maxillary incisors. Although there has been some discussion that unusual wear patterns are most frequently seen in females as a result of the sexual division of labor, both of these individuals appear to be male.

SHOVELING

Hrdlicka (1920) was one of the first to document the unusual characteristic of shovel-shaped in mongoloid racial groups. This particular trait seen in American Indians can be described as prominent marginal ridges on the mesial and distal lingual aspect of the upper incisors. These ridges may be so noticeably raised that the lingual surface of the teeth will have an extremely visible fossa, thus giving the impression of a shovel (Bass, 1987; Goldstein, 1948; Leigh, 1925b; Steele and Bramblett, 1988). Turner et al. (1991) have developed a method of standardizing the scoring of this morphological feature with the use of plaster casts. This classification system rates the presence of shoveling from faintly visible (1) to barrel shaped (7).

Turner (1987) explained the presence of this dental feature as not being environmentally induced, but a genetically inherited characteristic. This trait has been linked to the Asian population and suggests a genetic relationship between American Indians and Asians. Harris (1980) has suggested that there is a correlation between sex differences and shoveling. He reported that lingual shoveling is statistically more common in female than in male American Indians, Asians, Pacific Islanders and
Caucasians. Harris proposed a genetic model suggesting a "dosage effect" from the X chromosome.

In the OSM population, many of the individuals displayed shovel shaped upper incisors (Table 26). Burials 22, 20, 18, 17, 5, 21 and 11 had the distinctive marginal ridging associated with this dental variation. Four of these individuals were females (B-5, B-18, B-20, B-22). Burial 17 was the only male. Sex was indeterminate in B-11 and B-21 since both of these individuals were subadults. However, as in the case of enamel hypoplasia, shovel shaped incisors could have occurred at a much greater frequency than reported, but with the extensive tooth loss it was unable to be ascertained.

ANOMALIES

The OSM population exhibited several dental anomalies (Table 26). Enamel pearls are an extension of the crown enamel that has clustered between the roots. They are often obscured from view if the teeth are imbedded in the alveolus (Bass, 1987). Enamel pearls are considered a common dental variation (Taylor, 1978). An enamel pearl is present on the right $M_3$ of B-28.

Another dental anomaly present in several individuals was a distinctive "fold" or wrinkle in the enamel, located midway on the lingual surface and horizontally positioned, of the upper incisors. Burials 5, 18, and 22 exhibited this unusual trait. The enamel fold appears to be a developmental disorder and not a result of tool usage,
disease or crowding. This dental anomaly has not been reported in other literature and may be unique to this particular population.

Impaction of the molars is a common dental disorder, most frequently occurring in the third molars (Taylor, 1978). This disorder is usually a result of tooth crowding. Ortner and Puschar (1985) state that tooth and jaw development are independent of each other and, because of this independence, the size of the two types of structures may not be congruent. Impaction is seen more often in the mandible. Three individuals in the OSM population display evidence of impaction (B-16, B-18. S-38). Burial 16 is a child, aged 2-3 years, with an impacted left DM². Both B-18 and S-38 exhibit an impaction of the right M³.

COMPARISON

Miller's (1989) study compared only four dental pathological conditions in the Mission San Juan Capistrano and Mission San Xavier populations: caries, abscesses, periodontal infection, and linear enamel hypoplasia. Percentages given were based upon the total population and all age categories were included (Table 24). Comparison to the OSM sample was also calculated based upon the total population number. However, this statistical method of calculating dental pathologies is probably not truly reflective of the adult population. Dental comparison should probably be made based on only those individuals with permanent dentition since sub-adult burials less frequently display dental pathologies, given the length of time it takes for most dental disease to manifest itself.
Carious activity was present in 22% of the OSM population, 28% in Mission San Juan Capistrano and 50% in Mission San Xavier. Evidence of abscesses was seen in 12% of the OSM sample, 34% in Mission San Juan and 63% in Mission San Xavier. Areas of lysis typical of periodontal infection were identified in 25% of the OSM burials, 24% of Mission San Juan and 13% of Mission San Xavier. Linear enamel hypoplasia was seen in 10% of the OSM population, 34% of Mission San Juan and 63% of Mission San Xavier.

The OSM sample was almost consistently lower in the number of dental pathological conditions observed. These percentages would be dramatically higher if only the adult population was used for statistical comparison: caries 48%, abscesses 26%, periodontal infection 57%, and linear enamel hypoplasia 22%. In each case, the percentages more than doubled when excluding the juvenile burials.

Statistical differences between the Mission San Juan and Mission San Xavier samples were thought to be a result of contrasting subsistence strategies. According to Miller (1989), Mission San Xavier was only active for eight years, with the individuals only having intermittent contact with Europeans. It was assumed that this Indian group probably maintained a hunter/gather type life-style, combined with food preparation techniques, a heavy amount of occlusal wear would cause the higher rate of dental pathologies observed. Miller also states that the Mission San Juan population was primarily agriculturist, who spent most of their lives under direct European influence. Although this population subsisted on a diet high in carbohydrates, which has been demonstrated to stimulate carious activity, differences in types of foods eaten and food
The OSM population was probably more similar to the Mission San Juan population. The Piro Indians were known to be agriculturalist even before Spanish contact. Even prior to their resettlement into the El Paso area, the Piro had been under direct Spanish influence since the early 1600's. Although it would be expected that the OSM and Mission San Juan samples would be nearly equivalent in the number of dental pathologies observed, the OSM sample exhibits fewer pathological findings. This discrepancy may be the result of dietary or regional differences between the two populations, such as fluoride in the ground water.
CHAPTER V
SKELETAL PATHOLOGY

The occurrence and prevalence of disease within a community is an indicator of population health within a locality. In those pathological conditions affecting bone, diagnosis of skeletal disease can be determined by direct observation, radiographs, histological examination, and, in some cases, microbiological culturing. While identifying specific pathological processes, it is important to take many factors into consideration such as: 1) age, 2) sex, 3) genetic affinity, 4) geographic location, and 5) time period (Ortner and Putschar, 1985). Although bone lesions can be attributed to a specific disease process, a variety of other disorders can cause similar pathological lesions. Metabolic disorders, trauma and hematolytic disorders are a few of the disturbances capable of causing osteolysis and osteonecrosis. Assignment of a diagnosis to a skeletal lesion is best done recognizing that there is a significant degree of uncertainty of the diagnosis since relatively few pathological conditions leave visible changes in dry bone. Generating a list of differential diagnoses may be more practical. Evaluation of dry bone epidemiology is an assessment, dependent upon the judgement and accuracy of the analyst, arrived at by using comparative techniques and deduction.

The OSM population was examined for the presence of any pathologic lesions. Diagnosis was based upon gross appearance of the bones, the pattern of lesions on the skeleton, and in some cases, x-ray images. Identification of disease was ascertained following the criteria established by Ortner and Putschar (1985), Steele and Bramblett (1988), and Steinbock (1976). As a result of the numerous pathologic conditions
identified in the OSM sample, it was necessary to separate the various disorders into several broad categories. Specific morbid conditions seen in the OSM population were classified as: 1) degenerative disease, 2) infectious disease, 3) anemia, 4) traumatic injuries, 5) skeletal dysplasia, 6) suture anomalies, 7) developmental anomalies, and 8) cultural modifications.

A complete description of skeletal pathological findings found in the OSM sample is detailed in Appendix A.

DEGENERATIVE DISEASE

Degenerative disease, for the purposes of this study, will be identified as those disorders where there is a retrogressive pathological change in which function or skeletal quality may be impaired or destroyed. Included in this category are osteoarthritis, osteophytosis and osteoporosis.

OSTEOARTHRITIS: Degenerative joint disease (DJD), also termed osteoarthritis, is a disorder of diarthrodial joints characterized by deterioration and abrasion of articular cartilage and formation of new bone at the joint surfaces (Steinbock, 1976). DJD is considered slowly progressive with visible bone changes occurring after years of repeated trauma to the articular cartilage (Ortner and Putschar, 1985). Onset of osteoarthritis is influenced by many factors such as age, sex, functional stress, endocrine agents and hereditary factors (Jurmain, 1977; 1980). In adults past middle age, these degenerative changes are associated with the physiological wear and tear to the fibrocartilage linked to the aging process. In young adults, DJD occurs in response to
a congenital defect, trauma or an infectious disease such as pyogenic osteomyelitis or tuberculosis (Steele and Bramblett, 1988; Steinbock, 1976). In the appendicular skeleton, DJD is most frequently seen in the knee followed by the first metatarsophalangeal joint, hip, shoulder, elbow, acromioclavicular joint, and sternoclavicular joint (Ortner and Putschar, 1985). The articular surfaces will often feature pitting, eburnation (giving the bone surface a polished appearance), enlargement of the ball and socket joints, or marginal lipping (Ortner and Putschar, 1985). In the lower limbs, DJD tends to be expressed symmetrically on both sides of the body, probably as a result of biomechanical stresses being evenly distributed over the weight-bearing articular surfaces (Jurmain, 1980). However, Jurmain reports that in the upper limbs, especially the elbow, DJD is usually asymmetric, most likely due to the functional stress of right-left handedness.

**OSTEOPHYTOSIS:** In the vertebral column, equivalent changes can be seen in the centrae, spinous processes and facets. Vertebral osteophytosis is characterized by bony protrusions on the cortex of the vertebral body and has been associated with degeneration of the intervertebral disc (Goodman et al., 1984). Extensive proliferation of osteophytes can cause fusion of the vertebral bodies producing ankylosis. Osteophytosis most frequently occurs in the lumbar and lower thoracic region.

In the skull, DJD can occur in the temporomandibular joint. Osteoarthritis seen in this region is thought to be associated with trauma or from mechanical demands from tool use.
OSTEOPOROSIS: Osteoporosis is a degenerative disease involving the loss of bone mass. Usually seen in postmenopausal women and elderly men, the compact bone will have a porous appearance due to the bone trabeculae becoming sparse and thin. As a result of the onset of old age, an imbalance between the sex hormones (estrogen and androgen) and adrenal glucocorticoid hormones causes a cessation in normal osteoblastic activity (Steinbock, 1976). Although osteoporosis is normally attributed to advanced aging, it is also a secondary pathological finding that can be associated with other skeletal disease such as scurvy, rickets, Cushing's syndrome, osteogenesis imperfecta, hyperparathyroidism, Gaucher's disease, sickle cell disease, and rheumatoid arthritis. In osteoporosis initiated by aging, the areas of the skeleton which are most frequently affected are those sites abundant in cancellous bone: the vertebrae, ribs, sternum, pelvis, skull, scapulae, and neck of the femur can manifest osteoporosis.

COMPARISON: Ten burials on the OSM sample displayed the presence of some form of degenerative disease (B-17, B-20, B-24, B-28, B-31, B-32, B-33, B-34, B-37). All were male except for one female (B-20). Five burials (B-28, B-31, B-32, B-33, B-37) revealed evidence of osteoarthritis. Moderate degenerative joint disease was primarily seen in the articular surfaces of the long bones in B-28, B-31 and B-37. Both B-32 and B-33 displayed severe osteoarthritis in all areas of the body. B-32 exhibited DJD on both scapulae, both clavicles, the left humerus, sternum, left ulna, right femur, right and left tibiae, and left tarsae. B-33 revealed pronounced osteoarthritis on both scapulae,
both clavicles, the right humerus, left and right radii, left ulna, and the hand and wrist bones.

Similar degenerative changes were also seen in the vertebrae. All nine of the adult males with morbid conditions also exhibited osteophytosis. It is interesting to note that only four of these males were in the old adult age category, with the remainder of the males ranging in age from 20-40 years. Although vertebral osteophytosis can occur as early as 30 years of age, the presence of this condition in young adults is most likely symptomatic of severe physical stress. Stewart (1947), however, suggests that degeneration of the vertebrae is indicative of population variation affecting movement. Steinbock (1976) indicates that all areas of the spine can be affected by osteophytosis and this is certainly true of the OSM sample. Assessment of all the vertebrae of the adult males reveals varying degrees of vertebral osteophytosis ranging from moderate to severe. Individual B-17 displays osteophytosis on L5. In individual B-24, an old adult, all lumbar vertebrae show evidence of osteophytosis. The presence of degenerative disease occurs on L2 of B-28. The sacral/pelvis articulation of B-31 also displays osteophytes. Old adult B-32 exhibits osteophyte formation on C1-2, T1 and L1-5. In the case of individual B-33, there is extensive osteophytosis of C2-5, all thoracic and lumbar vertebrae. Adult male B-34 reveals vertebral osteophytosis of T7-12 and L3-4. Fusion of the cervical vertebrae occurs in B-36 from C1-5 with disease progressing to T1. There are also osteophytes present on the lower thoracic vertebrae extending to L5. In individual B-37, vertebral osteophytosis occurs on C-2, T9-10 and L2-4.
The only evidence of osteoarthritis occurring in the skull is seen in B-20 which exhibits degenerative change in the temporomandibular joint with subluxation of the left condyle.

Two individuals (B-20, B-31) display evidence of osteoporosis. In B-20 (female), the left scapula shows evidence of bone loss on the superior acromion. In the case of B-31 (male), this condition was noted by the thin cortex of the right humerus.

*Schmorl's Nodes:* Schmorl's nodes are viewed as small, shallow depressions, usually only a few millimeters across, located on the body of the centrum in the vertebral column. The depressions can be located on the either the inferior or superior surface.

*Comparison:* Schmorl's nodes were identified in five individuals (B-22A, B-28, B-32, B-36, B-37). All the nodes were located in either the thoracic or lumbar vertebrae. Only B-22A was sexed female with the remainder identified as male.

**Infectious Disease**

Infectious disease is a generalized term used to describe the invasion of a foreign microorganism and the subsequent pathology caused by the host's immune response, or inflammatory response to that organism, or the actual damage caused by the organism itself.

*Periostitis:* Periostitis is an acute inflammatory disease of the periosteum which affects the underlying bone and is most commonly caused by an infectious process.
Infection of the periosteum occurs after a microorganism has been introduced, usually from an infected lesion or trauma. The most common bacteria capable of producing this osseous lesion are *Staphylococcus aureus* or *Streptococcus* species. Both Ortner and Putschar (1985) and Steinbock (1976) agree that periostitis is not only an isolated process, but that it can also occur as a secondary pathological finding as part of the expression of a special disease, such as syphilis. The resulting inflammation gives the periosteal bone formation an irregular, porous and thickened appearance. The long bones, especially the tibiae, are the most commonly affected, although any areas of the skeleton can be susceptible to infection.

*TREPONEMAL INFECTION*: Endemic syphilis, venereal syphilis, yaws, and pinta are four treponemal infections of which only the first three may have the effect of causing osseous lesions in the skeleton. Whereas yaws and pinta are primarily restricted to tropical environments, the historical record has traced the worldwide spread of venereal and endemic syphilis following colonization. Since a vast amount of research has been done on the origin, etiology and epidemiology of syphilis, for the ease of discussion, only a brief review of information critical for the assessment of this study will be discussed.

