CERRO MANGOTE: INTERPRETATIONS OF SPACE BASED ON MORTUARY ANALYSIS

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DISSERTATION

Submitted in partial fulfillment of the requirements for
the degree of Doctor of Philosophy in Anthropology
in the Graduate School of
Binghamton University
State University of New York
2013

Accepted in partial fulfillment of the requirements for
the degree of Doctor of Philosophy in Anthropology
in the Graduate School of
Binghamton University
State University of New York
2013

April 19, 2013

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ABSTRACT

Cerro Mangote (7000-5000 BP uncalibrated) is a Preceramic site on the central Pacific coast of Panama. The site is unusual since it is the only Preceramic site to date in Central America with over 100 burials excavated from the site. By re-analyzing the sample of human skeletons from Cerro Mangote, this dissertation establishes a more reliable biological profile, details mortuary treatments, and combines musculoskeletal stress markers and activity patterns with previously published stable isotopes (C and N) (Norr 1991), to explore population structure and site use based on food procurement patterning and mortuary treatments. Based on local and regional archaeological evidence, researchers how proposed that the transient inhabitants of Cerro Mangote had a mixed diet, including local amphibians, reptiles, birds and mammals, wild and cultivated plants, estuarine fish, and shellfish (Piperno and Pearsall 1998, Ranere and Cooke 2003). While archaeological diet is inferred, it is unclear what segments of a population used the site and the terms of site use. This dissertation aims to flesh out the cultural history of site use by examining direct and indirect dietary data, mortuary structure, demography and skeletal markers of activity. These lines of data demonstrate that the diet relied heavily on local marine and terrestrial vertebrates. The mortuary treatments indicate a slight preference for flexed, supine primary burials, with the heads facing north. Secondary burials appear to be created as encountered, since they are found in association with primary burials. This research highlights the experimentation in both resource use and mortuary pattern by the living population, illustrating variation not typically assumed in a Preceramic site.

To the people of Panama,
both past and present

ACKNOWLEDGMENTS

At the risk of adding a few more pages, there are a number of people I must thank for their help and support through this process. I am not sure I have enough words to truly express my gratitude, please know it is much deeper than anything I can express in a few sentences.

First, I thank my advisor, Dr. Dawnie Steadman, for her continued guidance, occasional prodding, and support. This would not have been possible without her. Thank you for your hard work and sharing your experiences with me. Your support here and in my continued success has meant more to me than you could know (and your constant vigilance against my misuse of the word 'population').

Thank you to my all committee members, both past and present. Dr. Michael Little, you helped me from the start to take a tangle of methods and form them into something meaningful. Thank you for your continued encouragement. Dr. Andy Meriwether, thank you for not only helping in this dissertation, but for your generosity in sponsoring the mtDNA pilot study. Your continued support in unraveling the ancient DNA samples is most appreciated. Dr. Bill Isbell has been invaluable in grounding my research in the archaeological questions and interests in the region. Thank you for your help and patience in the structuring (and restructuring) of my arguments and thoughts. Thank you to Dr. Peter Stahl for his early help in the importance of the archaeofaunal and mortuary information in Central and South America. Dr. Tony Ranere, thank you not only for your work in Panama, but also your help in leading me through the nuanced landscape of research in the region. Last, but not least, I must thank Dr. Gale Spencer for graciously agreeing to be my outside examiner. Thank you for your guidance and willingness to evaluate my work.

The data collection for this project took me to several institutions and I am deeply indebted to everyone who provided permissions for me to examine the necessary skeletal material. A special thanks to Richard Cooke, for your continued help with my research, my writing, your sponsorship at the Smithsonian, and your encouragement of my work. Thanks to the Smithsonian Tropical Research Institute for their generosity through the Short Term Fellowship.

Thanks to the UHS Foundation, Phil Evans, and Joan Hensberry at the Wilson Medical Center for their help with the CT scans needed for my research. A special thank you to Will Peacock for giving up a Saturday morning to help me create the necessary scans.

Thank you to Jennifer Luedtke Kennedy for her time, blood, and sweat in the ancient DNA laboratory at Binghamton University. Without you, the pilot study would not have been been possible. Thank you to the Binghamton Foundation and the Department of Anthropology for their generosity and funding of a portion of this research and writing through the Dissertation Writing Grant.

This research began as I finished my MA in Arkansas, and found myself looking for a project to fill my remaining time. Thank you to Dr. Charles McGimsey III for finding me a “short inventory project” that turned into much, much more. Thank you to the Mary Suter and the Arkansas Archaeological Survey for their help, support, and willingness to mail almost anything.

Thank you to Carolyn Robinson for her graphic design wizardry. The sketches I sent you are the only records we have of some of the mortuary contexts. Thank you for all your help in restoring them. Thank you to my brother, Dr. Zachary Huard first, for your love, support, and invaluable comedic timing. Thank you also for always answering your phone, knowing full well it was yet another question about programming, R, or how to get my data from one program to the next.

Finally, I must thank my friends and family for their help, love, support, motivation, and occasional cheering. To Jenny, Krisit, Brittney, Jocelyn, Nikki, Jason, Heather, Mimi, Liam, and so many more, we made for a rather strange Binghamton family, but a family nonetheless. To Jeanne and Carolyn, thank you for everything, you are always in my heart. Thank you to my parents, Thomas and Susan Huard, for your unfailing support and inspiration. Thank you for always encouraging my education, even if it has not always been the easiest path. And to my husband Andrew, I am grateful for your steadfast support, your occasionally not-so-gentle reminders to finish this project, and your love. Thank you for your encouragement throughout graduate school to pursue my dreams, no matter what.

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CHAPTER 1: INTRODUCTION

Archaeological investigations of prehistoric Panamanian land bridge sites, on the main conduit of migrations to South America, have greatly impacted understandings of initial population movement and continuous settlement of the isthmus. For decades, archaeologists have worked to understand the timing, mode and mechanism of settling of the new world, and Central America figures prominently in these inquiries. The central issues contemporary archaeologists tackle include the peopling of the land bridge and when each site was utilized and how these two areas reflected social changes through time. In order to examine these central questions, researchers have combined data regarding population increase, the growing importance of agriculture and coastal resource use, expanding trade and exchange, the establishment of a sedentary farming life and, ultimately, rank-based societies (see Briggs 1989, Cooke and Ranere 1992c, Cooke and Sánchez 2004a, Cooke 2005, Linares 1977b, Linares & Ranere 1980, Piperno 2011a, 2011b, Ranere 2006). Due to poor preservation in the region, human skeletal data has been considered less answering in these questions, but can provide corroborating evidence of occupation and site use, the importance and evolution of cultural beliefs through mortuary treatments, as well as direct evidence into the health of the group utilizing the site.

Much of the above research compares how individuals at various sites utilized resources spatially and temporally, using data such as archaeobotanical remains, archaeofaunal remains, or items denoting status. Studies clearly differentiate the Paleo-Indian and Ceramic periods by settlement types and material objects, but the time in between – the Preceramic period – shows variety in both site types and resources (see Cooke 2005, Piperno 2011a, 2011b). This greater variety suggests more experimentation and exploration of the available resources than other periods. While previous research agendas have focused on single sources of evidence to address exploitation within the Preceramic period, this disciplinary compartmentalization creates false boundaries. Too broad strokes can limit our understanding as to the impact and scope of how the people viewed their local landscape. The purpose of this research is to integrate multiple lines of evidence to elicit a clearer picture of health and occupation at a single site: Cerro Mangote. The current evidence regarding site use, material culture, environmental changes, and site data are reviewed to ground the questions of occupation and health at Cerro Mangote, a Preceramic site from Panama.

To consider organize the multiple methods used in this dissertation, the questions are arranged into two categories. The first category will consider the occupation type, cemetery arrangement and use, and subsistence patterns.

To address occupation, the following questions are considered:

1. Does intra-cemetery biodistance analysis suggest the burials are arranged within the space based on familial groups (defined by biological affinity)?
2. Is there a discernible pattern to how the cemetery was organized?
3. Are Cerro Mangote burial patterns more similar to other Preceramic groups or other Ceramic groups?
4. Was the site of Cerro Mangote occupied year-round or seasonally?

5. Are the musculoskeletal stress markers (MSM) and cross-sectional geometry patterns of Cerro Mangote consistent with those published for modes of food procurement?

I argue that Cerro Mangote is a multi-use site with a locally constructed landscape to accommodate year-round occupation. Three lines of evidence will be used to evaluate site use: new biological profiles from skeletal data, mortuary practices from excavation notes, and dietary data from stable isotopes (Norr 1991, 1995) and skeletal markers. They will be used to elucidate a pattern of resource exploitation and site use situated within the framework of known characteristics of seasonal and year-round occupied sites. The new data and interpretations provoke re-evaluation of earlier studies.