The origin of syphilis has been much debated. There is some argument for treponematosis having originated in the New World and appearing in Europe after the return of Columbus (Pusey, 1938; Baker and Armelagos, 1988). Skeletal evidence of treponemal infection has been found in many geographic areas of the United States, such as the southeast (Bullen, 1972), Midwest (Morse, 1973), Northern Plains (Walker,
1983), Texas (Comuzzi et al. 1986, Goldstein, 1957; Humphreys, 1971; Jackson, 1933) and the Southwest (Hooton, 1930; Cole et al. 1955).

Untreated acquired syphilis requires an incubation period of approximately three weeks (unless contracted in utero), which eventually leads to serious complications, such as debilitation and death (Rudolph, 1989). Syphilis attacks the bones, producing periostitis and, in some cases, osteitis which may occur on a single bone, along the whole length, or in one or more isolated areas at one time (Dennie, 1928). Although the flat bones are less frequently affected, the skull—especially the frontal—is the most commonly attacked, followed by the proximal end of the clavicle, the sternum, nose, and hard palate (Dennie, 1928). Destruction of the bone may produce a localized thickening, perforation, coarsely striated, "worm-eaten" excavations or puckered scars (caries sicca) when healed (Dennie, 1928). In the long bones, the tibia followed by the femur, fibula, humerus, radius/ulna, are sites of osseous syphilis (Steinbock, 1976). According to Steinbock, bone involvement usually begins with a periosteal inflammation followed by subperiosteal bone formation. As a result of the new bone being deposited on the cortex, there will be a marked diaphyseal expansion (Baker and Armelagos, 1988; El-Najjar, 1979). These proliferative bone changes resulting from syphilis can also include narrowing of medullary canals, superficial cavitation, and pathological fracture (Baker and Armelagos, 1988). The vertebrae are less frequently affected. Steinbock reports that the cervical vertebrae are usually the only sites of involvement. Rarely more than two vertebrae are involved. Vertebral involvement often resembles osteophytosis.
TUBERCULOSIS: Tuberculosis (TB) is an infectious disease caused by Mycobacterium tuberculosis. Transmission of infection occurs by airborne droplets being coughed up by an infected person and inhaled by persons repeatedly breathing contaminated air. Dissemination of the organism occurs via the lungs to lymph nodes and then into the blood stream to other organs (Grange, 1980). Any bone or joint can be involved, but the most common lesions occur in the vertebrae (frequently at or near the 10th thoracic vertebra) ribs, knee, sternum, and hip (Grange, 1980; Lawrence, 1989). The weight-bearing joints of the legs follow next in frequency (Lawrence, 1989; Steinbock, 1976). In the spinal column the common areas of involvement are the thoracic and lumbar vertebrae, with the cervical spine affected only 2-3% of the time (Wolinsky, 1992). Destruction of the vertebrae usually begins in the intervertebral disc which causes narrowing of the disc space, followed by destruction of the two adjacent vertebral bodies (Wolinsky, 1992). Progression of the disease in the spine can result in deformity (Pott’s disease), collapse, and ankylosis (El-Najjar, 1979; Kelley and El-Najjar, 1980). Lesions in the ribs and sternum are circular, varying in depth and ranging in size. TB in the hips and knees produces an arthritic destruction characterized by pitting, erosion, subluxation, and periostitis along the adjacent surfaces of the diaphyses (Kelley and El-Najjar, 1980). TB lesions can often resemble other pathologies: metastatic carcinoma, vertebral trauma (fracture and compression), pyogenic osteomyelitis, and mycotic infections such as actinomycosis, coccidioidomycosis, and blastomycosis (Kelley and El-Najjar, 1980; Ortner and Putschar, 1985; Steinbock, 1976).
Susceptibility to TB can be dependent upon many factors; poor nutrition, fatigue, diabetes mellitus, and environmental stress have been known to increase susceptibility. There is also some evidence to support that the theory of genetic predisposition to tuberculosis does exist. The extreme susceptibility and high mortality of American Indians following European contact seems to indicate a racial pre-disposition (Clark et al., 1987; Kelley and El-Najjar, 1980).

TB has been reported in specimens from Pecos Pueblo, New Mexico (Hooton, 1930) and Pueblo Bonito, New Mexico (Judd, 1954). El-Najjar (1979) suggests that the Pueblo Indians of the American Southwest were particularly susceptible to TB because of their crowded and poorly ventilated habitation spaces.

**COCCIDIOIDOMYCOSIS:** Coccidioidomycosis is a fungal infection caused by *Coccidioides immitis*, an organism indigenous to the deserts of the American Southwest, Mexico and South America. The arthrospore is dispersed by wind currents and is contracted by inhalation where it disseminates into the osseous tissue. The appearance of lesions can be described in two forms: a scooped-out area of destruction or an irregularly destroyed area of cortex with some periosteal new bone formation (Benninghoven and Miller, 1942). The lesions are usually 5 to 32 mm in size (Buikstra, 1976). Although these "punch-out" lesions resemble cloacae, when viewed macroscopically they do not appear to drain into a cavity (Fink, 1985).

A striking characteristic of this disease is its multiple site involvement and the symmetry of the lesions. There is a tendency for *Coccidioides* to attack the bony prominences, ligamentous insertions, and metaphyses of the weight-bearing areas of the
skeleton, although all areas of the skeleton are susceptible (Dalinka et al., 1971). The ribs and vertebrae show the highest frequency of involvement, probably due to their close proximity to the lungs. Bone involvement in the ribs usually occurs in the midshaft region and is much more prevalent with *C. immitis* than with tuberculosis (Long and Merbs, 1981). In the vertebrae, there is a predilection for the thoracic vertebrae to be affected first, followed by the lumbar and cervical vertebrae (Buikstra, 1976). According to Long and Merbs (1981), the transverse and spinous processes, as well as the bodies, can be the sites of erosive activity. Infection of the pelvis will typically display symmetrical lesions on the ischium, iliac, and pubic symphysis (Dalinka et al., 1971). Frequently, infection of the femoral neck is seen as a result of the direct extension from the pelvis to the femur. Diaphyseal destruction in the long bones is rare with *C. immitis*. More frequently the joints will have the highest percentage of lytic disease (Bisla and Taber, 1976; Fink, 1985). There is no particular site of susceptibility in the skull. The frontals, parietals, and occipital can all be involved, although infection of the temporomandibular joint is rare (Benninghoven and Miller, 1942). Erosive lesions in the skull will have a "punched-out" appearance. These sites are reactive areas in response to soft-tissue abscesses.

Mortality rates for *C. immitis* infections are significantly greater in age groups younger than five years and older than 50 years (Sievers, 1974). Males generally show a greater susceptibility to infection, although Buikstra (1976) suggested that the uneven sex distribution may reflect occupational specialization (i.e., agricultural labor) that increases risk of exposure.
COMPARISON: The presence of periostitis was seen in five burials (B-18, B-20, B-24, B-31, B-36). Periosteal infection was noted on the ribs in B-18, B-24 the right clavicle, and in B-31 the right tibia and right femur. Two individuals, B-20 and B-36, had extensive periostitis present in all areas of the skeleton indicating widespread infection.

Evidence consistent with treponemal infection was seen in two individuals (B-20 and B-36). In the case of individual B-20, a well-healed puncture area was present on the right frontal boss. In addition both tibiae, femora, ulnae, radii, humeri, and clavicles exhibit significant periosteal inflammation characteristic of the skeletal distribution not commonly associated with syphilis. In B-36, similar osseous lesions were seen. This individual also displayed two areas of lysis on the right frontal orbit and severe periostitis with destruction in the vertebrae, clavicles, scapulae, sternum, ribs, humeri, ulnae, pelvis, femora, and tibiae consistent with syphilis. (See Figure 3.)

The case of B-36 presents a unique, but perplexing pathological problem. A detailed description of B-36 is provided in Appendix A. Multiple areas of lysis are found in nearly every bone in the skeleton (Figures 11–14). Although many of the osseous lesions are consistent with treponemal infection, more than one systemic condition appears to be present. Many of the pathological conditions displayed may be more indicative of mycotic or mycobacterial infection, since syphilis infrequently attacks the vertebrae, ribs, pelvis, and scapulae. All these areas, particularly the cervical vertebrae and the midshaft of the ribs, showed such widespread destruction that syphilis alone cannot be responsible. To ascertain a possible etiology, B-36 was sent to Arizona State University, Department of Anthropology, where it was examined by Drs. C. F.
Figure 11.

Periostitis of the cervical vertebrae

with subsequent fusion of the vertebrae to the skull (Burial 36).
Figure 12.

Severe periostitis of the sternum, lateral view (Burial 36).
Figure 13.

Periostitis of the ribs (Burial 36).
Figure 14.

Radiograph of ribs showing severe widespread periostial infection (Burial 36).
Merbs, B. D. Ragsdale and Ph.D. candidate Elizabeth Miller. They concluded that the pathological conditions displayed appeared to be the result of two conditions, treponemal infection and metastatic disease (specifically prostate cancer). In their opinion, metastatic disease was indicated by the lysis of the sphenoid, sternum, scapulae, ribs, and ilia.

Prostatic cancer, however, doesn't seem compatible with the age category of this individual. Prostate cancer normally attacks older adult males past the age of 50 and increases with each passing decade of life (Blair, 1990; Perez et al., 1989). In studies done of males with advanced prostatic cancer and osteosclerotic metastases, the mean age was 72 years (Elomaa et al., 1992). When prostate cancer metastasizes, it most commonly affects the soft tissue (lymph nodes, bladder, rectum, lungs, liver) and the bones of the pelvis and lower spine by the way of the vertebral veins (Blair, 1990; Perez et al., 1989). Studies indicate that 50–65% of prostate cancer cases are localized, while 20–25% are metastatic (National Cancer Institute, 1993). Pathologic fractures are occasionally seen, with lytic metastases in the subtrochanteric areas of the femur (Perez et al., 1989). Mortality rates of males with advanced prostatic cancer are approximately 70% at the end of five years (Elomaa et al., 1992; Klein, 1979). In the case of B-36, this individual is a young adult, approximately 25-35 years old, which is much younger than the typical age seen in individuals with prostatic cancer. Also, based on the advanced degree of bone lysis, this individual would have had to develop the disease in his late teens or late twenties which is also extremely rare in prostatic carcinoma. Although it may not be possible to reach a definitive diagnosis, since more than one
disease process may be at work in B-36, a list of possible alternatives in order of
decreasing likelihood is offered: treponemal infection, coccidioidomycosis, tuberculosis,
metastatic disease. The most likely diagnosis is a combination of treponemal infection
and coccidioidomycosis. This conclusion is based upon the lytic areas visible in the
tibiae, frontal and sternum, which are indicative of treponemal disease, and coccidioides
by the multiple sites of involvement seen in the vertebrae, ribs, clavicles and scapulae.
This diagnosis of coccidioidomycosis is also supported by Dr. Paul Sledzik and Dr.
Marc Micozzi (1993) of the Armed Forces Institute of Pathology. Upon reviewing
slides and radiographs of B-36 they stated that given the appearance of lesions, the
location of the osseus lesions, age of the individual, and the geographical location of
the burial, strong evidence for fungal infection particularly coccidiomycosis, is
suggested.

NEOPLASIA

Neoplasia is a pathological process which results in the formation of abnormal
tissue, that grows by cellular proliferation more rapidly than normal, and continues to
grow after the stimuli that initiated the new growth ceases. It can display partial or
complete lack of structural organization and functional coordination with the normal
tissue, but usually forms a distinct mass of tissue.

OSTEOMA: According to Ortner and Putschar (1985) osteomas are benign neoplastic
lesions consisting of dense lamellar bone found almost exclusively in the skull.
Osteomas are initiated by an osteosclerotic response of the bone to a lesion. Sometimes
called "button" osteomas, they are viewed as circular projections frequently located on
the parietal or frontal region of the cranium. Usually the osteoma remains relatively
small in size with the average being not more than two centimeters. In comparison to
the bone of the cranium, the texture of the osteoma is smooth and ivory-like.

COMPARISON: The OSM sample was examined for evidence of neoplastic disease.
Three individuals exhibited button osteomas (B-22, B-33, B-37). In the case of B-22,
one osteoma was located on the occipital and a second osteoma was visible on the left
parietal. B-33 yielded one osteoma on the frontal region. Multiple button osteomas
were present on B-37. Three osteomas were located on the left parietal and one
osteoma on the right parietal.

POROTIC HYPEROSTOSIS: Porotic hyperostosis is a condition characterized by areas
of diploë expansion with erosion of the outer table of the bone. As the outer table
thins, the inner trabeculae become exposed, thus giving the bone a coral-like
appearance. Pathological lesions associated with porotic hyperostosis are usually limited
to the roof of the orbits and the cranial vault. Active lesions produce raised areas of
reactive bone with an appearance similar to sponge. Healed lesions of porotic
hyperostosis will be expressed as pitting, characterized by smaller porosities (Angel,
1967; El-Najjar et al., 1976; Hengen, 1971; Moseley, 1963; Ortner and Putschar, 1985;
Steele and Bramblett, 1988; Steinbock, 1976).

Porotic hyperostosis has been attributed to several disorders. Its presence has
been associated with congenital hemolytic anemias (i.e., sickle cell anemia), dietary
deficiencies, bacterial infections, prolonged breast feeding, parasitic infection and heart
disease (Britton et al., 1960; El-Najjar et al., 1976; Martinez-Torres and Layrisse, 1974;
Nice et al., 1964; Ortner and Putschar, 1985; Smith, 1954; Steele and Bramblett, 1988;
Steinbock, 1976; Stuart-Macadam, 1987). El-Najjar (1976) described porotic hyperosto-
sis in Anasazi Indians resulting from iron deficiency caused by a dietary imbalance of
protein and maize. He states that, since many of the Southwestern Indians depended
on maize as a main food source, hematopoietic disorders were fairly common.

**COMPARISON:** In the OSM sample three individuals exhibited evidence of porotic
hyperostosis (B-5, B-17, B-2019). All three individuals displayed symmetrical lesions
on the skull. Burial 5 revealed lesions on both sides of the sagittal/lambdoidal suture
junction. Indication of porotic hyperostosis is evident in B-17 on both the right and left
parietal along the sagittal suture line. In the case of B-2019, evidence of porotic
hyperostosis is visible along the sagittal and coronal suture on both parietals and on the
occipital, but very well-healed.

**TRAUMATIC INJURIES**

Fractures are one of the most common traumatic injuries affecting the skeleton.
Ortner and Putschar (1985) state that the term fracture is used to describe any traumatic
event that results in partial or complete discontinuity of a bone. Fractures occur as the
result of an externally applied force which can be sudden or continuous. Torsion is also
included as a traumatic injury. Although the trauma acting upon the bone is insufficient
to cause a break, the stress is excessive enough to cause a post-traumatic deformity.
COMPARISON: Three individuals (B-32, B-34, B-36) exhibited pathological findings indicative of fracture. Burial 32 (male) displayed multiple areas of skeletal trauma on the right side of the body. The right and left nasals have been broken but are healed. There is an un-united fracture of the right ulna (Figure 15). The apposing ends show significant bony remodeling. There is also an un-united fracture of the right third rib. The right fourth and fifth rib have been fractured but have fused offset. Burial 34 (male) displays evidence of a possible fracture of the ulna, very old and well-healed. Individual B-36 exhibits a possible pathological fracture of a right mid-rib associated with an area of lytic activity.