To address health, the following questions are considered:

1. What is the paleodemographic profile of Cerro Mangote?
2. Are Cerro Mangote skeletal lesions similar to other Preceramic groups?

I argue that Cerro Mangote's paleodemographic profile illustrates growth of the population, with indicators consistent with overall good health. The impact of fertility and mortality will be used to sketch the expected hazards and population structure at the site for the paleodemographic profile. Health will be evaluated by observing the frequency of infectious disease, trauma, and dental disease. These three corroborating lines of evidence will be used to examine a pattern overall health at the site and compared to other known regional skeletal samples.

Cerro Mangote offers the chance to synthesize a rich collection of data, including mortuary patterns, paleodemographic information, zooarchaeology, micro and macro paleobotany, and isotopes. Skeletal research is an excellent means to address questions of local site use based on the importance of burial style, biological profiles, disease patterning, and biological affinities of individuals. Approximately 110 individuals were buried at the site. At Cerro Mangote, the number of burials, the variety of arrangements of bodies within the graves, and the arrangement of graves across the site suggest the population that utilized this site considered it to be more than merely a food-gathering location. Cerro Mangote may have been an early center for trade and development of mortuary rituals seen in later Ceramic sites in Parita Bay.

1.1 Brief description of study context

The main geographic contexts within the Panamanian landscape this dissertation focuses upon are Central Pacific Panama and Chiriquí highlands (see Figure 1.1). The

Figure 1.1: Map of Central and South America. Panama is highlighted by the arrow. Modified from Butler 2011.

Central Pacific Panama region consists of the foothills of the Pacific coastal plain and Pacific coast of central Panama. Unlike most of Central America, the Pacific side of Panama (rather than the Caribbean side) has a wider coastal plain, with winding rivers and extensive floodplains. The Chiriquí highlands correspond to the western highlands in Chiriquí. Both areas contain a number of Preceramic and Ceramic period rock-shelters and open sites used for comparison throughout this dissertation. While these areas or "culture provinces" (Cooke and Ranere 1992a) are not static, the hypothetical boundaries used to differentiate the Coclé region from the Chiriquí region are based on variations in Ceramic and flaked stone tool technologies. Though the sites of the Chiriquí highland illustrate a different cultural trajectory from Central Pacific Panama, there are some overall patterns of occupation shared between the two regions that are particularly useful in the assessment of site use at Cerro Mangote.

Location of Cerro Mangote. The site of specific interest to this dissertation is Cerro Mangote. The site of Cerro Mangote (7000-5000 BP) is located in Central Pacific Panama, approximately 10 km from the present, active shoreline of Parita Bay (see Figure 1.2). This shell-midden site was located 1.5 – 4 kilometers from the coastline at the time of occupation (Cooke and Ranere 1999, Ranere and Hansell 1978). The hill *Cerro Mangote* (for which the site is named) is on the northern bank of the Santa Maria River, with the archaeological site located on the eastern end of the hill. Parita Bay is, currently, a shallow embayment on the northwest corner of the Gulf of Panama with extensive mud-flats, flanked by mangrove swamps, marshes and salt flats.

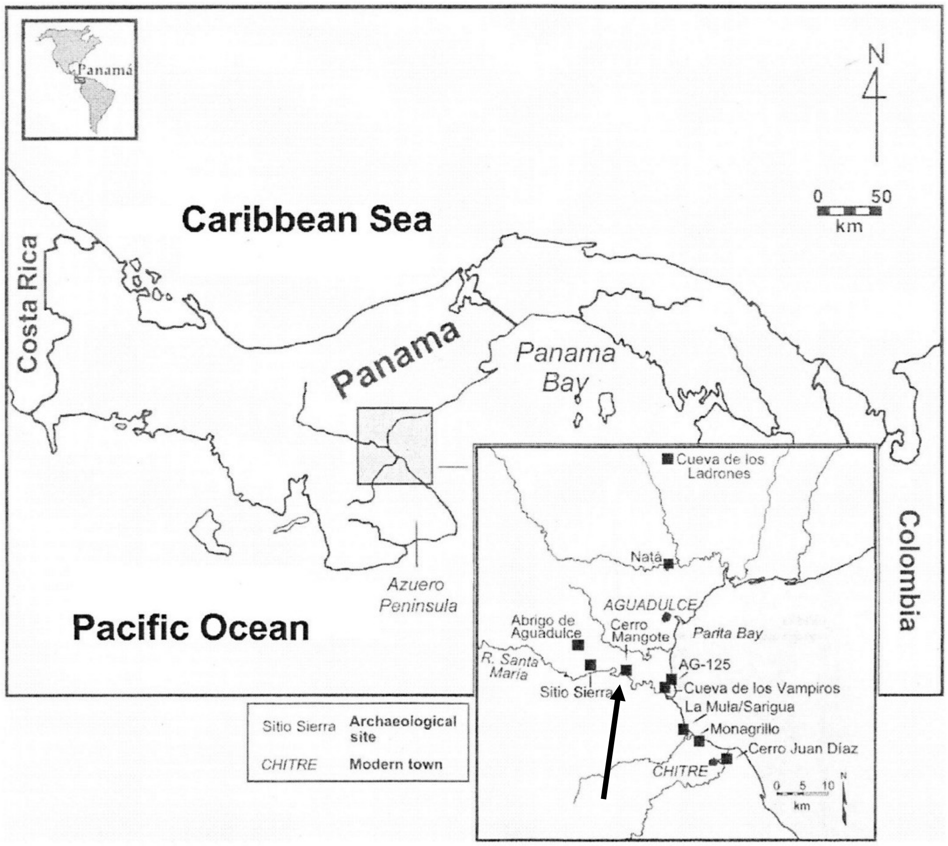

Figure 1.2: Map of Panama, Parita Bay in insert. Cerro Mangote highlighted with arrow. Modified from Cooke and Jimenez 2004: 21.

Multiple data corroborate how and when the coastlines in Parita Bay, Panama shifted (Bailey and Parkington 1988, Clary *et al.* 1984, Cooke 2005, Cooke and Ranere 1984, Dickau 2005, Lange 1979), causing the ecology of Cerro Mangote to eventually transform from a coastal site to an estuary site (Piperno *et al.* 1991a, 1991b, Piperno and Pearsall 1998, Ranere and Cooke 2003). Faunal evidence mirrors the changing ecology, since the older deposits (7000-6000) contain marine organisms, particularly mollusks, whereas the more recent (6000-5000 BP) are overwhelmingly crab – specifically *Cardisoma,* a mangrove dwelling crab (McGimsey *et al.* 1987, Ranere n.d.).

Seasonal and year-round sites. Materials recovered during the Proyecto Santa Maria (PSM) contribute much of what is known regarding the use of various archaeological sites from the Paleo-Indian period through the Ceramic period. Both Chiriquí highland and Central Pacific Panama sites can be classified based on their seasonal or year-round usage. The term 'seasonal sites' is used to describe archaeological sites where a particular resource is exploited for one season. The term 'year-round site' is used to describe a permanently occupied site where a series of resources are exploited throughout the year. Cooke (2005) also proposes that these year-round sites may have supplemented their locally available resources through trade (see also Cooke 1984, McGimsey 1956, McGimsey *et al.* 1987, Griggs 2005, Ranere and Hansell 1978).

Current theories regarding site use at Cerro Mangote focus on local resource exploitation. The first two theories focus on seasonal, local resource exploitation. Griggs (2005) suggests Cerro Mangote may have been utilized during the dry season to collect salt, a practice observed at the nearby site of Monagrillo[1]. Norr (1991, 1995) proposes the site was used also during the dry season to collect marine resources, but that the inhabitants spent more time further inland. She interpreted the stable isotopes to indicate that the inhabitants of Cerro Mangote relied on a diet higher in plant and terrestrial resources than marine (Norr 1995).

Other theories of site occupation and use consider the variety of resources utilized at the site. Carvajal-Contreras and Hansell (2008) advocate for a more mixed economy, citing evidence of plant exploitation, hunting, particularly deer and iguana

[1] Monagrillo (4500 – 3200 BP) is one of the first sites in the Early Ceramic period discovered in Central Pacific Panama (on occasion, the Early Ceramic period is referred to as the Monagrillo period). The Monagrillo type site is a shell mound near the shoreline of Parita Bay. The pottery is characterized by simple forms with infrequent decoration. The Monagrillo complex appears to be located not only along the Pacific coast, but also near the Continental Divide and Caribbean foothills (see Willey and McGimsey 1954, Cooke 1995, Cooke 2005, Griggs 2005).

(Cooke and Martin 2010), collecting crabs and shellfish, and shore-based fishing (see also Cooke and Ranere 1992b, 1999, Ranere and Cooke 2003). Carvajal-Contreras and Hansell's proposal fits well with new starch[2] evidence indicating maize was present at Cerro Mangote, suggesting the "plant exploitation" is agriculture (Piperno 2011a, 2011b). Finally, Cooke (2005) contends that it evidence is equivocal that Cerro Mangote was occupied year-round and supplied by inland and coastal trade routes. Based on the coeval layers at Cueva de los Ladrones, Aguadulce Shelter, and Playa Don Bernado, Cooke and Ranere hypothesize a connection between the hillside sites (for planting during the rainy season) and coastal marine sites.