SKELETAL DYSPLASIA

Skeletal dysplasia, for the purposes of this study, will be termed as any pathological disorder causing abnormal tissue development of the cartilage or bone in which infectious disease or trauma can be ruled out.

COMPARISON: In the OSM sample, one individual B-18, the right femur displays a femoral head torsion of 30° with a three-centimeter shortening of the bone in comparison to the left femur (Figure 16 and Figure 17). The left fibula is also two centimeters shorter than the right fibula and does not articulate with the left tibia at the proximal end. The etiology of this condition is unknown, although possible causes could include a traumatic injury which possibly injured the epiphysis and disrupted the blood supply, a congenital abnormality, or a pathological condition such as polyostotic fibrous dysplasia which causes asymmetric distortion of the bone.
Figure 15.

Un-united fracture of right ulna of Burial 32.
Figure 16.

Torsion of femoral head of Burial 18.
Figure 17.

Shortening of the right femur and left fibula of Burial 18.
Burial 18.
One female (S-38) displayed evidence of skeletal dysplasia in the area of the nasals by a condition referred to as "saddle nose" (Figure 18). Although the etiology of saddle nose in this particular individual is unknown, the evidence of saddle nose has been attributed to several pathological conditions. Saddle nose is a secondary pathological finding in individuals with kidney disease, proteinuria, pyoderma gangrenosum, necrotizing sinusitis, rheumatoid arthritis, inherited nasal chondropathy, relapsing polychondritis, chondrodysplasia punctata, short arm deletion of chromosome 1 (Fallot’s syndrome), muscular dystrophy, fragile-X syndrome, fetal alcohol syndrome, cardiac anomalies, hypergonadotropic hypogonadism, Down’s syndrome, syphilis, and atrophic rhinitis (Baser et al., 1990; Eustis and Yaplee, 1990; Kramer et al., 1990; Kurien and Seshadri, 1989; Ohashi, 1992; Saruta, 1990; Tabata, 1991; Trepel et al., 1989). Since B-38 contained no post-cranial elements, no specific pathological condition could be attributed to the saddle nose deformity.

SUTURE ANOMALIES

Two common variations of the cranial sutures are Wormian ossicles and Inca bones. Wormian ossicles are small bones scattered along the suture line which arise when there are multiple ossification centers. An Inca bone is a portion of the occipital bone that ossifies in the membrane at the point at which the temporoparietal, temporoccipital, and lambdoidal sutures meet. The Inca bone can persist into adulthood if the suture remains unfused (Steele and Bramblett, 1988).
Figure 18.

Skull 38 exhibiting "saddle nose".
COMPARISON: Eight individuals (B-6A, B17, B-20, B-25, B-32, B-33, B-37, S-29) exhibited the presence of Wormian ossicles. In all cases the Wormian ossicles occurred along the lambdoidal suture line. Only two individuals were female (B-6A, B-20), with the remainder identified as male. A very large Inca bone was present in the occipital bone of S-20. This individual was also identified as male. It is interesting to point out that 47% of the adult male population from this sample had suture anomalies. The high number of suture anomalies is probably indicative of a small breeding population where gene flow is restricted.

CULTURAL MODIFICATIONS

As a result of a chronic but mild trauma inflicted upon a bone, the normal shape may be altered. This type of deformity may be the result of an intentional artificial modification which is cultural in nature or an unintentional deformation produced by a unique physical activity.

SQUATTING FACETS: Facets and articular extensions on the femur have been offered as evidence for habitual squatting (Ubelaker, 1979). The facets can be identified as smooth areas on the bone located above the posterior-superior margins of the femoral condyles. They are produced by stress brought about by frequent hyperdorsiflexion of the joint and articular cartilage. Any activity such as a kneeling or working posture can produce these facets if the activity is chronic.
**COMPARISON:** Three individuals (B-6B, B-28, B-32) in the OSM sample displayed squatting facets. Two of these individuals (B-6B, B-28) exhibited the facets in both the right and left femur. Burial 32 revealed a facet only on the left femur. All three of these individuals were identified as male.

**CRANIAL DEFORMATION:** Cranial deformation is a generic term used to describe asymmetry of the cranium or flattening of the occipital as a result of pressure placed on the cranium. One type of unintentionally caused deformation is typically the result of the individual sleeping on a hard surface during infancy and childhood (Ortner and Putschar, 1985). In some populations, intentional cranial deformation was practiced and appears to be connected with the beginnings of "high culture" (Munizaga, 1976). This type of cranial deformation was induced either by banding or tablets.

**COMPARISON:** Nine individuals (B-5, B-6A, B-17, B-18, B-20, B-22A, S-27, S-29, S-38) exhibited flattening of either the right or left side of the occipital (Figure 19). This skeletal modification does not appear to be intentional, but more likely the result of lying on a hard surface. A recent study has shown that infants characteristically adopt a lateral head position which increases nasal airflow through the upper nasal passage (Martin et al., 1988). This could be a possible explanation for the unusual flattening pattern seen in this population. Only three of these individuals (B-17, S-27, S-29) were identified as males, the rest were females.
Figure 19.

Cranial deformation of Burial 18.
Skull 20 exhibited an unusual cranial shape. The cranium appears to have an elongated appearance with a low sloping forehead. However, it is not possible to determine if this was a result of intentional deformation.

DEVELOPMENTAL ANOMALIES

Developmental anomalies, for the purposes of this study, will be defined as those conditions not pathological in nature, but those that are structurally unusual or deviate from the norm. The following conditions will be discussed and identified: 1) bifid sacral hiatus, 2) septal aperture, 3) asymmetry, 4) vertebral variation, and 5) endochondral ossification.

**BIFID SACRAL HIATUS:** A common defect in the sacral area of the spine is a condition classified as bifid sacral hiatus (also called spina bifida occulta). It is identified as an incomplete bony fusion of one or several spinous processes in the sacrum (Ortner and Putschar, 1985).

**COMPARISON:** Seven individuals (B-6A, B-17, B-24, B-28, B-32, B-33, B-36) displayed a bifid sacral hiatus of the sacrum (Figure 20). Only B-6A was identified as female.

**SEPTAL APERTURE:** At the distal end of the humerus, a foramen may be present extending through the olecranon fossa. This foramen, called a septal aperture, can vary in size and has been reported more frequently in females (Hrdlicka, 1932; Bass, 1987).
Figure 20.

Bifid sacral hiatus of Burial 36.
**COMPARISON:** Three individuals (B-17, B-18, B-22A) exhibited the presence of a septal aperture at the distal end of the humerus. Both B-18 and B-22A were identified as female and B-17 as male.

**ASYMMETRY:** Occasionally, opposite sides of the body or the extremities will exhibit a noticeable inequality of bone length. This condition can be the result of an infectious disease (i.e., poliomyelitis), trauma to the epiphyses that retards normal growth, or a developmental deviation.

**COMPARISON:** In the case of B-20, the left zygomatic articulation is shorter with the left condyle significantly smaller than the right condyle (Figure 21). Inspection of the mandible does not reveal any indication of trauma, but is probably due to a developmental anomaly. Another individual, B-18, displays a right femur which is three centimeters shorter than the left (Figure 17). The left fibula is also two centimeters shorter than the right fibula (Figure 17). Upon examination, neither the femur or fibula reveals any evidence of any pathogenic process. Both B-18 and B-20 were sexed female.

**VERTEBRAL VARIATION:** A common variation of the vertebrae is either an increase or reduction in the functional number of vertebrae per segment (Steele and Bramblett, 1988).
COMPARISON: One individual B-32 (male), exhibited the presence of one extra lumbar vertebrae and the congenital absence of the left transverse process of L1 (Figure 22).

ENDOCHONDRAL OSSIFICATION: The formation of osseous tissue with cartilage is termed endochondral ossification. Typically this ossification process is the method by which bones grow in length however, this condition can be viewed as a developmental anomaly when it occurs in cartilage which does not normally ossify.

COMPARISON: In the case of B-33 (male), a small section of the trachea was ossified. This anomaly could possibly be representative of a skeletal disorder called diffuse idiopathic skeletal hyperostosis (DISH). Occasionally, skeletal sites subject to abnormal stresses respond by extensive ossification in such areas as ligaments, tendons or cartilage (Resnick et al., 1978). DISH has also been known to accompany co-existing diseases such as rheumatoid arthritis. Clinically, DISH generally affects individuals older than 60 years and usually accompanies abnormalities of the vertebrae, such as osteophytosis (Resnick et al., 1978).

COMPARISON OF PATHOLOGICAL FINDINGS TO MISSION SAN JUAN CAPISTRANO AND MISSION SAN XAVIER

In Miller's (1989) study, three pathological conditions were used for comparison: porotic hyperostosis, cribra orbitalia, and periosteal infection. The incidence of the disorders was used for comparison between the OSM population and the other two
Figure 22.

Congenital absence of the left transverse process (Burial 32).
mission sites (Table 27). Porotic hyperostosis was present in only 6% of the OSM sample, in 59% of Mission San Juan and in 40% of Mission San Xavier. Cribra orbitalia is a pathological condition not previously discussed in this study. It can be viewed as an area of extensive vascularization in the orbital plate. No evidence of cribra orbitalia was seen in the OSM population, nor in the Mission San Xavier sample. This condition was noted in 32% of the Mission San Juan population. Periosteal infection was identified in 10% of the OSM sample, in 78% of Mission San Juan and in 39% of Mission San Xavier.

The appearance of these particular pathological disorders was consistently lower in the OSM population. Although both porotic hyperostosis and cribra orbitalia, and to some degree periosteal infection, have been attributed to dietary imbalances, it would be difficult to speculate upon the causes for the lower frequencies of pathological conditions viewed in the OSM sample. It is worth noting, however, that the individuals at the OSM, upon examination, lacked pathological changes normally attributed to malnutrition, which could possibly explain the absence of lesions typical of hemolytic anemias. Possibly the OSM population had access to more stable regional food sources not available at the other missions, if agricultural crops failed. Whether the presence of disease reflects nutritional differences or perhaps a population’s ability to adapt to biological stresses, is difficult to say. However, in comparison, individuals at the Old Socorro Mission appear to be less affected by infectious disease than the inhabitants of the other missions.
Table 27. Comparison of percentage of skeletal pathological conditions observed. Percentages based on the total population.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Old Socorro Mission</th>
<th>Mission San Juan Capistrano</th>
<th>Mission San Xavier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porotic Hyperostosis</td>
<td>6%</td>
<td>59%</td>
<td>40%</td>
</tr>
<tr>
<td>Cribra Orbitalia</td>
<td>0</td>
<td>32%</td>
<td>0</td>
</tr>
<tr>
<td>Periosteal Infection</td>
<td>10%</td>
<td>81%</td>
<td>39%</td>
</tr>
</tbody>
</table>
It has been documented that following missionization, there was an overall decrease in the health of the native population. However, when the OSM population is compared to other mission groups, results indicate that this native group appeared to experience a higher level of health and nutrition. This is suggested by the lack of pathological lesions consistent with chronic disease and the pronounced degree of sexual dimorphism between the sexes.

Appendix C provides a listing of the skeletal disorders present and the burials which were affected. Both males and females are relatively robust in comparison to stature, with the males displaying characteristic evidence of strong muscle attachments. The presence of numerous dental disorders, although high in frequency, is not unexpected in an agricultural society. In the adult burials, skeletal disorders seem to be equally distributed between the sexes. However the large number of subadult burials, suggests that childhood was particularly stressful and mortality was most likely the result of an acute etiologic process. The overall impression of the OSM sample seems to indicate a well-nourished population, although the large number of young adults with osteoarthritis is reflective of the physically demanding lifestyle of an agricultural community.
CHAPTER VI
SUMMARY

The Old Socorro Mission is the oldest Spanish Mission known in Texas. The population analyzed consisted of the Piro Indians who resided at the mission. The sample consisted of 51 individuals of both sexes and all age categories. The large sample size has added significantly to the understanding of the effect European contact had on native populations.

It was possible to estimate the age of 51 individuals: 1 fetal, 15 infant, 5 early childhood, 3 late childhood, 1 adolescent/adult, 19 adult, and 7 old adult. Comparison of the age distribution to two other Spanish missions revealed that the OSM sample consisted of an equal number of adult and sub-adult individuals, not consistent with the findings at Mission San Juan Capistrano and Mission San Xavier. Both San Juan Capistrano and San Xavier showed the greatest percentage of mortality in the adult age category. However, this might be explained by the fact that sub-adult remains may have been poorly researched at these sites. Soil conditions and methods of recovery could have also played a role in the recovery of sub-adult burials. There is a sharp decrease in mortality in the adolescent age category. This would seem to indicate that once a child was past late childhood, prospects of reaching adulthood were high. Mortality again sharply increased in adulthood.

The overall sex ratio of the OSM population was almost 2:1 in favor of males. Of a total of 23 adults that had either pelvic or cranial elements, the number of males totaled 15. This proportion was identical to the findings of the Mission San Juan
Capistrano sample, but is different than the 1:1 distribution exhibited in the Mission San Xavier population. This deviation has several possible explanations. One possibility is that there is a significant excess of males sexed in worldwide archaeological skeletal samples. Since most sexing techniques are based on the "larger-smaller" characteristics, intermediate skeletal material is often sexed as male, which could result in an excess number of males being identified. Differential burial customs favoring high status individuals or one sex would additionally introduce a systematic error when appraising the sample population. Unrepresentative sampling or poor preservation of female skeletal material could have also been a factor in the male bias of this sample. Although a possible explanation may never be determined, the sex ratio of the OSM and San Juan Capistrano samples are consistent with Hooton's findings in his study of the Pecos Pueblo Indians, and may just be the norm.

Stature and robusticity have been shown to be indicative of biological affinity, nutritional health, and environmental stress. Estimates of stature and sexual dimorphism in the OSM sample were reconstructed from measurements taken from intact long bones of mature individuals. Male and female statures differed significantly. Females were smaller in stature than the males, although it must be remembered that females were less represented in the OSM population and it is possible that there is more overlap between the sexes than was observed in this small sample. There was little significant difference between the estimated stature of the OSM sample when compared to other regional areas of Texas.
Visual observation indicated that the OSM population appeared to be relatively robust. The males and females displayed a noticeable degree of sexual dimorphism. Metric analysis used for assessing robusticity, however, was not informative. Comparison of mean measurements tabulated for the humerus, radius, ulna, femur, and tibia indicated that the females appeared to be equally dispersed within the male measurements.

Studies have shown that both stature and robusticity can be influenced by nutrition. Insufficient amounts of protein and calories can adversely affect bone growth. Malnourished individuals do not attain normal bone growth and upon visual inspection appear to have a gracile appearance. Therefore, the males will lack the robusticity expected in a well-nourished population. This is not the case with the OSM sample. The males, upon examination, display well-defined areas of muscle attachment, prominent browbridges, flaring gonial angles, and muscle ridges on the occipital bone. The females appear small and gracile in comparison. This would be expected in a well-nourished population.

The dental pathology of the OSM sample was also very revealing. Numerous pathological conditions were observed. Nineteen of the 26 adults exhibited some level of pathogenic activity in the dental remains. Cariogenic activity was noted in 11 of the adults. Two hundred and two teeth were examined, with a total of 31 teeth displaying caries. Comparison between the OSM population and the other two mission groups indicated that there was a significant difference. The Mission San Juan Capistrano population revealed that 28% of the individuals exhibited caries and the Mission San
Xavier showed 50%, whereas the OSM sample findings indicated a 22% cariogenic activity. Since caries are stimulated by dietary factors such as the presence of carbohydrates, and have been known to have become a major health problem with the development of agriculture, this discrepancy may indicate that the OSM population was less dependent on plant cultigens than the other missions.

Antemortem tooth loss was seen in 15 of the 26 adult burials. Frequently, caries, excessive occlusal attrition, abscesses, and periodontal disease contribute to premature loss of teeth. All the individuals also exhibited alveolar resorption to some degree accompanying the tooth loss. Six of the adults exhibited extensive tooth loss ranging from 16 to 32 lost. Nine other burials displayed evidence of antemortem tooth loss ranging from 1–7 missing. Statistically, this reveals that 58% of the adult population or 29% of the total population (all age categories) exhibited, to some degree, a premature loss of teeth. Unfortunately, comparative data were not available for the Mission San Juan Capistrano and Mission San Xavier samples.

The presence of abscesses were viewed in six of the adult burials. Apical abscesses were most frequently seen in the maxilla (86.6%). The Mission San Xavier sample revealed that 63% of the total population exhibited abscessing and Mission San Juan Capistrano 34%, whereas the OSM sample exhibited 12%. Again, this could be related to dietary factors, tool use, or trauma.

Enamel defects are good indicators of nutritional inadequacies, metabolic dysfunction, or parasitic infection. Typically, the canine is the most sensitive to growth disturbances because of its long developmental period. Five individuals exhibited
evidence of enamel hypoplasia. Comparison between the total populations of the other two mission sites showed that the OSM sample revealed 10% of the population with linear enamel hypoplasia, Mission San Juan Capistrano 34%, and Mission San Xavier 63%. However, it must be remembered that the OSM population had a high degree of antemortem tooth loss in the adult population, therefore it is possible that enamel hypoplasia could have occurred at a much higher frequency but was not visually apparent because of the loss of teeth.

Periodontal infection was evident in 13 of the adult burials. Given the amount of caries, abscesses and antemortem tooth loss in this population, it is not surprising that so many of the individuals exhibit periodontal disease since it can be affected by diet, attrition, and environmental factors. Comparison to the other two mission sites was not possible since this particular pathological condition was not noted.

Two unusual dental characteristics were observed in this population, shovel-shaped incisors and enamel "wringling." Shoveling was expected in this group since it is a particular trait most frequently seen in American Indians and Mongoloid racial groups. Seven individuals, all adults, displayed this particular morphological feature. A "wrinkle", or fold on the lingual surface of the upper incisors, was noted in three individuals. Since this unusual anomaly appears to be independent of any pathological condition, it most likely is due to a developmental defect.

Analysis of the skeletal remains exhibited numerous pathological findings. As a result of the vast size, it was necessary to separate the various disorders into several broad categories. Three different classes of degenerative disease--osteoarthritis,
osteophytosis, and osteoporosis--were identified. Ten individuals displayed evidence of osteoarthritis. This condition was primarily seen in the articular surfaces of the long bones. Nine of the adult males exhibited osteophytosis. Five of these males were in the 20–40 year old category, which is typically not characteristic of the age of onset of osteophytosis. However, its presence in young adults most likely is symptomatic of severe physical stress. Only two individuals displayed evidence of osteoporosis. In B-31, which is an old adult male, this condition can be attributed to advanced age. In B-20, an adult female, this condition is probably a secondary pathological finding associated with some other skeletal disorder.

Analysis of the skeletal remains for indications of infectious disease was also very revealing. Four categories of infectious disease were documented: periostitis, treponemal infection, tuberculosis, and coccidioidomycosis. Periostitis, an inflammatory process of the periosteum affecting the underlying bone, was noted in five adult burials. Two of these individuals (B-20, B-30) had extensive periostitis present in nearly all areas of the skeleton, indicating widespread inflammation. Treponemal infection was suspected in two individuals. In both cases, B-20 and B-36, significant periosteal inflammation was exhibited, consistent with the skeletal distribution most commonly associated with syphilis. One individual, B-36, displayed several pathological lesions which may be indicative of mycotic or mycobacterial infection such as coccidioidomycosis or tuberculosis, respectively. Although metastatic disease has been offered as a possible diagnosis, the age of the individual and the locations of lytic activity do not seem consistent with this diagnosis.
The skeletal remains were also assessed for the presence of neoplasia. Typically, neoplasia is identified as a pathological process which results in abnormal tissue growth. Two neoplastic conditions were identified: "button" osteomas and porotic hyperostosis. Three individuals exhibited osteomas on either the parietal or occipital. Porotic hyperostosis was evident in only three burials. Porotic hyperostosis has been attributed to several pathological disorders such as dietary deficiencies, bacterial infection, hemolytic anemia, and parasitic infection. Given the Southwestern Indians' dependency on maize as a food source, the appearance of porotic hyperostosis is usually diagnosed as resulting from iron deficiency anemia.

Analysis of the OSM population for evidence of traumatic injury resulted in the identification of three individuals with pathological findings indicative of fracture. One burial displayed torsion of the femoral head which could have been caused by either a traumatic injury or a pathological condition such as polyostotic fibrous dysplasia.

Two common variations of the cranial sutures were evident in nine individuals. Eight adults exhibited the presence of Wormian ossicles along the lambdoidal suture line. A very large Inca bone was present in one individual. The high number of suture anomalies is common in American Indian populations.

Cultural modifications were also evident in the OSM population. Squatting facets on the femur were identified in three of the male burials. Asymmetry of cranium, often referred to as cradle boarding, was identified in nine individuals. This particular modification does not appear to be intentional, but most likely is due to lying on a hard surface.
Numerous interesting developmental anomalies were exhibited in this sample. Seven individuals possessed a bifid sacral hiatus, three individuals exhibited septal apertures at the distal end of the humerus, five individuals possessed Schmorl’s nodes on the vertebral column, one individual exhibited a noticeable asymmetry in long bone length, one individual possessed one extra lumbar vertebra, and one individual exhibited endochondral ossification of the trachea.

The osteobiological analysis of the Old Socorro Mission provides an insightful view as to the physical health and demographic profile of a native American/Spanish mission population. Future research should be concentrated on a skeletal analysis of the disturbed burials and scattered surface finds. Because of their questionable provenance, the best approach would be to treat this aspect of the sample as an ossuary burial. Once all the skeletal remains have been analyzed, a more encompassing view of Spanish Mission life and its affect on a native population will be possible.
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APPENDIX A

DESCRIPTION OF SKELETAL REMAINS

OLD SOCORRO MISSION (E.P.C.M. 31:106:7:23)
TABLE OF CONTENTS

DESCRIPTION OF SKELETAL REMAINS

OLD SOCORRO MISSION (E.P.C.M. 31:106:7:23)

Burial 3 .......................... 192
Burial 4 .......................... 193
Burial 5 .......................... 178
Burial 5* Lot 336,324,338,330 .......................... 198
Burial 6 .......................... 190
Burial 7 .......................... 202
Burial 8 .......................... 191
Burial 8* .......................... 199
Burial 9 .......................... 201
Burial 10 .......................... 201
Burial 11 .......................... 187
Burial 12 .......................... 193
Burial 14 .......................... 195
Burial 15 .......................... 196
Burial 16 .......................... 182
Burial 17 .......................... 177
Burial 18 .......................... 176
Burial 18(B) .......................... 195
Burial 20 .......................... 174
Burial 21 Lot 1072 .......................... 198
Burial 21 .......................... 181
Burial 22 .......................... 173
Burial 24 .......................... 196
Burial 25 ........................................ 199
Burial 28 ........................................ 189
Burial 30 ........................................ 194
Burial 31 ........................................ 170
Burial 32 ........................................ 182
Burial 33 ........................................ 179
Burial 334 Lot 1183 ......................... 197
Burial 34 ........................................ 172
Burial 35 ........................................ 171
Burial 36 ........................................ 166
Burial 37 ........................................ 168
Burial 38* ....................................... 200
Skull 20 .......................................... 188
Skull 25 .......................................... 184
Skull 27 .......................................... 185
Skull 29 .......................................... 186
Skull 38 .......................................... 185
Skull 2019 ....................................... 187
DESCRIPTION OF SKELETAL REMAINS

OLD SOCORRO MISSION (E.P.C.M. 31:106:7:23)

Information compiled within the following appendix is representative of only the discrete burials removed from beneath the church floor. Individuals lacking postcranial remains will be listed as S-#. Burials containing more than one individual will be listed as B-#A, B, or C. Each burial will contain the following description if available: burial number, material present, minimum number of individuals, sex, age, stature, pathological conditions, and anomalies. Abbreviations will be used whenever possible. The skeletal remains are presently curated at Texas A&M University, Department of Anthropology, College Station, Texas.

BURIAL 36

MATERIAL PRESENT: Burial 36 is represented by a nearly complete skeleton.


CRANIUM: Complete cranium.


MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Male, based on mandibular size and shape, cranial shape, sciatic notch width, sub-pubic angle shape, bowl shape of pelvis, and general size and robusticity.
AGE: Adult, circa 25-35 years. This assessment was based on epiphyseal fusion, cranial suture closure, and degree of dental wear. Age was also based on morphology of the pubic symphysis.

STATURE: Femur: Stature = \((2.26 \times 44.2) + 66.379 = 166.271 \pm 3.417\) cm.
Tibia: Stature = \((1.96 \times 35.45) + 93.752 = 163.234 \pm 2.815\) cm.

DENTAL PATHOLOGICAL CONDITIONS: Caries were noted on the right PM\(^1\), left M\(_1\), left M\(_2\) and abscessing was noted in association with right I\(^2\), right P\(^2\). Enamel hypoplasia was observed on the left I\(^2\), right C\(^*\), left C\(^*\), right I\(_1\), left I\(_1\), left I\(_2\), left C\(_1\), right PM\(_1\), left PM\(_1\). Antemortem loss was noted in association with left M\(^2\), right M\(^3\), left M\(^3\).

SKELETAL PATHOLOGICAL CONDITIONS: There was slight eburnation of both temporo-mandibular joints, affecting both the mandibular condyles and mandibular fossae, severe erosion of the mandibular condyles, and a new area of articulation for the mandibular condyle immediately forward of the left mandibular fossa. The right frontal orbit has two areas of lysis, both which appear to be in the final stages of healing. The left dorsal sphenoid has a lytic area, oval in shape, 1.5 x 1 cm in size. The first through fifth vertebrae are fused to each other and display severe deterioration, lipping, and pitting. The sternum is extremely deteriorated with lysis along the entire length with old layers of periosteal bone formation along the manubrium and gladiolus, with a large lytic lesion (5 x 2 x 3 cm) that is oval in shape on the left side of the gladiolus. There is a second lytic area (2 x 2 x 2 cm) on the superior edge of the gladiolus, and a third area (.5 x .3 x .5 cm) directly adjacent to the second. There is also minor costochondral ossification on the manubrium, lysis and deformation of the right clavicular notch with corresponding changes on the right clavicle. The right scapula has a small lytic area (.2 x .1 cm) immediately below the spine on the distal edge. Both scapulae display a very fine, new periosteal reaction primarily on the acromion, along the superior and inferior borders of the spine to the medial edge, and along the medial edge to the distal end. Both scapulae have a facet on the distal end, possibly for increased muscle
attachment. There is evidence of slight osteoarthritis on the first thoracic vertebra and a Schmorl’s node on the inferior surface of the fourth. The third lumbar vertebrae has a lytic area on the tip. The lower thoracic and the lumbar vertebrae displayed osteophytosis. The left iliac spine has a periosteal reactive area and the ventral surface of the left iliac tuberosity has a small lytic area (.3 x .3 cm). The right ilium has an area of roughness associated with a possible pulled gluteus medius on the dorsal surface. There is pitting and increased muscle attachment on the superior ventral surfaces of the pubis adjacent to the pubic symphysis. Both humeri have the beginnings of periosteal bone with slight healing. The right clavicle has slight lipping on the sternal/clavicle juncture. Both ulnar diaphyses have slight, well-healed periosteal bone growth. Three left ribs display well-healed periosteal reaction at the midshaft with a small lytic area on one. Five right ribs are severely affected by lytic activity along the length and on all surfaces, along with old and new periosteal reaction, and a possible antemortem fracture of one right rib associated with one of these areas of lysis. Both femora are severely affected by periosteal reaction on the distal two-thirds of the linea aspera. The left femur displays evidence of strong muscle attachments with a bony spur for the vastus lateralis attachment, and a slight, new periosteal reaction below the greater trochanter. Both tibiae have symmetrical periosteal reaction along entire length of shaft with concentrated areas on the distal ends. There is a slight periosteal reaction on both fibulae.

The majority of the pathological conditions displayed in this skeletal appears to be the result of three systemic conditions: treponemal infection, metastatic disease or mycotic infection. The remainder of the pathological conditions appear to be the result of trauma.

ANOMALIES: The incisors display marked shoveling. The sacrum was noted to have a bifid sacral hiatus to S-3, with the first coccygeal element fused to the sacrum.

BURIAL 37

MATERIAL PRESENT: Burial 37 is represented by a nearly complete skeleton.
CRANIUM: Complete cranium.
MINIMUM NUMBER OF INDIVIDUALS: One.
SEX: Male, based on mandibular size and shape, cranial shape, sciatic notch, general size and robustness.
AGE: Adult, circa 30-35 years. This assessment was made based on epiphyseal fusion, cranial suture closure, general size and robusticity.
STATURE: Femur: Stature = (2.26 x 43.8) + 66.379 = 165.367 ± 3.417 cm.
Tibia: Stature = (1.96 x 35.75) + 93.752 = 163.82 ± 2.815 cm
DENTAL PATHOLOGICAL CONDITIONS: The maxilla and mandible exhibit severe attrition. In the maxilla all teeth except the left C, left PM1, and left M2 were lost antemortem with significant alveolar resorption occurring. All teeth in the mandible exhibit extreme heavy wear with dentin exposed. Right I1, left I1, right PM2, right M1, right M2, right M3, left M3 were lost antemortem and the tooth sockets are no longer visible.
SKELETAL PATHOLOGICAL CONDITIONS: There is a depressed but well-healed injury on the left parietal by the coronal suture. Three button osteomas are located on the left parietal and one on the right parietal. C-2 exhibits osteophytosis on the superior surface. Schmorl’s nodes are present on T-5 (superior), T-8 (superior) and L-4 (superior). There is slight osteophytosis also on T-9, T-10, L-2, L-3 and L-4. The right sternal end of the clavicle has a defect. The zyphoid process of the sternal body is fused. The left humerus contains an indentation (.5 x .5 cm) in the head. The right humerus exhibits slight osteoarthritis on the head. The proximal end of the left ulna reveals slight
lipping. Both femora contain osteoarthritis on the tibia articular surface. One patella displays an exostosis.