Cooke and Sanchez (2004) highlight the presence of a manatee bone at Cerro Mangote – a species only found on the Caribbean side of Panama, never on the Pacific coast side. The manatee bone suggests that the inhabitants of Cerro Mangote may have had at least minimal contact with groups from the Caribbean coast, and probably a trade circuit throughout central Panama (see also Carvajal-Contreras *et al.* 2008, Cooke 2005, Cooke and Jimenez 2008a, 2008b, Cooke *et al.* 2007, 2008, Cooke *et al.* 2013, Griggs 2005). Each of these theories, though, centers more on the archaeofaunal and archaeobotanical records, which are equivocal regarding seasonal or year round occupation.

Temporal divisions. The archaeological record indicates a movement of crops, technologies, and goods between various groups in the land bridge territory before

[2] The analysis of starch grains examines the shapes and patterns of the main mechanism for food storage in plants. The residues have been used by archaeologists to identify elements of the diet of a particular human group; what a particular tool on which starch grains appear was used for; and even climate and vegetation of the region of an archaeological site in which the starch grains were discovered. Piperno and Pearsall (1998) and Dickau (2005) utilized residue analysis on the stone tools of multiple sites in Panama as part of their studies on the domestication of plants in the regions.

approximately 1400 BP (Piperno 2011a). Table 1.1 lists the sites considered with approximate time periods and uncalibrated radiocarbon dates. After the Clovis horizon, archaeological, linguistic, and genetic evidence indicates continuous occupation of the land bridge area (see Barrantes *et al.* 1990, Constenla 1991, Cooke 2005, Cooke and Ranere 1999, Cooke *et al.* 2007, Correles 2000, Dickau 2005, Kolman *et al.* 1995, Merriwether *et al.* 1994, Merriwether *et al.* 1995, Perego *et al.* 2012, Piperno *et al.* 2004, Piperno 2011a, 2011b, Ruiz-Narvaez *et al.* 2005).

Groups appear to have been fairly mobile until the Late Preceramic, occupying most sites according to seasonal availability and abundance of resources (referred to in this dissertation as seasonal sites), such as palm nut collection at Aguadulce shelter[3] (Dickau 2010, see also Griggs 2005, Piperno 2011a, 2011b). There is also archaeological evidence for larger populations and for more intensively occupied sites than in the Early Preceramic sites (Cooke 2005, Cooke and Ranere 1992b, 1999, Dickau 2010, Ranere and Cooke 1996, Ranere and Hansell 1978, Piperno 2011a, 2011b, Piperno & Pearsall 1998, Piperno *et al.* 2000, Piperno *et al.* 2009). Cerro Mangote is important to the Parita Bay area and isthmian perspective because the site was occupied during the Late Preceramic period, a time that witnessed the consolidation of plant food production in the isthmian subsistence economy, and an intensification of coastal resource use – at least along the Pacific coast where sea levels stabilizing after post-glacial transgression provided appropriate conditions for estuary formation (Clary *et al.* 1984, Cooke and Ranere 1999).

[3] The Aguadulce Shelter is a rockshelter site found in the Central Pacific Panama of Central Panama, with deposits dating between 11,000 – 1500 BP. Details of this site, and other resources collected, are found in Chapter 2.

Table 1.1: Early cultural sequence in Panama including the most important sites (modified from Cooke 2005, Dickau 2005, Griggs 2005, Piperno 2006)		
Period	Important sites	Dates
Paleo-Indian	Lake Madden La Mula-West Corona Vampiros-1 Sitio Nieto La Yeguada Abrigo Carabalí Aguadulce Shelter	11,200 – 10,000 BP
Early Preceramic	Vampiros-1 Abrigo Carabalí Aguadulce Shelter La Yeguada Late Madden-West	10,000 – 7000 BP
Late Preceramic	La Cueva de los Ladrones Cerro Mangote Aguadulce Shelter Hornito Casita de Piedra Trapiche Vaca de Monte Abrigo Los Santanas Playa Don Bernardo (Pearl Islands) Sitio Lasquita (Caribbean)	7000 – 4500 BP
Early Ceramic	Aguadulce Shelter Cueva de los Ladrones Monagrillo Zapotal Abrigo Calavera (Caribbean)	4500 – 3000/2300 BP

Environmental Context. Between the Paleo-Indian period and Preceramic period, the isthmian climate became warmer and wetter (Coates 1997, Cooke 2005, Webb 1997). The changing forest composition best illustrates the changes between the Pleistocene/Late Glacial Stage and the Holocene period, where the Pleistocene forests were more open and drier than their modern counterparts, most likely containing a higher animal biomass (see Bartlett and Barghoorn 1973, Bush and Colinvaux 1990, Dickau 2010, Piperno 2011a, Piperno 2011b, Piperno *et al.* 1991a, 1991b, Piperno *et al.*

1992, Piperno and Pearsall 1998, Ranere and Cooke 2003). The slopes of the foothills show evidence of increasing erosion and slash and burn forest clearing, increasing since approximately 8,600 BP due to human forest clearing for agriculture (Piperno 2006, 2011a, Piperno *et al.* 2007). With intensifying slash-and-burn cultivation, humans cleared vegetation at a much more rapid rate, thereby transforming the landscape (Piperno 2006, Piperno 2011b).

Following the ecological transition from the Late Glacial Stage, the research focus broadened to include the impact and distribution of trade systems on plant domestication and population movement. It is clear that by the end of the Early Preceramic period (8000 BP), some plants were already under domestication, such as leren, arrowroot and squash (see Cooke 2005, Piperno 2011a, 2011b, Piperno and Pearsall 1998). The archaeological record at Cerro Mangote indicates the people at the site used many of these resources. Cerro Mangote offers a chance to illustrate the local variation in resource use, as well as a chance to explore how the inhabitants viewed their landscape.

1.2 Hypotheses

This brief overview of the geographic, environmental, cultural, and temporal context demonstrates the variation in site use and exploitable resources. An understanding of site occupation and population health could contribute much to the understandings of the region. In addition, there are several theories that can be tested with skeletal data. Patterns of biological stress elucidate overall well-being of the Cerro Mangote people. Together, these themes provide a more holistic yet nuanced look at life at Cerro Mangote. The ambiguity concerning Cerro Mangote site usage may be resolved by new data, derived from skeletal remains, as well as re-interpretation of existing data.

The specific hypotheses regarding occupation to be tested are:

A. **The faunal evidence will be consistent with year round exploitation of local resources.**

The lists of known faunal remains collected in the three excavations at Cerro Mangote will be compared to published materials regarding the seasonality of the organisms. To determine the species within the faunal record of Cerro Mangote, excavation notes and previous publications will be consulted (see Cooke 1984, 1992a, Cooke and Ranere 1984, 1989, 1999, Cooke *et al.* 1985, Cooke *et al.* 2007, Cooke *et al.* 2008, Cooke *et al.* 2013, McGimsey 1956, McGimsey *et al.* 1987, Ranere n.d.). Piperno (2011a, 2011b) illustrates through the vegetation history of Central Pacific Panama that the current archaeobotanical record alone is inconclusive in discerning occupation types (see also Piperno and Pearsall 1998). Particular attention is paid to the extensive fish faunal analysis (Cooke 1992, 1993, Cooke and Tapia 1994, Cooke and Jimenez 2008a). If the site of Cerro Mangote was occupied year-round, then the faunal collection should include organisms collected in both the wet and dry seasons. Particular attention is paid to the species of birds and crabs identified at the site, since both have differential seasonal abundance.

B. **Burials grouped by intra-cemetery structures at Cerro Mangote will contain individuals more closely related to each other (within group similarity).**

The presence of a cemetery at a site suggests the location was particularly important, the meanings of which are explored in Chapter 3. The mere presence of a cemetery suggests the site was utilized differently than other regional sites.

McGimsey *et al.* (1987) published the burial arrangement and initial demographic patterns, but found no clear patterning within the cemetery based on burial orientation, position within the grave, number of individuals, age, sex, or pathology (see also McGimsey 1956, Ranere unpublished). Since the original demographic analysis, the sample has been re-inventoried and resorted, using new aging methods to provide a more nuanced understanding of the mortuary practices and demography. Chapter 2 describes the approximate 30 stacked stone columns that appear to divide the cemetery into three main burial groupings (McGimsey 1956). Based on correlations between inter-individual biological distance matrices from dental measurements, within- and between-group relationships can be measured. The presence of familial grouping is assumed if the biological affinity among individuals within a stone column grouping is greater than between groupings (based on Ricaut *et al.* 2010). Comparative sites with year-round occupation (see Chapter 2) indicate the presence and organization of cemeteries increased from the Preceramic periods into the later periods.