ANOMALIES: Wormian ossicles are located on the lambdoidal suture.

BURIAL 31

MATERIAL PRESENT: Two partial skeletons (31A and 31B) are represented.

DENTITION: None present.

CRANIUM: Not present.

POST-CRANIAL ELEMENTS: 31A consists of a lft. os coxa, rt. ilium, rt. pubis, rt. humerus, rt. radius, lft. ulna, eight mid-rib fragments, rt. and lft. femora, rt. and lft. tibiae, rt. and lft. fibulae, rt. and lft. tarsale, rt. and lft. metatarsale, and mixed phalanges. 31B consists of two infant femora.

MINIMUM NUMBER OF INDIVIDUALS: Two (31A - adult, 31B - infant).

SEX: (31A) Male. This assessment was made based on the sciatic notch width, sub-pubic angle shape, bowl shape of pelvis, and robusticity of the long bones. (31B) Indeterminate.

AGE: (31A) Old Adult, based on the degeneration of the pelvis and the articular surfaces of the long bones. (31B) Infant, based on the length of the femora.

STATURE: (31A) Femur: Stature = (2.26 x 45.1) + 66.379 = 168.305 ± 3.417cm. Tibia: Stature = (1.96 x 37.16) + 93.752 = 166.585 ± 2.815cm (31B) Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: (31A) None observed. (31B) None observed.

SKELETAL PATHOLOGICAL CONDITIONS: (31A) The cortex of the right humerus is thin probably due to osteoporosis and the neck is atrophic. There is slight osteoarthritis of the right radius. Osteophytosis is present on the articular surface of the left and right ilium and sacrum. The rim of the right acetabulum exhibits slight osteoarthritis. The anterior superior iliac spine of the left os coxa displays sites of heavy muscle attachment. There is slight periosteal reaction on
the medial and lateral condyle of the right tibia. Both right and left femora display heavy muscle attachment along the dorsal shaft. The right femur shows evidence of periosteal reaction on the medial and lateral epicondyle, and some lipping along the later condyle and patellar surface with bone deposition on the patellar surface. (31B) None observed.

ANOMALIES: None observed.

BURIAL 35

MATERIAL PRESENT: Burial 35 is represented by a nearly complete skeleton.


CRANIUM: Complete cranium.

POST-CRANIAL ELEMENTS: Hyoid, seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, sacrum, rt. and lt. clavicle, rt. and lt. ilium, rt. and lt. ischium, rt. and lt. pubis, rt. and lt. scapula, sternal body, rt. and lt. humeri, rt. and lt. radii, rt. and lt. ulnae, hand and wrist bones, twelve rt. and twelve lt. ribs, rt. and lt. femora, lt. tibia, rt. and lt. fibulae, tarsale, metatarsale, and mixed phalanges.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Late childhood, circa 7–8 years. This assessment was made on gracile nature of the remains and the presence of deciduous and permanent dentition.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: The maxilla displays evidence of carious activity on the right DP2 (mesial), left DP1 (distal), left DP2 (mesial). The right PM1, right M2, left M2, left M2, right M2 are present but not fully erupted.

SKELETAL PATHOLOGICAL CONDITIONS: None.

ANOMALIES: None observed.
BURIAL 34

MATERIAL PRESENT: Burial 34 is represented by two partial skeletons (34A and 34B).

DENTITION: (34A) Rt. C, lt. PM₁, rt. PM₁, lt. PM₂, rt. PM₂, rt. M₁, rt. M₂, rt. M₂, mandible. (34B) None present.

CRANIUM: (34A) None present. (34B) Rt. parietal.

POST-CRANIAL ELEMENTS: (34A) Seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, twelve rt. and twelve lt. ribs, sacrum, rt. and lt. clavicle, rt. and lt. os coxae, rt. scapula, sternal body, rt. and lt. humeri, rt. and lt. radii, rt. and lt. ulnae, rt. femur, rt. patella, rt. fibula, tarsale, metatarsal. (34B) None present.

MINIMUM NUMBER OF INDIVIDUALS: Two (34A - adult, 34B - infant).

SEX: (34A) Male. This assessment was based on square chin, robust mastoids, gonial angle, os coxa morphology, general size and robusticity. (34B) Indeterminate.

AGE: (34A) Adult, circa 20-30 years. This assessment was made based on pubic symphysis, epiphyseal fusion and general size. (34B) Infant, based on size and thinness of parietal.

STATURE: (34A) Femur: Stature = (2.26 x 43.55) + 66.379 = 168.305 ± 3.417cm. 
Tibia: Not present.
(34B) Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: (34A) Right I₁, left I₁, right I₂, left I₂, left C₁, right M₃, left M₃ were lost antemortem and displayed significant alveolar resorption. Carious activity is associated with right M₁ (mesial and distal), left M₁ (mesial), right M₂ (distal and buccal). (34B) None observed.

SKELETAL PATHOLOGICAL CONDITIONS: (34A) There is a circular pit located on T-1 where right rib facet should be. Osteophytes are located on T-7, T-8, T-10,
T-11, T-12, L-3, L-4. The right os coxa is fused to the sacrum. The left ulna shows evidence of a possible fracture, very old and very well-healed.

(34B) None observed.

ANOMALIES: None discernable.

BURIAL 22

MATERIAL PRESENT: Burial 22 is represented by one nearly complete skeleton (22A) and one intrusive burial represented by only two ribs (22B).


(22B) None present.

CRANIUM: (22A) Complete cranium.

(22B) None present.

POST-CRANIAL ELEMENTS: (22A) Seven cervical vertebrae, eleven thoracic vertebrae, four lumbar vertebrae, lft. and rt. scapulae, rt. and lft. humerus, rt. radius, rt. and lft. ulnae, rt. and lft. clavicle, lft. femur, rt. tibia, twelve rt. and twelve lft. ribs.

(22B) One rt. and one lft. rib.

MINIMUM NUMBER OF INDIVIDUALS: Two, based upon two extra ribs (22A - Adult, 22B - Intrusive adult).

SEX: (22A) Female, based on the gracile nature of the cranium, sites of muscle attachment, general size and robusticity.

(22B) Indeterminate.

AGE: (22A) Adult, circa 20-25 years. This assessment was based on epiphyseal fusion occlusion of all permanent teeth and only slight degree of attrition of dentition.

(22B) Adult, based on size of ribs but it is not possible to put this individual in any specific age category.
**STATURE:** (22A) Femur: Stature = (2.59 x 43.55) + 49.742 = 162.53 ± 3.816cm.

Tibia: Stature (2.72 x 34.975) + 63.781 = 155.58 ± 3.513cm.

(22B) Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** (22A) The right I\(^2\) displays a fold in the enamel (lingual), left M\(^1\) has a large carie (mesial) with an abscess at the tip, both right M\(^1\) and M\(^2\) have abscessing at root tip, right M\(^3\) was lost antemortem, right M\(_1\) was lost antemortem with alveolar resorption. There is heavy attrition of the occlusual surface of left M\(_1\). There is antemortem loss of left M\(_2\) with alveolar resorption, and an extremely large carie on the left M\(_3\). Slight enamel hypoplasia is present on the maxilla with significantly more noted on mandible. There is slight periodontal disease as witnessed by the receding alveolar sockets.

(22B) None present.

**SKELETAL PATHOLOGICAL CONDITIONS:** (22A) A button osteoma (0.2 mm) on left parietal, button osteoma (0.2 mm) on occipital. A Schmorl’s node is present on the inferior surface of L-4.

(22B) None present.

**ANOMALIES:** (22A) The incisors display a marked degree of shoveling. The occipital is flattened, probably due to some kind of cradle boarding. A large septal aperture of the olecranon fossa is located in both humeri.

(22B) None observed.

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**BURIAL 20**

**MATERIAL PRESENT:** Burial 20 is represented by a nearly complete skeleton.


**CRANIUM:** Complete cranium.

**POST-CRANIAL ELEMENTS:** Seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, sacrum, rt. and lft. ilium, rt. and lft. clavicle, rt. and lft. scapulae, sternal body, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae,
twelve rt. and twelve lft. ribs, rt. and lft. femora, rt. patella, rt. and lft. tibiae, rt.
and lft. fibulae, tarsale, metatarsale, and mixed phalanges.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Female. Based upon gracile nature of cranium and post-cranial remains, sciatic
notch width, general size and robusticity.

AGE: Adult, circa 20-25 years. This assessment was made based on epiphyseal fusion,
eruption and occlusion of the third molar, general size and robusticity.

STATURE: Femur: Stature = (2.59 x 39.0) + 49.742 = 150.75 ± 3.816cm.
Tibia: Stature + (2.72 x 33.75) + 63.781 = 155.58 ± 3.513cm.

DENTAL PATHOLOGICAL CONDITIONS: There is antemortem loss and alveolar
resorption of right PM₁ and PM₂, left M₁, right M₂, left I₁ and I₂, left M₂. Caries
are located on the left PM₂ (distal), left M₃ (occlusal), right M₃ (occlusal). There
is also a buccal pit and fissure on the right M₁ and M₂. Slight enamel
hypoplasia is also present.

SKELETAL PATHOLOGICAL CONDITIONS: The left zygomatic articulation is shorter
with the left condyle significantly smaller than right condyle, however, this is
probably not due to a traumatic injury but a developmental anomaly. The left
scapula displays a lytic area (inferior/distal) on the sides of the acromion. There
is bone loss on the superior acromion and the vertebral border has an area of
osteoclastic activity. The right scapula has lytic activity along the inferior side
of the acromion with destruction. The left humerus shows evidence of a
periosteal infection on distal end of shaft. The right humerus displays more
periosteal infection than the left with remodeling and the lateral epicondylar
ridge has an area of healed periosteal infection. Both left and right radii exhibit
periosteal infection on the proximal ends. The right radius has a healed
depressed area (possible cloaca) on the midshaft region. The left and right
ulnae exhibit periosteal infection on the proximal ends, with the left ulna having
a swollen appearance. Both right and left clavicles exhibit periosteal infection
almost the entire length to the sternal articulation. Both femora have severe but
remodeled periosteal infection on distal two-thirds of shaft. Both tibiae have
severe periosteal infections on entire length of the shaft which varies from well-modeled to brand new. Periosteal infection is exhibited in the left fibula (distal end) and the right fibula (proximal end). The right talus and calcaneus both have periosteal reactive areas. There is a healed puncture area on the right frontal boss.

ANOMALIES: A Wormian ossicle is located on the lambdoidal suture. The incisors display marked shoveling. The occipital is flattened probably due to some kind of cradle boarding.

BURIAL 18

MATERIAL PRESENT: Burial 18 is represented by a nearly complete skeleton.

DENTITION: Rt. I¹, lft. I¹, rt. I², lft. I², rt. C¹, lft. C¹, rt. PM¹, lft. PM¹, rt. PM², lft. PM², rt. M¹, lft. M¹, rt. M², lft. M², rt. M³, lft. M³, rt. I¹, lft. I¹, rt. I², lft. I², rt. C¹, lft. C¹, rt. PM¹, lft. PM¹, rt. PM², lft. PM², rt. M¹, lft. M¹, rt. M², lft. M², rt. M³, lft. M³, rt. M₄, lft. M₄.

CRANIUM: Complete cranium.

POST-CRANIAL ELEMENTS: Seven cervical vertebrae, ten thoracic vertebrae, five lumbar vertebrae, sacrum, rt. and lft. os coxae, lft. and rt. scapulae, sternal body, rt. and lft. humeri, rt. and lft. radius, rt. and lft. ulnae, rt. and lft. clavicle, twelve rt. and twelve lft. ribs, rt. and lft. femora, rt. and lft. tibiae, rt. and lft. fibulae, tarsalia, metatarsals, mixed phalanges.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Female, based upon the gracile nature of the cranium and the post-cranial remains, morphology of the os coxae, general size and robusticity.

AGE: Late adolescent/adult, circa 16-25 years. This assessment is based on the eruption of the third molar and epiphyseal fusion has just been completed in the vertebrae and scapulae.

STATURE: Femur: Stature = (2.59 x 40.10) + 49.742 = 153.60 ± 3.816cm.
Tibia: Stature = (2.72 x 33.375) + 63.781 = 154.56 ± 3.513 cm.
DENTAL PATHOLOGICAL CONDITIONS: Significant carious activity is present on the occlusal surface of the right M₄. A buccal pit and fissure is present in the right M₃. There is an impaction of the M₂ and an enamel fold on the lingual left I₂. There is some enamel hypoplasia evident on the maxilla.

SKELETAL PATHOLOGICAL CONDITIONS: Slight pitting is exhibited on the frontal region. One left lower rib and two right mid-ribs show some evidence of periosteal infection on the shaft. The right femur is 3 cm shorter than left with a femoral head torsion of 30°. The left fibula is 2 cm shorter than the right fibula. The right calcaneus is roughened and mis-shapened on the talar surface.

ANOMALIES: The occipital is flattened probably due to some kind of cradle boarding. A small septal aperture is located on the left humerus and a medium septal aperture is located on the right humerus. The incisors display a marked degree of shoveling. The coccyx is fused to the sacrum.

BURIAL 17

MATERIAL PRESENT: Burial 17 is represented by a nearly complete skeleton.


CRANIUM: Complete cranium.

POST-CRANIAL ELEMENTS: Seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, sacrum, rt. and lft. os coxae, rt and lft. scapulae, sternal body, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae, rt. and lft. clavicle, wrist bone, twelve rt. and twelve lft. ribs, rt. and lft. femora, rt. and lft. tibiae, rt. and lft. fibulae, tarsalae, metatarsals.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Male, based on mandibular size and shape, cranial shape, os coxa morphology, general size and robusticity.
AGE: Adult, circa 20-25 years. This assessment was based on eruption and occlusion of dentition along with the slight degree of attrition, pubic symphysis morphology and general size.

- **STATURE:** Femur: Stature = (2.26 x 43.70) + 66.379 = 165.141 ± 3.417cm.
  Tibia: Stature = (1.96 x 35.10) + 93.752 = 162.548 ± 2.815cm.

**DENTAL PATHOLOGICAL CONDITIONS:** The mandibular dentition displays extreme enamel hypoplasia. The left I\(^1\) was lost antemortem with alveolar resorption occurring. The maxilla and mandible exhibit slight periodontal infection in the region of the incisors and premolars.

**SKELETAL PATHOLOGICAL CONDITIONS:** There is evidence of pitting on browridge. There is a possible region of healed porotic hyperostosis along the suture line of both the right and left parietal. There is complete bilateral spondylosis of the L-5 vertebra. The sacrum displays incomplete fusion of the spinous processes.

**ANOMALIES:** Wormian ossicles are located on the lambdoidal suture. The incisors display a marked degree of shoveling. The occipital is flattened probably due to some kind cradle boarding. There is a bifid sacral hiatus of the sacrum. The left humerus has a large septal aperture.

**BURIAL 5**

**MATERIAL PRESENT:** Burial 5 is represented by a nearly complete skeleton.

**DENTITION:** Rt. I\(^1\), lft. I\(^1\), rt. I\(^2\), lft. I\(^2\), rt. C\(^1\), lft. C\(^1\), rt. PM\(^1\), lft. PM\(^1\), rt. PM\(^2\), lft. PM\(^2\), rt. M\(^1\), lft. M\(^1\), rt. M\(^2\), lft. M\(^2\), rt. M\(^3\), lft. M\(^3\), rt. I\(^1\), lft. I\(^1\), rt. I\(^2\), lft. I\(^2\), rt. C\(^\cdot\), lft. C\(^\cdot\), lft. PM\(^1\), rt. PM\(^2\), lft. PM\(^2\), lft. M\(^1\), rt. M\(^2\), lft. M\(^2\), rt. M\(^3\), lft. M\(^3\).

**CRANIUM:** Complete cranium.

**POST-CRANIAL ELEMENTS:** Seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, sacrum, rt. and lft. os coxae, rt. and lft. scapulae, sternal body, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae, rt. and lft. clavicle, hand and wrist bones, twelve rt. and twelve lft. ribs, rt. and lft. femora, rt. and lft. patellae, rt. and lft. tibiae, rt. and lft. fibulae, tarsalae, metatarsale.
MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Female, based upon the gracile nature of cranium and post-cranial remains, morphology of the os coxae, general size and robusticity.

AGE: Adult, circa 25-30 years. This assessment is based on eruption of third molar and slight degree of attrition, epiphyseal fusion, and pubic symphysis morphology.

STATURE: Femur: Both femora have been sectioned.

Tibia: Stature = (2.72 x 34.60) + 63.781 = 157.89 ± 3.513cm.

DENTAL PATHOLOGICAL CONDITIONS: There is an enamel fold of the left I₂. Significant wear is present on right C. Periodontal infection is evident on the of the maxilla. The right PM₁ and right M₁ were lost antemortem. Significant carious activity is present on the occlusal surface of the left M₁ and right M₁. The right PM₂ is eroded to the cervical margin. Periodontal infection is exhibited on the mandible.

SKELETAL PATHOLOGICAL CONDITIONS: Healed porotic hyperostosis is evident on both sides of the sagittal/lambdoidal suture junction.

ANOMALIES: The incisors exhibit significant shoveling. The occipital is flattened probably due to some kind of cradle boarding. The floor of the palate displays a palatine torus.

BURIAL 33

MATERIAL PRESENT: Burial 33 is represented by a nearly complete skeleton.


CRANIUM: Complete cranium.

POST-CRANIAL ELEMENTS: Seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, sacrum, rt. and lft. os coxae, rt. and lft. scapulae, sternal body,
rt. and lft. humeri, rt. and lft. radii, lft. ulna, rt. and lft. clavicle, hand and wrist bones, twelve rt. and twelve lft. ribs, ossified tracheal cartilage.

**MINIMUM NUMBER OF INDIVIDUALS:** One.

**SEX:** Male, based on mandibular size and shape, cranial shape, os coxa morphology, general size and robusticity.

**AGE:** Old adult, circa 45 + years. This assessment is based on degenerative changes of the vertebrae, os coxa, joint areas and degree of attrition on the dentition.

**STATURE:** Femur: Not present.

Tibia: Not present.

Humerus: Stature = \( (2.92 \times 31.75) + 73.94 = 166.65 \pm 4.24 \)*

Radius: Stature = \( (3.55 \times 25.1) \times 80.71 = 169.815 \pm 4.04 \)*

Ulna: Stature = \( (3.56 \times 27.45) + 74.56 = 172.282 \pm 4.05 \)*

*The stature estimate was made using the lengths of the upper limbs since no lower limb bone was available, using the method developed by Trotter and Gleser (1958).

**DENTAL PATHOLOGICAL CONDITIONS:** Right I\(^1\), left I\(^1\), right I\(^2\), left I\(^2\), right M\(^1\), right M\(^2\) exhibit evidence of heavy wear. Left P\(^2\), left M\(^2\), left M\(^3\), right M\(^3\) lost antemortem with resorption. All teeth of maxilla exhibit heavy wear. The right and left M\(^2\) are not present but probably never erupted. Mandible shows evidence periodontal infection.

**SKELETAL PATHOLOGICAL CONDITIONS:** A button osteoma is located on the frontal. There is eburnation of the odontoid process of the axis (C-2). Osteophytes are present on C-2, C-3, C-4 and C-5. A moderate degree of osteophytoses is present on all the thoracic vertebrae with osteoarthritis exhibited on all thoracic transverse processes. There is severe osteophytoses of the lumbar vertebrae. "Kissing" vertebrae of the lumbar is present as a result of hyperflexion. The sacrum displays a large osteophyte on the right wing of the ala with an accessory facet that articulates with pelvis. The right os coxa exhibits an accessory facet that articulates with sacrum. Both acromions of the scapula exhibit arthritic changes. The clavicular facts of sternal body display slight
osteoarthritis. The right humerus displays osteoarthritis on distal end. The left radius reveals a flattening of the radial tuberosity and some degenerative changes. The right radius exhibits osteoarthritis along the distal edge of the head with lipping of the radial tuberosity. The left ulna shows evidence of osteoarthritis on the head, styloid process, olecranon and coronoid processes. Degenerative changes are present on the acromion end of both clavicles. Osteoarthritis is present in the hand and wrist bones. Degenerative changes are present on the articular surface on ribs.

ANOMALIES: A large pterygoid process is present in the sphenoid. A small Wormian ossicle occurs along the lambdoidal suture. The is a bifid sacral hiatus of the sacrum. The manubrium body and xiphoid process of the sternum are not fused. A small area of the trachea was ossified. The coccyx is fused to sacrum.

BURIAL 21

MATERIAL PRESENT: Burial 21 is represented by a nearly complete skeleton.


CRANIUM: Complete cranium.

POST-CRANIAL ELEMENTS: Seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, five sacral vertebrae, rt. and lft. os coxa, rt. and lft. scapulae, unfused sternal body, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae, rt. and lft. clavicle, hand and wrist bones, twelve rt. and twelve lft. ribs, right and lft. femora, rt. and lft. patellae, rt. and lft. tibiae, rt. and lft. fibulae, tarsalae, epiphysis.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Late childhood, circa 9-13 years. This assessment is based upon dental eruption, epiphyseal closure and general size.

STATURE: Indeterminate.
PATHOLOGICAL CONDITIONS: There is evidence of slight premature closure of the sutures in the cranium.

ANOMALIES: The incisors display a slight degree of shoveling.

BURIAL 16

MATERIAL PRESENT: Burial 16 is represented by a partial skeleton.

DENTITION: Rt. DI₁, lft. DI₁, rt. DI₂, lft. DI₂, rt. DC₁, lft. DC₁, rt. DP₁, lft. DP₁, rt. DM₁, lft. DM₁, rt. DM₂, lft. DM₂, rt. DI₁, lft. DI₁, rt. DI₂, lft. DC₁, lft. DC₂, rt. DP₁, lft. DP₁, rt. DM₂, lft. DM₂.

CRANIUM: Miscellaneous skull fragments, sphenoid.

POST-CRANIAL ELEMENTS: Seven cervical vertebral bodies, twelve thoracic vertebral bones, five lumbar vertebral bodies, rt. and lft. ilium, rt. and lft. pubis, rt. and lft. scapulae, rt. and lft. humeri, rt. and lft. ulnae, rt. and lft. clavicle, one carpal, six metacarpals, one phalange, rib fragments, rt. and lft. tibiae, rt. and lft. fibulae.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant/Early childhood, circa 18 mos. - 3 years. This assessment was made based on eruption of the dentition and general size.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: There is an impaction of left DM₂.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.

BURIAL 32

MATERIAL PRESENT: Burial 32 is represented by a nearly complete skeleton.


CRANIUM: Complete cranium.
**POST-CRANIAL ELEMENTS:** Hyoid, seven cervical vertebrae, twelve thoracic vertebrae, six lumbar vertebrae, sacrum, rt. and lft. os coxae, rt. and lft. scapulae, sternal body, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae, rt. and lft. clavicle, hand and wrist bones, twelve rt. and twelve lft. ribs, rt. and lft. femora, rt. and lft. patellae, rt. and lft. tibiae, rt. and lft. fibulae, tarsale, metatarsale, mixed phalanges.

**MINIMUM NUMBER OF INDIVIDUALS:** One.

**SEX:** Male, based on robustness of cranium, square chin, sites of muscle attachment, morphology of os coxae and robusticity of post-cranial remains.

**AGE:** Old adult, circa 45+ years. This assessment was made based on the degree of attrition of the permanent dentition, obliteration of the sagittal and coronal sutures, degenerative changes of the vertebrae and joint areas.

**STATURE:** Femur: Stature = (2.26 x 48.10) = 66.379 = 175.085 ± 3.417cm.  
Tibia: Stature = (1.96 x 38.90) + 93.752 = 169.996 ± 2.815cm.

**DENTAL PATHOLOGICAL CONDITIONS:** There is evidence of severe periodontal disease which resulted in extensive tooth loss and resorption of the bone in both the maxilla and mandible. Both mandibular canines display severe enamel hypoplasia and heavy wear. A buccal pit is evident on the left M₂.

**SKELETAL PATHOLOGICAL CONDITIONS:** Both right and left nasals have been broken and healed. There is severe osteophytosis of C-1, C-2, T-1, L-1, L-2, L-3, L-4, L-5. Schmorl’s nodes are evident on T-7 (inferior), T-8 (superior and inferior), T-11 (superior and inferior), T-12 (superior), L-2 (superior), L-3 (superior). Degenerative changes are evident in the joint of right and left scapula. There is slight osteoarthritis of the sternal body. The left humerus exhibits lipping of the capitulum and trochlea down into the neck. The left radius displays osteoarthritis on head. The right radius exhibits an indentation on the shaft which corresponds with articulation of an ulna fracture. Osteoarthritis is present on the radial notch and the coronoid process of the left ulna. The right ulna exhibits an un-united fracture. Slight osteoarthritis is evident on the proximal and distal ends of both the right and left clavicle. The metacarpals
display slight evidence of osteoarthritis. The right third rib displays an un-united fracture. The right fourth and fifth rib have been fractured but have fused offset. The left femur has a large squatting facet. The right femur exhibits osteoarthritis on the lateral and medial condyles. Slight osteoarthritis is present in both patellae. There is severe osteoarthritis on the proximal ends of both tibiae. The left tarsale displays slight osteoarthritis. All left metatarsale exhibit severe arthritis with deformity of the distal ends.

ANOMALIES: Wormian ossicles are located along the lambdoidal suture. An extra lumbar vertebra (L-6) is present. The is a bifid sacral hiatus of the sacrum.

SKULL 25

MATERIAL PRESENT: Burial 25 is represented by a skull only.

DENTITION: None present.


POST-CRANIAL ELEMENTS: None present.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Male, based on the very prominent supraorbital tori and pronounced nature of the nuchal crest.

AGE: Old adult, circa 45+ years. This assessment was made based on the severe degree of tooth loss with resorption of bone, general size and suture closure.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: All teeth of the maxilla were lost antemortem with full alveolar resorption.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: Wormian ossicles occur on the lambdoidal suture.
SKULL 27

MATERIAL PRESENT: Burial 27 is represented by a skull only.

DENTITION: Rt. C, lft. PM'.


POST-CRANIAL ELEMENTS: None present.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Male, based on the prominent supraorbital tori, pronounced nature of the nuchal crest, squared chin and sites of muscle attachments.

AGE: Old adult, circa 45+ years. This assessment was made based on the severe degree of antemortem tooth loss, alveolar resorption, general size, and suture closure.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: Severe enamel hypoplasia on the right C' and left PM' (only teeth present). Both the maxilla and mandible exhibit rampant periodontal infection with subsequent tooth loss and alveolar resorption.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: The occipital is flattened probably due to some kind of cradle boarding.

SKULL 38

MATERIAL PRESENT: Burial 38 is represented by a skull only.


POST-CRANIAL ELEMENTS: None present.

MINIMUM NUMBER OF INDIVIDUALS: One.
SEX: Female, based on the absence of a perceivable nuchal crest and supraorbital tori, the presence of a rounded chin and gracile nature of the cranium.

AGE: Adult, circa 21-35 years. This assessment was made based on the presence of the third molar, slight degree of attrition and suture closure.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: An occlusal pit is located on the left M\textsuperscript{1}, right M\textsuperscript{2}. Slight wear is evident on the right M\textsuperscript{1}, right M\textsubscript{1}, right M\textsubscript{2}, left M\textsubscript{1}. The right M\textsubscript{3} is impacted.

SKELETAL PATHOLOGICAL CONDITIONS: The nasals exhibit a condition called "saddle nose".

ANOMALIES: The occipital is flattened probably due to some kind of cradle boarding.

SKULL 29

MATERIAL PRESENT: Burial 29 is represented by a skull only.

DENTITION: Rt. PM\textsuperscript{2}, lft. M\textsuperscript{1}, rt. P\textsuperscript{1}, lft. P\textsubscript{1}, lft. P\textsubscript{2}, lft. M\textsubscript{1}.

CRANIUM: Frontal, rt. and lft. parietal, occipital, rt. and lft. temporal, rt. and lft. zygomatic, palatine, maxilla, mandible, rt. and lft. nasal, ethmoid, rt. and lft. lacrimal, vomer, sphenoid.

POST-CRANIAL ELEMENTS: None present.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Male, based on the present of a very pronounced nuchal crest, supraorbital tori and sites and muscle attachment.

AGE: Old adult. This assessment is made based on the severe degree of antemortem tooth loss with alveolar resorption of bone, severe degree of attrition and suture closure.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: There is antemortem loss of the right l\textsuperscript{1}, left l\textsuperscript{1}, right l\textsuperscript{2}, left l\textsuperscript{2}, left C\textsuperscript{1}, left PM\textsuperscript{1}, left PM\textsuperscript{2}, right M\textsuperscript{1}, right M\textsuperscript{2}, right M\textsuperscript{3}, left M\textsuperscript{3}, right PM\textsubscript{2}, right M\textsubscript{1}, right M\textsubscript{2}, left M\textsubscript{2}, right M\textsubscript{3}, left M\textsubscript{3} with alveolar
resorption in all regions. Extreme heavy wear is evident on the left $M^1$, right $PM^2$, right $PM_1$, left $PM_1$, left $M_1$. Large caries are located on the left $M_1$ (distal) and left $M^2$ (distal).

**SKELETAL PATHOLOGICAL CONDITIONS:** None present.

**ANOMALIES:** Wormian ossicles occur on the lambdoidal suture. The occipital is flattened probably due to some kind of cradle boarding.