C. The inhabitants of Cerro Mangote will have similar robusticity of the upper limbs and lower limbs, indicating a mixed subsistence.

Subsistence patterning can point to a particular site use, since the model differentiates hunter/gatherer groups (more common in migratory groups) from a more mixed subsistence (more common in sedentary groups). Musculoskeletal stress markers (MSM) are areas of muscle attachment on bone that change robusticity due to mechanical demands. Rhode (2006) suggests Central and South American populations subsisting on marine- or agriculturally-based food procurement are differentiated through MSM robusticity patterns, but mixed subsistence patterns are more problematic, since individuals are assumed to have similar robusticity of upper and lower limbs. Since MSM consider only the external changes from mechanical strain, I have also calculated the cross-sectional geometry of available humeri and femora. Cross-sectional geometry describes the internal structural changes of a bone in response to stimuli and strain. The calculated changes due to forces and strain are expected to remain relatively constant for both upper limbs (represented by humeri) and lower limbs (represented by femora).

The specific hypothesis regarding health to be tested is:

D. **The individuals at Cerro Mangote will have low frequencies of dental defects, indicating low stress and overall good health.**

From the late Preceramic to Ceramic periods, groups throughout Panama consumed increasing amounts of agricultural produce, though they continued to exploit estuarine habitats for food (Carvajal-Contreras *et al.* 2008, Cooke 2001, Cooke and Ranere 1992a, 1992b, Cooke and Jimenez 2004, 2008a, 2008b, Cooke *et al.* 1996, Cooke *et al.* 2007, Dickau 2005, Piperno 2011a, 2011b, Piperno *et al.* 2000, Piperno *et al.* 2004). While agrarian diets are commonly associated with poor health, any source of nutrient imbalance can impact overall health through stress, including poor foraging (see Temple 2007, Temple and Larsen 2007). To assess overall health, dental defects, particularly linear enamel hypoplasias (LEH), are utilized to show whether an individual was under stress during growth and development. High frequencies of LEHs indicate more stress, whereas lower frequencies of LEHs indicate less stress (see Boldsen 2005, 2007). To assess “low” versus “high” frequencies, Ubelaker's (1995) standards for Ecuadorian samples are used.

Chapter Overviews. Chapter 2 establishes the criteria for evaluating year-round occupation and site use. Here I will examine the archaeology of Panama, describing how the early populations slowly progressed from migratory hunting in the Late Glacial Stage, to the initial exploitation and domestication of plants, to more permanent settlements and agriculture throughout the Holocene period. Comparative sites in Central Pacific Panama, the Chiriquí highlands, and Colombia are discussed, with particular attention paid to how the sites were utilized within the Early and Late Preceramic periods. Additionally, Chapter 2 considers the findings specific to Cerro Mangote, examining not only the resource exploitation within the framework of Panama, but also the importance of the burials found at the site, given the temporally distinct burial practices.

Chapter 3 considers the implications of mortuary archaeology, exploring the characteristics of cemeteries, how the cemetery can establish familial lineage and connections to important resources, and the possibility of utilizing burial evidence to assess year-round occupation. Chapter 4 outlines the materials and methods used to examine, record, and analyze the biological profiles, paleodemography, musculoskeletal stress markers, cross-sectional geometry, and dental metrics for biodistance. Chapters 5 and 6 report the osteological and subsistence patterning findings from these analyses. The osteological results summarize burial description data, biological profiles, and biodistance analyses. The subsistence patterning results include the findings from the musculoskeletal stress markers, cross-sectional geometry, archaeofaunal, and isotopic data. Finally, Chapter 7 frames the results within the context of the hypotheses of this dissertation and broader archaeological research. The significance of this research lies in its reconsideration of complexity and sedentism. Cerro Mangote allows for a finer understanding in how the settlements in the region do not fit the previously held dichotomies, indicating more variation in site use than typically considered.

CHAPTER 2: THE GEOGRAPHIC AND CULTURAL LANDSCAPE OF ANCIENT PANAMA

In this chapter I present a summary of the period between first human immigrations into Panama (at least by 11,000 BP) through the Late Preceramic period (7000-5000 BP), when Cerro Mangote became a sizable dwelling and mortuary site. This brief account considers cultural and biological data recovered through excavation and survey, the results of sediment core analyses, and historical geomorphology. First, I discuss the climate and landscape changes between the Late Glacial Stage to the Holocene period, using data from changes in temperature, rainfall, sea level, and geomorphology. Next, I consider the human migrations through and within Panama. Theories regarding the preClovis/Clovis migration and its impact on Panama are reviewed. The impacts of later population movements within the Central Pacific Panama region and Chiriquí highlands are explored both within the two areas, as well as the larger cultural context of Costa Rica and Colombia. To consider population movement, the original theories introduced by Willey in the 1950s are reviewed and updated with more recent data. These data includes human alterations to habitat, archaeofaunal and archaeobotanical information, domestic debris, lithics, and the introduction of ceramics. Finally, the specific details of Cerro Mangote are reviewed, looking at the significance of the site, previous excavations, and previous research as it pertains to the cultural history of Cerro Mangote.

To begin, when Cerro Mangote was first discovered in 1955, it was the only reliably-dated Preceramic site in Central America. Since it was clearly very near the sea when first occupied, it was presented in the literature as a "coastal" site with a "coastal" subsistence economy[4]. Subsequent research in the 1980s, collected more evidence to reconsider the biomes from specific sites in both the Chiriquí highlands and Central Pacific Panama (see Figure 2.1). Within Central Pacific Panama, Ranere and Cooke conducted transect and purposive surveys in the Santa Maria drainage basin, a 3,315 sq. km area comprising a variety of biomes, including highland, foothill, alluvial plain and coastal biomes. The major emphasis of the PSM survey was on locating sites that would provide data on the antiquity and development of agriculture and agriculture's effects on human settlement prior to 1500 BP (Cooke and Ranere 1984, 1992b, 1992c, Weiland 1984).

2.1 **Geography and Paleoenvironment of Panama**

Central and South America were subject to changes in ocean and terrestrial temperature and precipitation during the Late Glacial Stage, beginning between 19,000 and 14,000 BP and ending between 11,000 and 10,000 BP. Within Central America, Late Glacial vegetation and inferred climate records are available for several water

[4] The term "coastal" was later abandoned in favor of estuary or mangrove-swamp site based on a more accurate understanding of the archaeofaunal and geological changes at Cerro Mangote.

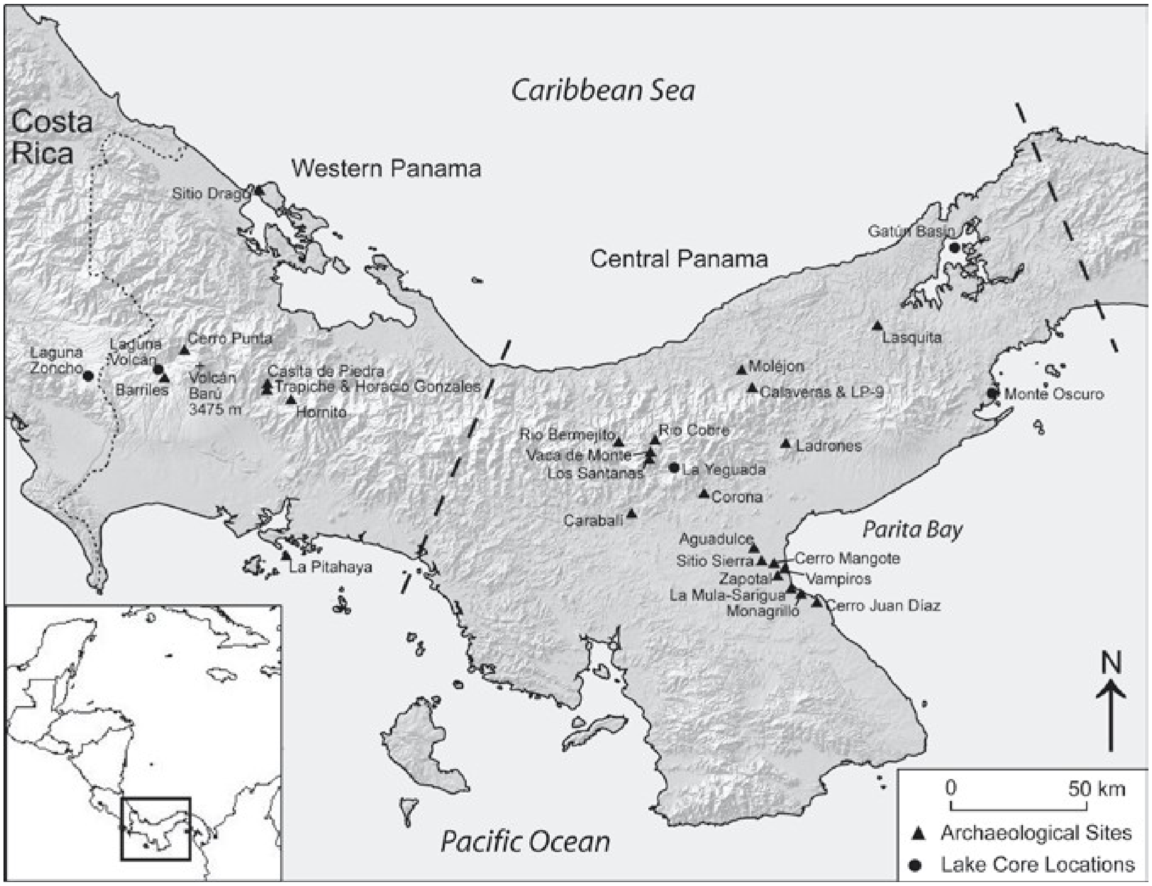

Figure 2.1: Map of Western and Central Panama indicating archeological sites and core locations (from Dickau 2010:101).