**SKULL 2019**

**MATERIAL PRESENT:** Burial 2019 is represented by a skull only.

**DENTITION:** None observed.

**CRANIUM:** Frontal, rt. and lt. parietal, occipital, rt. and lt. temporal.

**POST-CRANIAL ELEMENTS:** None present.

**MINIMUM NUMBER OF INDIVIDUALS:** One.

**SEX:** Female, based upon the gracile appearance of the cranium.

**AGE:** Adult. This assessment is made based upon the degree of suture closure on the cranium. However, because of the lack of dентition it is not possible to assign this burial to any particular age category.

**STATURE:** Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** None present.

**SKELETAL PATHOLOGICAL CONDITIONS:** Porotic hyperostosis is present along the sagittal and coronal suture on both parietals and occipital, but very well-healed.

**ANOMALIES:** None observed.

**BURIAL 11**

**MATERIAL PRESENT:** Burial 11 is represented by only a partial skeleton which is extremely fragmented.

**DENTITION:** Rt. $DI^1$, lt. $DI_1$, rt. $DI^2$, lt. $DI_2$, rt. $DC^-$, lt. $DC^-$, rt. $DP^1$, lt. $DP_1$, rt. $DM^1$, rt. $DI_1$, lt. $DI_1$, rt. $DI_2$, lt. $DI_2$, rt. $DC_-$, lt. $DC_-$, rt. $DP_1$, lt. $DP_1$, rt. $DM_1$, lt. $DM_1$. 
CRANIUM: Rt. and lft. frontal, rt. and lft. parietal, occipital, rt. and lft. temporal, rt. and lft. zygomatic, rt. and lft. maxillae, rt. and lft. wings of sphenoid, nine small skull fragments.

POST-CRANIAL ELEMENTS: Six centrum, seventeen neural arch halves, two fused neural arch halves, partial rt. os coxae, fragmented rt. pubis, fourteen rib fragments, shaft of rt. femur, one fibula fragment.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant, circa 2 years ± 8 mos. This assessment is based upon eruption and occlusion of dentition, epiphyseal fusion and general size.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: The incisors display a marked degree of shoveling.

SKULL 20

MATERIAL PRESENT: Burial 20 is represented by a skull only.


CRANIUM: Frontal, rt. and lft. parietal, occipital, rt. and lft. temporal, rt. and lft. zygomatic, palantine, maxilla, rt. and lft. nasal, ethmoid, rt. and lft. lacrimals, vomer, sphenoid.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Male, based on the pronounced nature of the nuchal crest, supraorbital tori, sites of muscle attachment and general robusticity.

AGE: Adult, circa 25-30 years. This assessment is based on the eruption of third molar, heavy degree of attrition, antemortem tooth loss with alveolar resorption and degree of suture closure.
**STATURE:** Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** The right I\(^1\) was lost antemortem with an apical abscess present. The left I\(^2\) is dead and discolored. The right C\(^1\) is associated with an apical abscess and displays heavy wear. The left C\(^1\) displays an apical abscess with heavy wear is also present. The right M\(^1\) was lost antemortem with subsequent alveolar resorption occurring. The left M\(^1\) displays heavy wear. The right M\(^2\) contains an occlusal caries. The left M\(^2\) was lost antemortem with alveolar resorption occurring. The left M\(^3\) was lost antemortem with alveolar resorption occurring. Left I\(_1\) and I\(_2\) were broken antemortem. The right I\(_1\) and I\(_2\) display heavy wear slanted labially. Both right and left C\(_1\) display heavy wear. The right PM\(_1\) was broken antemortem. The left PM\(_1\) shows evidence of heavy wear. The left M\(_1\) exhibits only slight wear. All teeth exhibit mild degree of calculus.

**POST-CRANIAL ELEMENTS:** None present.

**ANOMALIES:** The right and left M\(_3\) seem to be congenitally absent. The occipital exhibits an extremely large inca bone. The cranium appears to have an elongated appearance with a low sloping forehead, but it is not possible to determine if this was a result of intentional deformation.

**BURIAL 28**

**MATERIAL PRESENT:** Burial 28 is represented by a nearly complete skeleton.


**CRANIUM:** Complete cranium.

**POST-CRANIAL ELEMENTS:** Seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, sacrum, rt. and lft. os coxae, rt. and lft. scapulae, sternal body, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae, rt. and lft. clavicle, hand
and wrist bones, ten rt. and nine lft. ribs, rt. and lft. femora, rt. and lft. tibiae, rt. and lft. fibulae, tarsale, metatarsale.

**MINIMUM NUMBER OF INDIVIDUALS:** One.

**SEX:** Male, based on the morphology of os coxae, the sites of muscle attachments, and the robusticity of the cranium and skeleton.

**AGE:** Adult, circa 20-25 years. This assessment was made based on eruption of third molar, degree of epiphyseal fusion, suture closure and general size and robusticity.

**STATURE:** Femur: \( \text{Stature} = (2.26 \times 45.30) + 66.379 = 168.757 \pm 3.417 \text{cm} \).
Tibia: \( \text{Stature} = (1.96 \times 37.225) + 93.752 = 166.713 \pm 2.815 \text{cm} \).

**DENTAL PATHOLOGICAL CONDITIONS:** The upper and lower incisors show a slight degree of wear slanted labially (perhaps from pulling something through the teeth).

**SKELETAL PATHOLOGICAL CONDITIONS:** The cervical vertebrae display bifid spinous processes of C-2, C-3, C-4 and C-5. Schmorl’s node on T-9 (superior). There is slight osteophytosis of L-2. There is also slight lipping of the olecranon process of the right and the left ulnae. Squatting facets are present on both right and left femora.

**ANOMALIES:** An enamel pearl is present on the right M\(^3\). There is a bifid sacral hiatus of the sacrum.

**BURIAL 6**

**MATERIAL PRESENT:** Burial 6 is represented by only partial skeletons of three individuals (6A - Adult, female; 6B - Adult, male; 6C - Infant).

**DENTITION:** (6A, 6B, 6C) None present.

**CRANIUM:** (6A) Frontal, rt. & lft. parietal, a partial lft. zygomatic, occipital, three sphenoid fragments, partial rt. and lft. nasal.
(6B) None present.
(6C) None present.
POST-CRANIAL ELEMENTS: (6A) Sacrum, rt. and lft. os coxae, lft. radius, rt. and lft. tibia, rt. and lft. fibulae.
(6B) Rt. os coxa, rt. and lft. femur, lft. tibia.
(6C) Rib fragment, lft. ilium, lft. ulna, distal end of humerus, femoral fragment, one epiphysis.

MINIMUM NUMBER OF INDIVIDUALS: Three (6A - Adult, female; 6B - Adult, male; 6C - Infant).

SEX: (6A) Female, based on morphology of os coxa and general gracile nature of bones.
     (6B) Male, based on morphology of right os coxa.
     (6C) Infant. Indeterminate.

AGE: 6A and 6B are both adults based on general size, robusticity and epiphyseal fusion. 6C is an infant based on general size and epiphyseal fusion.

STATURE: None present.

DENTAL PATHOLOGICAL CONDITIONS: None present.

SKELETAL PATHOLOGICAL CONDITIONS: (6A) The coccyx is fused to the sacrum. (6B) Both the right and left femora display squatting facets on the distal end. (6C) None observed.

ANOMALIES: (6A) A bifid sacral hiatus of the sacrum is present. Wormian ossicles occur on the lambdoidal suture. The occipital is flattened probably due to some kind of cradle boarding. (6B) None observed. (6C) None observed.

BURIAL 8

MATERIAL PRESENT: Burial 8 is represented by only a partial skeleton.

DENTITION: Two hollow deciduous incisor crowns, one deciduous molar crown, two deciduous tooth fragments, three maxilla fragments, mandible fragments.

CRANIUM: Rt. and lft. frontal, rt. & lft. parietal, five occipital fragments, rt. and lft. temporal, rt. and lft. zygomatic, three sphenoid fragments.
POST-CRANIAL ELEMENTS: Twenty-one centrum, forty-five neural arch halves, rt. and lft. ilium, lft. scapula, rt. radius, rt. ulna, lft. clavicle, four hand fragments, nine rt. and eleven lft. ribs, four rib fragments.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant, 6 months ± 3 months. This assessment was made based on eruption of dentition, general size, and robusticity.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.

BURIAL 3

MATERIAL PRESENT: Burial 3 is represented by a nearly complete fetus imbedded in a dirt matrix. The remains are extremely fragile.

DENTITION: None present.

CRANIUM: Complete cranium.

POST-CRANIAL ELEMENTS: Lft. scapula, lft. ulna, numerous rib fragments, three centrum, one neural arch halve, rt. and lft. tibiae, rt. fibia.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Fetal. This assessment was made based on the extremely diminutive size and poorly ossified cortical bone present (late fetal).

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.
BURIAL 4

MATERIAL PRESENT: Burial 4 is represented by a partial skeleton.

DENTITION: None present.

CRANIUM: Rt. parietal fragment, three skull fragments.

POST-CRANIAL ELEMENTS: Five hand and wrist bones, one centrum, rt. ilium, rt. ischium fragment, partial rt. femur, rt. and lft. tibial shaft, rt. fibular shaft, three tarsalae, mixed phalanges.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant. This assessment was made based on the epiphyseal fusion, general size and gracile nature of the remains.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.

BURIAL 12

MATERIAL PRESENT: Burial 12 is represented by a partial skeleton.

DENTITION: Rt. DC, lft. DC, rt. DP, lft. DI, lft. DM, lft. DM.

CRANIUM: Complete cranium, rt. and lft. mandibular fragment, numerous skull fragments.

POST-CRANIAL ELEMENTS: Rt. and lft. clavicle, rt. humerus, rt. radius, rt. ulna, two long bone fragments, two epiphyses, eleven lft. and nine rt. ribs, twenty-one centrum, thirty-eight neural arch halves, one atlas, twenty-six vertebral fragments, eleven foot phalanges.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant, 18 months ± 6 months. This assessment was made based on eruption of dentition, epiphyseal fusion, general size and gracile nature of remains.
**STATURE:** Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** None observed.

**SKELETAL PATHOLOGICAL CONDITIONS:** None observed.

**ANOMALIES:** None observed.

**BURIAL 30**

**MATERIAL PRESENT:** Burial 30 is represented by partial skeletal remains of three individuals (30A, 30B, and 30C). However, 30A and 30B are badly fragmented and it is not possible to assign specific bones to a particular skeleton.

**DENTITION:** Rt. I¹, lft. DI¹, rt. DI², rt. DI₁, rt. DI₂, lft. DI₂.

**POST-CRANIAL ELEMENTS:** Rt. and lft. parietal, lft. temporal, rt. clavicle, two lft. clavicles, two rt. scapulae, lft. scapula, two sternal bodies, rt. and lft. humeri, rt. and lft. radii, three rt. ulnae, lft. ulna, eleven ribs, twelve rib fragments, atlas, axis, six thoracic vertebrae, one lumbar vertebrae, rt. ilium, two rt. femora, lft. femur, rt. fibular shaft.

**MINIMUM NUMBER OF INDIVIDUALS:** Three (30A and 30B-Adult; 30C-late childhood).

**SEX:** (30A) Female, based on the gracile nature of the post-cranial remains. (30B) Male, based on the morphology of the os coxa, general size and robusticity. (30C) Indeterminate.

**AGE:** 30A and 30B are both adults based on epiphyseal fusion, robusticity and general size. 30C is late childhood based on eruption of dentition in the maxilla, epiphyseal fusion and general size.

**STATURE:** (30A, 30B, 30C) Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** (30A, 30B, 30C) None observed.

**SKELETAL PATHOLOGICAL CONDITIONS:** (30A, 30B, 30C) None observed.

**ANOMALIES:** (30A, 30B, 30C) None observed.
BURIAL 14

MATERIAL PRESENT: Burial 14 is represented by a partial skeleton.

DENTITION: Lft. DI₁, rt. DI₂, lft. DI₂, rt. DI₁, lft. D₂, rt. DP₁, lft. DP₂, rt. DM₁, lft. DM₁.

CRANIUM: Mandible, rt. and lft. frontal, rt. temporal, lft. emporal, seven skull fragments, 3 sphenoid fragments, rt. parietal, lft. parietal, lft. scapula.

POST-CRANIAL ELEMENTS: Lft. scapula.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant, circa 18 months ± 6 months. This assessment was made based on eruption of dentition, epiphyseal fusion, general size (18 months ± 6 months).

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.

BURIAL 18(B)

MATERIAL PRESENT: Burial 18 is represented by only one skeletal element.

DENTITION: None present.

CRANIUM: None present.

POST-CRANIAL ELEMENTS: Rt. clavicle.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Adult. This assessment was made based on epiphyseal fusion and general size.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None present.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.
BURIAL 24

MATERIAL PRESENT: Burial 24 is represented by only a partial skeleton.

DENTITION: None present.

CRANIUM: None present.

POST-CRANIAL ELEMENTS: Three hyoid fragments, rt. clavicle, rt. scapula, rt. humerus, two wrist bones, three metacarpals, fifteen mixed phalanges, six rt. and seven lft. complete ribs, twenty-one rib fragments, twelve thoracic vertebrae, five lumbar vertebrae, six vertebral fragments, sacrum, rt. ilium, partial rt. ischium, two unknown bone fragments.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Male. This is based on the width of the sciatic notch, the area of the sacroiliac articulation, and width of the body of the sacrum to the ala.

AGE: Old adult, circa 45+ years. This assessment is made based on the degree of degeneration of the lumbar vertebrae.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None present.

SKELETAL PATHOLOGICAL CONDITIONS: The right clavicle displays some periosteal infection at the sternal articulation. All five of the lumbar vertebrae exhibit osteophytosis.

ANOMALIES: There is a bifid sacral hiatus of the sacrum.

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BURIAL 15

MATERIAL PRESENT: Burial 15 is represented by only a partial skeleton.

DENTITION: Rt. DI₁, lft. DI₁, rt. DI₂, lft. DI₂, rt. DI, lft. DC₁, rt. DP₁, lft. DP₁, rt. DM₁, rt. DM₁, lft. DM₁, rt. DI₁, lft. DI₁, rt. DI₂, lft. DI₂, rt. DC₁, lft. DC₁, rt. DP₁, lft. DP₁, rt. DM₁, lft. DM₁, lft. DM₂ (crown only).

CRANIUM: Frontal, six parietal fragments, four occipital sections, rt. and lft. zygomatic, palatine, three sphenoid fragments, twenty-one skull fragments.
**POST-CRANIAL ELEMENTS:** Six centrum, atlas, three cervical vertebrae, eight neural arch halves, rt. and lft. first rib, one epiphyses, three unknown fragments.

**MINIMUM NUMBER OF INDIVIDUALS:** One.

**SEX:** Indeterminate.

**AGE:** Early childhood, circa 3-4 years. This assessment was made based on the eruption of dentition, epiphyseal fusion and general size.

**STATURE:** Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** None observed.

**SKELETAL PATHOLOGICAL CONDITIONS:** None observed.

**ANOMALIES:** There is copper staining of the frontal bosses and both parietals.

**BURIAL 34 LOT 1183**

**MATERIAL PRESENT:** Burial 34 Lot 1183 is represented by two partial burials (34A, 34B).

**DENTITION:** (34A) None present.

(34B) None present.

**CRANIUM:** (34A) Frontal fragment, occipital fragment.

(34B) None present.

**POST-CRANIAL ELEMENTS:** (34A) Ilium, scapular body, one centrum, six neural arch halves, one complete neural arch, five rib fragments, rt. and lft. femora, lft. humerus, lft. tibia, two complete thoracic vertebrae.

(34B) Vertebrae, one complete lumbar vertebrae.

**MINIMUM NUMBER OF INDIVIDUALS:** Two (34A - Child, 34B - Adult).

**SEX:** (34A) Indeterminate. (34B) Indeterminate.

**AGE:** (34A) Child. Unable to assign a specific age category due to the fragmented nature of the remains. (34B) Adult. Unable to assign a specific age category due to the limited amount of remains.

**STATURE:** (34A) Indeterminate. (34B) Indeterminate.
DENTAL PATHOLOGICAL CONDITIONS: (34A) None observed. (34B) None observed.

SKELETAL PATHOLOGICAL CONDITIONS: (34A) None observed. (34B) None observed.

ANOMALIES: (34A) None observed. (34B) None observed.

BURIAL 21 LOT 1072

MATERIAL PRESENT: Burial 21 Lot 1072 is represented by only a partial skeleton.

DENTITION: Lft. DI₁, rt. DI₂, rt. DC₁, rt. DP₁, lft. DP₁.

CRANIUM: Mandible.

POST-CRANIAL ELEMENTS: Three hyoid fragments, two rib fragments, one complete rib, distal end fibula, two epiphyses.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant. This assessment was made based on eruption of dentition.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.

BURIAL 5* LOT 336, 324, 338, 330

MATERIAL PRESENT: Burial 5 is represented by only a partial skeleton of two individuals (B5A and B5B).

DENTITION: (5A) Rt. I¹, lft. I¹, M₂, M₃, lft. M², two premolar roots.

(5B) One deciduous molar, one DI¹, one DP, one DM.

CRANIUM: (5A) None present. (B5B) None present.

POST-CRANIAL ELEMENTS: (5A) Sternal body, three hyoid fragments,

(5B) 19 rib fragments, two neural arch halves, hand bones.

MINIMUM NUMBER OF INDIVIDUALS: Two (5*A - Adult, 5*B - Child).
SEX:  (5*A) Indeterminate. (5*B) Indeterminate.

AGE:  (5*A) Adult. (5*B) Child. Unable to assign to particular age categories because of limited nature of remains.

STATURE:  Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS:  The right I displays a large interstitial cavity. The left I also exhibits two caries distal and mesial. M\textsuperscript{2} and M\textsubscript{3} also display carious activity.

SKELETAL PATHOLOGICAL CONDITIONS:  None observed.

ANOMALIES:  None observed.

BURIAL 25

MATERIAL PRESENT:  Burial 25 is represented by only one skeletal element.

DENTITION:  None present.

CRANIUM:  None present.

POST-CRANIAL ELEMENTS:  Rt. rib fragment.

MINIMUM NUMBER OF INDIVIDUALS:  One.

SEX:  Indeterminate.

AGE:  Adult. Unable to assign to a particular age category due to limited nature of remains.

STATURE:  Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS:  None observed.

SKELETAL PATHOLOGICAL CONDITIONS:  None observed.

ANOMALIES:  None observed.

BURIAL 8*

MATERIAL PRESENT:  Burial 8 is represented by only a partial skeleton of two individuals (8A and 8B).

DENTITION:  (8A) None present. (8B) None present.

CRANIUM:  (8A) None present. (8B) None present.
POST-CRANIAL ELEMENTS: (8A) Two patellae, five metatarsals, five phalanges, seven unidentifiable bone fragments. (8B) One rib fragment.

MINIMUM NUMBER OF INDIVIDUALS: Two (8A - Child, 8B - Infant).

SEX: Indeterminate.

AGE: (8A) Based on general size and gracile nature of remains appears to be a small child. (8B) Appears to be an infant. However, due to limited nature of remains assessment to a particular age category is not possible.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: (8A and 8B) None observed.

SKELETAL PATHOLOGICAL CONDITIONS: (8A and 8B) None observed.

ANOMALIES: (B8A and B8B) None observed.

BURIAL 38*

MATERIAL PRESENT: Burial 38 is represented by only a partial skeleton.

DENTITION: Five deciduous incisors.

CRANIUM: Rt. mandible, thirty skull fragments.

POST-CRANIAL ELEMENTS: Forty-one neural arch halves, one clavicle, two scapulae, two humeri, two ulnae, two radii, two ilium, two femora, two tibiae, two fibulae, thirty-two rib fragments, two metacarpals, twenty-two epiphyses.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant, circa 1 year ± 4 months. This assessment was based upon eruption of dentition, epiphyseal fusion and general size.

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed. However, bones are in an extremely fragile state and badly fragmented.

ANOMALIES: None observed.
BURIAL 10

MATERIAL PRESENT: Burial 10 is represented by only a partial skeleton.

DENTITION: Rt. DI₁, rt. DP₁.

CRANIUM: Rt. and lft. frontal, rt. parietal, four occipital sections, rt. and lft. temporal, rt. and lft. zygomatic, three sphenoid fragments.

POST-CRANIAL ELEMENTS: Nineteen centrum, forty-four neural arch halves, rt. ilium, rt. and lft. scapulae, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae, lft. clavicle, miscellaneous hand bones, eleven lft. and eleven rt. ribs.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.

AGE: Infant. This assessment was made based on epiphyseal fusion and general size (<2 years).

STATURE: Indeterminate.

DENTAL PATHOLOGICAL CONDITIONS: None observed.

SKELETAL PATHOLOGICAL CONDITIONS: None observed.

ANOMALIES: None observed.

BURIAL 9

MATERIAL PRESENT: Burial 9 is represented by only a partial skeleton.

DENTITION: Rt. DI₁, lft. DI₁, rt. DI₂, lft. DI₂, rt. DP₂, rt. DI₁, lft. DI₁, rt. DI₂, lft. DI₂, rt. DP₁, lft. DP₁.

CRANIUM: Rt. frontal fragment, right parietal, four occipital sections, rt. and lft. temporal, rt. zygomatic, forty-five miscellaneous skull fragments.

POST-CRANIAL ELEMENTS: Nine centrum, seven fused neural arches, five neural arch fragments, rt. and lft. radii, lft. ulnae, rt. and lft. clavicle, hand bones, eight lft. and two rt. ribs, one foot phalange.

MINIMUM NUMBER OF INDIVIDUALS: One.

SEX: Indeterminate.
**AGE:** Infant, circa 18 months ± 4 months. This assessment was based on eruption of dentition, epiphyseal fusion and general size.

**STATURE:** Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** None observed.

**SKELETAL PATHOLOGICAL CONDITIONS:** None observed.

**ANOMALIES:** None observed.

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**BURIAL 7**

**MATERIAL PRESENT:** Burial 7 is represented by only a partial skeleton.

**DENTITION:** Rt. Dl1, lft. Dl1, rt. Dl2, lft. Dl2, rt. DC1, lft. DC1, rt. DP1, lft. DP1, rt. DM1, lft. DM1, rt. Dl1, lft. Dl1, rt. Dl2, lft. Dl2, rt. DC1, lft. DC1, rt. DP1, lft. DP1, rt. DM1, lft. DM1.

**CRANIUM:** Frontal, rt. and lft. parietal, occipital, rt. and lft. temporal, wing fragment of sphenoid, five skull fragments.

**POST-CRANIAL ELEMENTS:** Twenty-six centrum, five cervical arches, fifteen neural arches, rt. and lft. ilium, rt. and lft. ischiium, rt. and lft. scapulae, rt. and lft. humeri, rt. and lft. radii, rt. and lft. ulnae, rt. and lft. clavicle, ten hand phalanges, twelve rt. and twelve lft. ribs, rt. and lft. femora, rt. patella, rt. and lft. tibiae, rt. fibula, eleven foot phalanges, five epiphyses.

**MINIMUM NUMBER OF INDIVIDUALS:** One.

**SEX:** Indeterminate.

**AGE:** Early childhood, circa 4–5 years. This assessment was based on eruption of dentition, epiphyseal fusion and general size.

**STATURE:** Indeterminate.

**DENTAL PATHOLOGICAL CONDITIONS:** None observed.

**SKELETAL PATHOLOGICAL CONDITIONS:** None observed.

**ANOMALIES:** None observed.
APPENDIX B

DESCRIPTION OF MEASUREMENTS
DESCRIPTION OF MEASUREMENTS

HUMERUS

MAXIMUM LENGTH: Measured by placing the humeral head against the fixed wall of the osteometric board and placing the movable upright against the distal end of the trochlea (Olivier, 1969).

MINIMUM CIRCUMFERENCE: Measured distal to the deltoid tuberosity, about one centimeter distal to the nutrient foramen. Measured with the use of a steel tape (Bass, 1987).

MINIMUM DIAMETER: Measured at the same location as minimum circumference, taken medial/lateral with the use of the sliding caliper (Bass, 1987).

VERTICAL MAXIMUM DIAMETER OF THE HEAD: Measured at the maximum distance between the margins of the head in a coronal plane; taken with the sliding calipers (Steele and Bramblett, 1988).

ARTICULAR SURFACE: Measured at the maximum distance between the trochlea and capitulum with the use of the sliding caliper (France, 1983).

BIEPICONDYULAR WIDTH: Measured at the maximum distance between the medial epicondyle and lateral epicondyle with the use of the sliding caliper (France, 1983).

TRANSVERSE DIAMETER OF THE HEAD: Similar to vertical maximum diameter but measured horizontally (anterior-posterior) with the use of the sliding caliper (France, 1983).

RADIUS

MAXIMUM LENGTH: Measured from the head to the tip of the styloid process. Measured with the use of the osteometric board. (Bass, 1987).

MINIMUM CIRCUMFERENCE: Can be measured any place on the shaft but usually between the radial tuberosity and the nutrient foramen (Olivier, 1969). Measured with the use of a steel tape.

MINIMUM DIAMETER: Measured at the midshaft with the use of the sliding calipers (Olivier, 1969).
ULNA

MAXIMUM LENGTH: Measured from the top of the olecranon process to the tip of the styloid process with the use of the osteometric board (Bass, 1987).

PHYSIOLOGICAL LENGTH: Measured from the ridge running across the floor of the semilunar notch to the deepest point of head (Bass, 1987). Measured with the use of the hinge caliper.

MINIMUM CIRCUMFERENCE: Measured at the point on the diaphysis above the head where the shaft becomes nearly cylindrical with the use of a steel tape (Bass, 1987).

MINIMUM DIAMETER: Measured at the same area as the minimum circumference with the use of the sliding calipers (Steele and Bramblett, 1988).

FEMUR

MAXIMUM LENGTH: Measured from the proximal-most point of the femur head to the distal-most point of the medial condyle (Olivier, 1969). Measured with the use of the osteometric board.

BICONDYLANAR LENGTH: Measured with both the lateral and medial condyle resting against the fixed wall of the osteometric board and the movable end placed against the head (Bass, 1987).

MIDSHAFT CIRCUMFERENCE: Measured at the midpoint of the shaft (determined from the osteometric board) with the use of the steel tape (Steele and Bramblett, 1988).

ANTERIOR (POSTERIOR) DIAMETER: Measured at the midshaft circumference anterior-posterior with the use of the sliding caliper (Bass, 1987).

TRANSVERSE DIAMETER: Measured at the same point as the midshaft circumference mediolateral with the use of the sliding calipers (Steele and Bramblett, 1988).

BICONDYLANAR WIDTH: Measured at the maximum width of the lateral condyle to the medial condyle with the use of sliding caliper (Giles, 1970).

HEAD DIAMETER: Measured in a vertical plane from margin to margin on the articular surface of the head with the use of the sliding caliper (Steele and Bramblett, 1988).
ANTEROIOR (POSTERIOR) SUBTROCHANTERIC DIAMETER: Measured on the shaft approximately 3.0 to 6.0 cm below the lesser trochanter with the use of the sliding caliper (Olivier, 1969).

TRANSVERSE SUBTROCHANTERIC DIAMETER: Measured at the same point as the anterior subtrochanteric diameter and perpendicularly to it with the use of the sliding caliper (Olivier, 1969).

TIBIA

MAXIMUM LENGTH: Measured from the most proximal point of the lateral condyle placed against the fixed wall of the osteometric board and the moveable end placed at the distal end of the medial malleolus (Olivier, 1969).

MIDSHAFT CIRCUMFERENCE: Measured at the nutrient foramen with the use of a steel tape (Olivier, 1969).

ANTEROIOR (POSTERIOR) DIAMETER: Measured at the same point as the circumference with the use of the sliding caliper (Bass, 1987).

TRANSVERSE DIAMETER: Measured at the nutrient foramen mediolaterally with the use of the sliding caliper (Bass, 1987).
APPENDIX C

LIST OF PATHOLOGICAL DISORDERS
AND AFFECTED BURIALS
LIST OF PATHOLOGICAL DISORDERS AND AFFECTED BURIALS

I. ASYMMETRY
   B-20

II. BIFID SACRAL HIATUS
    B-6A   B-28   B-36
    B-17   B-32   B-24   B-33

III. COCCIDIOIDOMYCOsis
     B-36*

IV. CRANIAL DEFORMATION
    B-5   B-18   S-27
    B-6A  B-20   S-29
    B-17  B-22A  S-38

V. ENDOCHONDRAL OSSIFICATION
   B-33

VI. OSTEOARTHRITIS
    B-20   B-32
    B-28   B-33
    B-31   B-37

VII. OSTEOPHYTOSIS
     B-17   B-33   B-37
     B-28   B-34
     B-32   B-36
VIII. OSTEOPOROSIS
   B-20
   B-31

IX. OSTEOMA
   B-22
   B-33
   B-37

X. PERIOSTITIS
   B-18    B-31
   B-20    B-36
   B-24

XI. POROTIC HYPEROSTOSIS
   B-5
   B-17
   B-2019

XII. SCHMORL’S NODES
   B-22A    B-36
   B-28    B-37
   B-32

XIII. SEPTAL APERTURE
   B-17
   B-18
   B-22A

XIV. SKELETAL DYSPLASIA
   B-18
   S-38
XV. SQUATTING FACETS

B-6B
B-28
B-32

XVI. SUTURE ANOMALIES

B-6A    B-25    B-37
B-17    B-32    S-29
B-20    B-33

XVII. TRAUMA

B-32
B-34
B-36

XVIII. TREPONEMAL INFECTION

B-20*
B-36*

XIX. TUBERCULOSIS

B-36*

XX. VERTEBRAL VARIATION

B-32

* Indicates that skeletal material displayed lesions consistent with a particular pathological disorder but can not be definitively identified.
VITA

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