bodies – (1) Lake Salpeten in Guatemala; (2) La Chonta bog in Costa Rica; (3) La Yeguada, an endorrheic lake of volcanic origin in the upper reaches of the Santa Maria River Basin; (4) El Valle, a now-dry lake basin in Panama; and the (5) River Chagres watershed, Panama (Piperno 2006, 2011a, 2011b, Piperno and Pearsall 1998, Piperno *et al.* 2000a, Piperno *et al.* 2000b).

The PSM also took cores in water bodies and coastal habitats with the goal of providing off-site data on vegetation, sedimentation history, and human influences and impacts. Between 1979 and 1982, geologists from Temple University, under the direction of John Adams, conducted vibracore surveys around the marine littoral of Parita Bay, establishing rates of sea level rise and coastal pro-gradation (Clary *et al.* 1984). Cores were raised from three Veraguas lakes in 1985, including Lake La Yeguada, recovering a 14,000 year record of forest history and human impacts across the Late Glacial/Holocene boundary. These analyses have been widely published (Bush *et al.* 1992, Piperno 2011a, 2011b, Piperno *et al.* 1991a, 1991b, 1992, Piperno and Pearsall 1998). Three important facts were established: 1) montane forest filled the basin (650 masl) until 10,000 BP suggesting a temperature depression of 5-7 degrees C, 2) humans entered the basin in Clovis times (ca. 11,100) and initiated burning that continued with increasing intensity during the Early Holocene , 3) the basin remained cleared of arboreal vegetation until the conquest.

Monte Oscuro is the closest location to Parita Bay and Cerro Mangote. The cores suggest modern locations with less than 2000mm of rain would have been “undifferentiated thorn woodlands, low scrub, and wooded savanna vegetation” in the Late Pleistocene (Piperno 2006: 276; see also Piperno 2011a, 2011b, Piperno and Jones 2003, Piperno and Pearsall 1998). The Late Pleistocene shoreline of Parita Bay was ca 50 km from the current coastline, since the sea levels were well below modern levels (Cooke 2005, Golik 1968, Ranere and Cooke 2003). The much expanded coastal plain and its more open wooded savanna vegetation during the Late Pleistocene probably promoted easy transit across the landscape (see Cooke 2005, Curtis *et al.* 1999, Leyden 1995, Piperno 2006, Piperno and Pearsall 1998).

2.2 Human migration and population movement

Because of past theories regarding how peoples progressed through and utilized certain areas, human migration and population movement have been separated by researchers. Though a number of terms have been used to define the two ideas, in this dissertation, the term human migration will be used for the earliest entry of groups to Panama, commonly referred to as the Clovis/PreClovis cultures. The term population movement will be used to describe the interrelations between groups and various geographic areas, with attention paid not only to Central Pacific Panama and the Chiriquí highlands, but also the macro-culture area proposed by Cooke (2005). While more recent research (see Piperno 2011a) is less divisive in regards to human migration *versus* population movement, in order to discuss the early theories of how groups entered Panama, the two concepts are treated separately temporarily.

The theories for human migration and population movement are both based on the same types of archaeological evidence. The paleoenvironment is recreated through lake cores and sediments, investigating the changes in precipitation, pollen, and soil types. These lake cores also illustrate the changes to the environment caused by human populations, particularly deforestation through slash-and-burn agriculture. Plant collection, cultivation, and agriculture are explored through the archaeological deposits at particular sites, including phytolith and starch analysis from soil samples, and tools. Archaeofaunal collections are used to determine hunting or exploitation patterns, in addition to the background species present (reinforcing data regarding environmental niches and biomes). Stone tool types and collections are used to approximately date stratigraphic layers based on styles, what types of tools are created, and what types of materials are utilized by groups (foreign or local). If available, radiocarbon dating from associated carbon indicates a more narrow range than a lithic style. The combination of these data and the areas in which particular pieces of evidence are found traces the pathway the associated groups took through and within Panama.

2.2.1 Clovis/preClovis migration

Since the 1950s, knowledge about Paleo-Indian and Preceramic populations in Panama has improved considerably, leading to important paradigmatic changes regarding entry time and site location. Central America does not have nearly as many early Pleistocene sites as South America, possibly because migration routes followed the now submerged Pleistocene coastlines (Cooke et al. 2013, Erlandson and Braje 2011, Goebel *et al.* 2008). Thus, preClovis migration routes and entry times remain somewhat vague. Most archaeologists accept the presence of preClovis peoples from southern Canada to Chile, and recent genetic evidence has suggested the use of a coastal route to these areas (Perego *et al.* 2012). The discovery of fluted Clovis points and associated extinct megafauna dated approximately 13,000 BP in North America initially influenced the interpretations of the South American sequence, with researchers proposing these groups moved through Central America and South America as far as the tip of Tierra del Fuego, thereby settling South America (Dillehay 2000, Fagan 1989, Haynes 1969, Lavallee 2000).

A detailed morpho-technological analysis subsequently undertaken by Ranere (2006) demonstrated the close similarities between the stone assemblage at the Clovis workshop at La Mula West and those of Clovis sites in the US. La Mula-Sarigua was completely disturbed, however, and no radiocarbon dates were obtained in association with the artifacts. Specific to Panama, Paleo-Indian tools, including bifacial points similar to Clovis points from US sites, as well as other "fish tail" points similar to South American fish tail points were found at La Mula-West, Sitio Nieto[5], Vampiros-1, and Lago Alajuela (Lake Madden), typologically dating approximately 11,500-10,500 BP (Cooke 2005,

[5] Sitio Nieto (a Paleo-Indian site) is located on the Asuero Peninsula in Central Pacific Panama, approximately 10km northwest from the modern town of Pesé. The site contains a Clovis quarry-workshop identified by Pearson (Pearson 2003, 2005).

Cooke and Ranere 1992b, Cooke *et al.* 2013, Ranere and Cooke 1996, Pearson 2003, Pearson and Cooke 2007, Piperno *et al.* 2000, Ranere 2000, 2006, Valerio 1985).

Fragments of two fluted points[6] were found at Vampiros-1 by Pearson sandwiched between uncalibrated radiocarbon dates of 11,550 ± 140 and 8970 ± 40 BP (Pearson and Cooke 2002, 2007). Now two kilometers inshore from the active marine shore, this site would have been well inland at the time of the Paleo-Indian occupation (Cooke and Sanchez 2004a, Pearson 2002). Further, phytolith evidence from archaeological sites corroborates the Paleo-Indians exploited a wide variety of environments (see Ranere and Cooke 1991, 2003, Piperno 2006, 2011). Lake cores from Lake Yeguada indicated that the Paleo-Indians began to clear the landscape through fire by at least 11,050 BP, suggesting a local intensification of particular resource exploitation (Piperno *et al.* 1991a). The archaeobotanical evidence is consistent with the supposition that groups may have moved into the watershed areas in order to hunt large game, but the Early Holocene, had shifted to collection and cultivation of local plant foods from nearby forests by the Early Preceramic period (Piperno 2006, Piperno and Jones 2003, Piperno and Pearsall 1998). The Paleo-Indian material indicates continuity between human migration and population movement.

2.2.2 Population movements in the Preceramic and Early Ceramic periods

A spatially irregular and chronologically imprecise data set indicates that Paleo-Indian bands across Central America occupied many different habitats, suggesting group mobility. It is likely that big game hunting was partly responsible for this pattern even though substantive data in the form of megafauna-artifacts associations are not available. Technological similarities in stone tools among these groups and also with

[6] One fluted point is indisputably Fishtail and the other of uncertain morphology (Pearson and Cooke 2007).

North American Clovis are striking and suggest rapid north-south movement of Clovis bands entering a probably thinly populated landscape. During the early Preceramic period, cultural regions began to distinguish themselves between Central Pacific Panama and the Chiriquí highlands. Early Holocene sites in Central America were likely settled seasonally in order to exploit particular resources, with increased sedentism as more cultivation and domestication occurred. The majority of Preceramic sites are rockshelters, while more of the Ceramic period sites are open. The sites, particularly the rockshelters, contain evidence for seasonal occupation to exploit particular resources.

Ranere (1980, 2006) discovered a Chiriquí highland Preceramic component coeval with Cerro Mangote, but very different from it materially and ecologically, showing that Preceramic peoples occupied interior forests above 800m as well as the mangrove-estuaries of the Pacific. This important discovery was corroborated by archaeological work in the plains around Parita Bay, where, in 1973, Ranere discovered the Aguadulce shelter, which had Preceramic deposits underlying Ceramic ones (Ranere and McCarty 1976, Ranere and Hansell 1978, see also Piperno *et al.* 2000). This proved the extensive and well-established occupation of inland sites in the Preceramic period.

In the following decades, more evidence for Preceramic occupation within Panama was amassed. In 1974, Junius Bird and Richard Cooke excavated Cueva de los Ladrones (Bird and Cooke 1978, Cooke 1984, 1995), discovering Preceramic deposits underlying others with pottery very similar to the Monagrillo complex. Piles of marine mollusks deposited in middens showed that coastal resources were consumed by the shelter's occupants in Late Preceramic and Early Ceramic times. This would have required trips to the coast (20-55 km away) or contacts with kin living at coastal sites. Theories regarding population movement began to include not only the individual site excavated, but a much larger contextual area, initiating the concept of a macro-cultural area extending through Costa Rica, Panama, and Colombia. The synthesis of information gathered from these excavations is discussed next.

During the Early and Late Preceramic, the archaeological record indicates increased economic specialization throughout Central and South America (see Cooke 2005, Cooke and Ranere 2003, Dillehay 1992, Dillehay 2000, Lavalee 2000). Though unevenly distributed, both highland Costa Rica and Central Panama contain numerous sites with archaic stone tools (Acuña 2000, Cooke 2005, Cooke and Ranere 1992c, Pearson 1999a, Pearson 1999b, Ranere and Cooke 1991, 1996, Sheets 1994a, Snarskis 1984). Data from pedestrian surveys suggested that the ratio of early to late Preceramic sites was 1:7, a distinct increase in the number and size of sites present (Cooke and Ranere 1992a, Ranere 2012, Weiland 1984). Central Panamanian rockshelters are occupied more intensively and artifacts and food waste are more abundant during the Late Preceramic and Early Ceramic than during the Early Preceramic. This probably reflects both an increase in the regional population and the more consistent use of these sites as dwellings.

The archaeobotanical and archaeofaunal records indicate an increase in collection, cultivation, and domestication of particular resources. Evidence for the use of domesticates is fairly inconsistent prior to 7000 BP (see Piperno 2011b). During the Late Preceramic period, many cultigens were used. Both La Yeguada and in the Gatún Basin contain evidence for slash-and-burn agriculture, with an increase in deforestation, invasion of weedy species, and increases in charcoal, all coinciding with an increasing number of settlements (Piperno 2006, 2011b).

Further, the data suggest continuous human disturbance as slash-and-burn activities cleared more land than previously thought for larger-scale agriculture (Piperno 2011a, Piperno and Jones 2003, Piperno and Pearsall 1998, Piperno *et al.* 1991b). Piperno then analyzed soils recovered by Cooke and Ranere in column samples taken at Ladrones in 1982, demonstrating that maize pollen and phytoliths were, in fact, present in the Preceramic layers deposited after 7000 BP (Piperno and Clary 1984, Piperno *et al.* 1985). The appearance of manioc (*Manihot esculenta*), wild yams (*Dioscorea trifida*), and maize between 7000 – 6000 BP (Piperno 2011b, Piperno and Pearsall 1998) and the decline of arrowroot (Piperno 1995, 2006) suggest what was initially assumed to be early cultivation and horticulture in the Preceramic was actually much more intensive agriculture.

Faunal evidence indicated an exploitation of coastal resources, particularly from mangrove-estuary and tidal habitats. The archaeological evidence pointed to reliance on marine resources (mollusks, crabs, and fish), mammals, and birds typically found in these two ecosystems (shorebirds, deer, iguana, small reptiles, and raccoon) (Carvajal-Contreras *et al.* 2008, Cooke 1992, Cooke and Ranere 1984, 1989, 1992b, 1999, Cooke and Jimenez 2008a, 2008b, Lange 1992). Further afield, Cooke and his research team have recently reported on the Late Preceramic site of Playa Don Bernado[7], whose lithic industry resembles that of Ladrones and the Aguadulce Shelter. Evidence has been provided for fishing reefs and in clear water currents, the highly selective collecting of marine mollusca, hunting an unusually small deer and other mammals in island forests, and exploiting sea mammals (*Delphinidae*) (Cooke and Jimenez 2008, Cooke *et al.* 2012, Martin *et al.* 2009).

Additionally, the archaeofaunal record indicates the indirect impacts of foraging patterns in Panama. Carvajal-Contreras *et al.* (2008) discuss the collection of mollusk shells at Vampiros-1. Over time, shell size indicates that smaller and smaller mollusks were collected by the population. This suggests that the average growth time of the

[7] Covering 1300m^2 on Isla Pedro Gonzalez, Pearl Islands, Playa Don Bernado was occupied by 5200 BP until historic times. The stratigraphy indicates continuous contact with the mainland. To date, the lithics and archaeofaunal analysis for only the Preceramic occupation of Don Bernado is reported. For other characteristics on the Ceramic and historic aspects, please see Martin *et al.* 2009. At the time of publication, the archaeobotanical analysis is pending.

mollusks was shortening as resources were continuously collected. The archaeological record shows evidence of increasing movement of marine and estuary resources, through transport or trade, to interior sites (Cooke and Ranere 1992a, Cooke *et al.* 2007, Cooke *et al.* 2008, Cooke *et al.* 2013, Jimenez and Cooke 2001, 2008a, Zohar and Cooke 1997).

In regards to lithic data, the Late Preceramic witnessed important changes in lithic technology, with the increased use of unifacial tools and bipolar reduction, the disappearance of bifacial reduction of chalcedony tools, as well as the increasing abundance and diversity of grinding and pounding tools (Cooke and Ranere 1999, Ranere 1975, 1980, Ranere and Cooke 1996, Ranere and Hansell 1978, Ranere 2000, n.d.). Ground stone tools for plant processing were added – notably, edge-ground cobbles and boulder milling stones – which became more abundant in Late Preceramic sites including Cerro Mangote (Cooke and Ranere 1992a, Hansell 1988, Ranere and Cooke 1996, 2003, Valerio 1985). Importantly, flakes were used as scrapers, knives, or other tools, with most showing little secondary retouch[8], suggesting these expedient tools were created for a specific job and then discarded (Ranere and Cooke 1996). At Playa Don Bernado, Martin *et al.* 2009 describe a classification of a multipurpose tool, based on the multiple types of wear present on each surface.

The Early Ceramic period (4500 – 2500 BP) brought further differentiation between the two cultural areas of Gran Chiriquí and Gran Coclé. In Gran Coclé, Monagrillo type pottery, characterized by pottery fired at a low temperature and smeared with soot, was found at a variety of sites between the Parita Bay and the central cordillera (Cooke 2005, Cooke and Sanchez 2004, Willey and McGimsey 1954) and also on the Caribbean slopes (Griggs 2005). The adoption of the new ceramic technology

[8] The recent excavations at the Preceramic period site of Playa Don Bernardo (Pearl Islands) have excavated small stone flakes with heavy wear. At the time of this dissertation, the excavation is incomplete and further analysis is pending (Martin and Cooke 2009).

did not impact the associated lithic technology (see Ranere and Cooke 1996), but coincided with increasing settlement sizes (Guissard 1984, Cooke 2005, Cooke and Ranere 1992b).

The cores from La Yeguada are continuous with the Preceramic period until approximately 2000 BP. These cores document the extensive destruction of the secondary forests in the foothills, which is consistent with expansion by agriculturalists (Bartlett and Barghoorn 1973, Piperno 1988, Piperno and Pearsall 1998, Piperno *et al.* 1991b). Faunal remains suggested fish were collected using fine-meshed nets and watercraft at Monagrillo and Cueva de los Ladrones (Cooke and Jimenez 2008, Cooke and Ranere 1992b). Also, the Early Ceramic layers at Cueva de los Ladrones contain evidence of a trade network through the presence of inland distribution of inshore marine fish (Cooke 1995, 2001). The terrestrial fauna, including peccary, deer, agouti, birds and reptiles, indicate a preferential hunting of species, as certain vertebrates, most notably deer, have a much higher relative abundance (Cooke and Ranere 1989, 1999).

Ceramics seem to have arrived much later in Chiriquí highlands than in Central Panamá. No coastal middens with marine shells dating to the Early Ceramic Period have been identified (Linares 1968, 1980b). In the Río Chiriquí rockshelters, Ranere identified a second Preceramic phase, Boquete (3350 – 2200 BP), whose toolbox differs from the earlier Talamanca Phase in the decline in heavy woodworking tools of igneous rocks, and the greater number and variety of grinding tools. New data (Dickau *et al.* 2007) indicate, however, that the Preceramic peoples of highland Chiriquí were utilizing several cultigens during both phases, including maize, manioc and arrowroot.

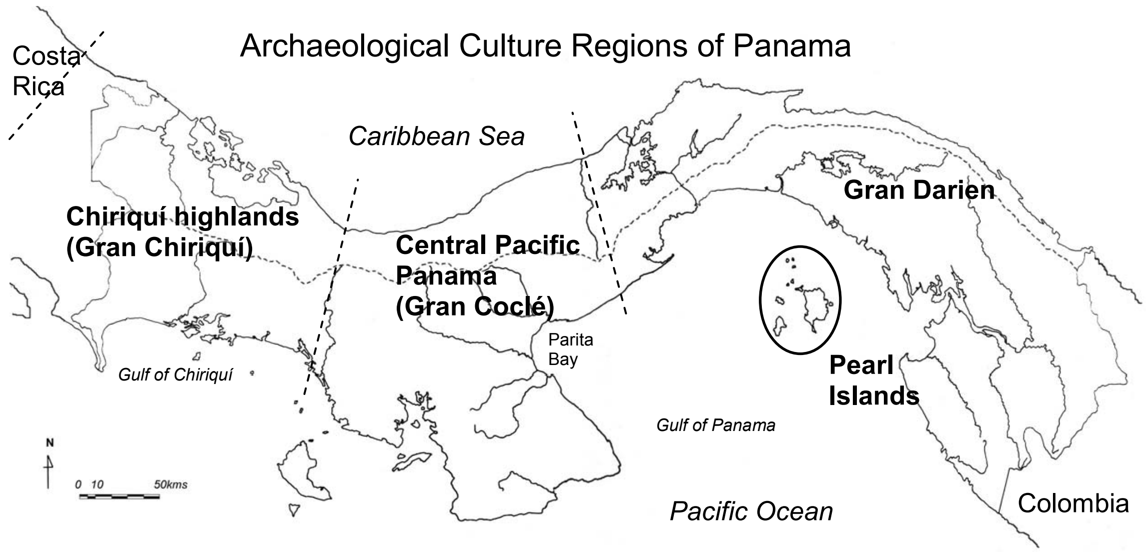

Figure 2.2 Map of the Gran Chiriquí, Gran Coclé, and Gran Darien cultural regions of Panama. Modified from Dickau 2005.

2.3 Panamanian cultural sites

As mentioned in the synthesis above, specific sites are critical to understanding the nuanced relationship between archaeological sites and the cultural changes within Panama. The two areas of the local Panamanian landscape this dissertation focuses upon are the Central Pacific Panama and Chiriquí highlands. The foothills of the Pacific coastal plain and Pacific coast of central Panama correspond to the later named Gran Coclé. Gran Coclé includes the modern provinces of Veraguas, Los Santos, Herrera, Coclé, and the western half of Colón (Cooke 1976, 2011, Cooke and Ranere 1992a, Griggs *et al.* 2002, Lothrop 1937, 1942, Ranere and Cooke 1996). The locations are here referred to by their geographic locations, or Central Pacific Panama and the Chiriquí highlands, since they represent only a portion of Gran Coclé and Gran Chiriquí respectively (see Figure 2.2). Through the larger territory data, the potential interactions of the population at Cerro Mangote can be interpreted by comparing the known pattern

Table 2.1: Summary of sites discussed in Chapter 2

Region	Site	Dates (BP)	Settlement type	Occupation	Site use	Cultural materials	Citations
Chiriquí highlands	Casita de Piedra	7000 – 2800	rockshelter	seasonal	local resource exploitation[1, 2]	Talamanca & Boquete lithics	Dickau 2005, Piperno 1988, Ranere 1980, Smith 1980
Chiriquí highlands	Trapiche	6550 – 2250	rockshelter	seasonal	local resource exploitation[2,3]	Talamanca & Boquete lithics	Dickau 2005, Ranere 1980, Ranere and Hansell 1978, Smith 1980
Chiriquí highlands	Hornitos	6270 – 5880	open site	seasonal	local resource exploitation[2,3]	Talamanca lithics	Cooke 1977, Dickau 2005, Ranere 1972, 1980
Chiriquí highlands	Cerro Punta	2380 – 1650	open sites	year-round	sedentary agrarian site[1,2,4]	ceramics, household debris	Dickau 2005, Linares *et al.* 1975, Linares and Sheets 1980, Sheets 1980, Smith 1980, Stewart 1978
Chiriquí highlands	Barriles	2000 – 740	open site	year-round	socio-ceremonial center[4]	high-status cemetery	Dickau 2005, Linares 1977, Linares and Sheets 1980, Smith 1980
Central Pacific Panama	Rio Cobre	5000 – 400	rockshelter	seasonal	hunting camp	lithics, ceramics	Cooke and Ranere 1984, Dickau 2005
Central Pacific Panama	Vaca de Monte	5600 – 400	rockshelter	seasonal	local resource exploitation[1,2]	flaked and edge-ground lithics	Cooke and Ranere 1992, Dickau 2005
Central Pacific Panama	Corona Shelter	10,400 – 650	rockshelter	unknown	local resource exploitation[1,2,3]	bifacial & ground lithics	Dickau 2005, Valerio 1985
Central Pacific Panama	Aguadulce Shelter	11,000 – 1500	rockshelter	seasonal	local resource exploitation[1,2,5,6,7,8]	5 burials; chipped lithics, ceramics	Dickau 2005, Cooke 2005, Piperno 1988, Piperno *et al.* 2000b
Central Pacific Panama	Abrigo Carabalí Shelter	8040 – 400	rockshelter	seasonal/ year-round	local resource exploitation; cultivation later[2,3,5,6]	ceramics, 5 burials, lithics	Cooke and Ranere 1984, Dickau 2005, Valerio 1985, 1987
Central Pacific Panama	Rio Bermejito	1270 – 390	rockshelter	unknown	hunting camp; plant processing[4]	ceramics	Cooke and Ranere 1992b, Dickau 2005
Central Pacific Panama	El Zapotal	4000 – 3500	open site	unknown	local resource exploitation[7,8,9]	ceramics, household debris, lithics	Cooke 2005, Cooke and Ranere 1992b, Ranere n.d., Willey and McGimsey 1954
Central Pacific Panama	Cueva de los Ladrones	7000 – 1500	rockshelter	seasonal	local resource exploitation; cultivation later[4,7]	household debris, hand-held cobbles	Bird and Cooke 1978, Cooke and Ranere 1992b, Dickau 2005, Piperno *et al.* 1985
Central Pacific Panama	Sitio Sierra	2200 – 900	open site	year-round	agrarian site[4]	household debris, ceramics, manos, metates, cemetery	Aizpurua 1993, Cooke 1979, 1984a, Norr 1995
Central Pacific Panama	Vampiros-1	11,500– 700	rockshelter	seasonal	Local resource exploitation; agriculture later[7,9,10]		Carvajal-Contreras and Hansell 2008, Carvajal-Contreras *et al.* 2008, Cooke and Ranere 1984, 1999; Pearson 2002, Pearson and Cooke 2007, Pearson *et al.* 2003, Piperno 2011a

[1]tree fruits; [2]palm fruits; [3]*Byrsonima crassifolia*; [4]cultigens including maize; [5]terrestrial fauna; [6]freshwater fauna; [7]mangrove fauna; [8]estuary fauna; [9]marine fauna; [10]arrowroot

at coeval sites to emphasize local variation. Table 2.1 (next page) highlights the cultural periods, important sites, and associated radiocarbon dates.

Though the sites of the Chiriquí highland illustrate a different cultural trajectory from Central Pacific Panama, there are some overall patterns of site use shared between the two cultural regions. Both regions have a shift in site type. The Preceramic period is dominated by rockshelter sites, while there is a shift to using both rockshelters and open sites in the Ceramic periods. During the early Preceramic, the rockshelters were likely used to exploit particular seasonal resources. From the late Preceramic period through the Ceramic period, sites show temporally longer settlements. The size and number of household gardens increased, with intensive agriculture recorded in the Late Preceramic. Evidence for year-round occupied sites appears in the archaeological record ca 2200 BP, with larger settlement sizes, mirroring a shift in technology to increase the amount of food procured (see Cooke 2005, Cooke and Ranere 1992b, 1999, Dickau 2005, Piperno 2011a, 2011b, Ranere and Cooke 2003).

2.3.1 Chiriquí highland cultural sites

The Chiriquí highlands have several Preceramic rockshelters and campsites near the continental divide in western Panama. Unlike the Central Pacific Panama region, the Preceramic sites identified in the Chiriquí highlands are only in areas with pre-montane forests; no Preceramic or Early Ceramic sites have been found along the coast. Ranere described a stone tool complex (6550 – 4250 BP) – Talamanca – which is strikingly different from that of coeval stone assemblages from central Panama. Comprised of scraper-planes, choppers, and large bifacially flaked wedges, the Talamancan tool kits were made of hard dark igneous stone (basalts and andesites) and were probably used as woodworking tools (Ranere 1975, 1980b, Ranere and Cooke 1996). The Talamancan

Phase did include edge-ground cobbles and milling stone bases similar to those found in Central Pacific Panama (Ranere 1980b). Archaeobotanical records show intensive palm use, primarily *Acrocomia aculeate* and *attalea butracea*, at the Chiriquí Highland sites (Smith 1980, Dickau et al. 2007). While the Aguadulce shelter has evidence for intensive palm use, the plant remains found were *Elaeis*, not *Acrocomia* or *Attalea* (Dickau 2005, Griggs 2005, Griggs *et al.* 2002). The archaeobotanical evidence also indicates less use of forest clearing in Chiriquí (Piperno 1988), with maize, manioc and arrowroot appearing in the sequence by 6000 BP (Dickau 2005, Dickau *et al.* 2007).

The vegetation at the time of occupation at the three Preceramic sites (Casita de Piedra, Trapiche, and Hornitos) and two Ceramic sites (Cerro Punta and Barriles) was most likely semi-evergreen seasonal forest (Ranere 1980). While initially thought to have been occupied for only one season (Norr 1995), Dickau (2005, 2010) suggests that the three Preceramic sites were likely occupied repeatedly for extended periods of time, based on lithic assemblages and archaeobotanical data. The lithic technology at Hornitos reinforces a seasonal occupation as well, since the core materials are not from the surrounding areas (Cooke 1977).

The two Ceramic sites are located west of the Preceramic sites, in the upper Rio Chiriquí Viejo watershed and on the western slopes of Volcán Barú (Linares and Sheets 1980). These Ceramic sites of the Chiriquí highlands illustrate the growth of year-round settlements, as well as increasing social stratification of the occupying groups. Barriles, in particular, also showed increasing complexity in burial patterns along with increasing religious complexity. Cerro Punto consists of several interrelated sites, illustrating how these sites used a combination of resources, including local resource collection of plant materials, hunting, and agriculture.

2.3.2 Central Pacific Panama cultural sites

Central Pacific Panama has been the focus of considerable archaeological survey and excavation, including the large-scale survey of the Santa Maria watershed (PSM) coordinated by Cooke and Ranere (1984, see also Cooke and Ranere 1992b, Ranere 2012). Five rockshelters (Vampiros-1, Corona Shelter, Aguadulce Shelter, Abrigo Carabalí Shelter, and Los Santanas) were occupied by the early Preceramic period and occupied continuously until at least the Ceramic period, if not until contact. Three additional rockshelters (Cueva de los Ladrones, Rio Cobre, and Vaca de Monte) were occupied from the Late Preceramic. Two of the rockshelters contain some of the oldest deposits in Central Pacific Panama, with the cultural deposits of Vampiros-1 and Aguadulce dating to the Paleo-Indian period.

Six of the rockshelters were initially used to exploit a particular resource, either as a hunting camp or for collecting plant resources. For example, the first occupations at the Corona shelter occupied the site to exploit the seasonal crops, with *Byrsonima crassifolia*, *Acrocomia* palm and other identified tree species (Valerio 1985). By the Late Preceramic, all eight of the sites show an intensification of occupation, indicating collection of multiple resources. The most current articles regarding plant cultivation revisit the questions of exactly how intensive the cultivation was at many of these sites. Piperno (2011a, 2011b, see also Dickau 2010) suggests many sites were, in fact, practicing intensive horticulture, combined with collecting and hunting. With the new assessment, sites like Vaca de Monte are now considered to have progressed from local exploitation of tree crops in the Preceramic periods to agriculture during the second colonial occupation (Cooke and Ranere 1992a, Dickau 2010).

Associated with the Preceramic levels at Aguadulce were the incomplete remains of five individuals. The fragmentary nature and broken long bones were attributed to cannibalism (Ranere and Greenfield 1981, Ranere and Hansell 1978). Similar fragmented remains were found in the Preceramic layers at Abrigo Carabalí rockshelter, also representing five individuals. Norr (1991) collected bone fragments for isotope analysis, but they did not yield results. More formal burials were excavated at Sitio Sierra and are discussed below.

After the Preceramic, many of the cultural deposits indicating an established trade network through the Ceramic periods. Vampiros-1 was used as an agricultural and processing station to cure and dry fish[9] (Carvajal-Contreras *et al.* 2007, Piperno and Pearsall 1998). The archaeological deposits at Cueva de los Ladrones contain near-shore fish and mangrove species, suggesting transport of dried marine food to interior sites in Central Pacific Panama (Bird and Cooke 1978, Cooke and Ranere 1992b, Piperno and Pearsall 1998). While the Central Pacific Panama rockshelters remained in use well into the Ceramic period, the Ceramic period also introduced a number of open sites, including Sitio Sierra and Zapotal.

Both Sitio Sierra and Zapotal include evidence of hearths and house structures with associated postholes. The subsistence at Sitio Sierra appears to be more maize based, while Zapotal was a coastal shell mound near salt flats. Zapotal is approximately 4Km downstream from Cerro Mangote, with similar resource exploitation to Cerro Mangote of coastal resources and mangrove resources (which are further detailed in Section 2.5). At the time of Zapotal's occupation, coastal resources had shifted significantly away from Cerro Mangote due to the prograding coastline (Cooke and Ranere 1992b, Ranere n.d.). Zapotal, being close to the coastline was a better location to exploit mangrove resources such as crab and crab-eating raccoons (Cooke 2005, Ranere n.d.).

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[9] The later layers at Vampiros-1 correspond to an agricultural occupation, dating between 1970 to 700 BP. Fish remains correspond to 99% of the fauna recovered, including *Scomberomurous sp.*, *Belonidae*, and *Caranx caballus* (Cooke 1988 , Cooke and Ranere 1999).

Clearly a sedentary site, Sitio Sierra contained one of the only other documented cemeteries in the Parita Bay area. The cemetery (n = 44) appeared to have two separate times of use, with initial estimates indicating a fairly small cemetery used from approximately 2200 – 1975 BP (Cooke 1979). The Period IV portion had Aristide ceramics[10] associated with flexed burials, along with sex-specific artifact associations. Some male burials had associated tool kits, specifically wood-working and axe-making tool kits. Some female burials included stone blades and ceramic-polishing stones (Cooke 1978, 1979, 1984a, Isaza Aizuprua 1993). Cooke (1984a) found maize associated with a burial and suggested that it may have been a burial offering. Norr's (1991, 1995) isotopic study suggested a diet heavy in maize. Later burials from Period VI were more disturbed by modern farming, but undisturbed individuals were buried in an extended position. With minimal adornment compared to contemporary Western Panamanian sites that have very elaborate mortuary contexts (see Lothrop 1937, Lothrop 1942, Mason 1942), these Period VI burials at Sitio Sierra contained only a few artifacts associated with a religious leader or shaman (Cooke 1984b).

2.4 Other important cultural sites

The sites in Central Pacific Panama and the Chiriquí highlands are commonly utilized as comparative sites with Cerro Mangote. However, as discussed in the introduction, the archaeological area extends beyond these two cultural regions. In addition to the above areas, the macro-cultural region includes Sitio Lasquita (or Lasquita), located on the Panamanian Caribbean coast (see Figure 2.1) and the Pearl

[10] Aristide ceramics, primarily in the western part of Coclé, were generally decorated with concentric or vertical parallel lines, from which geometrical ornaments were hung. The ceramics also used zigzag or upside-down "T" designs. Color divides pottery into two groups: one painted black on a red background, and the other painted black over the natural color of the clay (Cooke 1985).

Islands sites (see Figure 2.1). Sitio Lasquita (Pn-53), the only Preceramic Caribbean site (5900 – 5700 BP), was first investigated by Griggs (2005)[11]. The archaeological and paleobotanical evidence is consistent with agriculturalists altering the landscape through deforestation (Piperno 2011a, 2011b) and hunting (Cooke *et al.* 1996, Griggs 2005).

Like the mainland, the settlement pattern on Isla Pedro Gonzalez implies the early inhabitants were scattered near the coastline, with later agricultural based settlers forming small villages on the broader edges of the low hills (Cooke and Sanchez 1998, Martin *et al.* 2009). The archaeofaunal analysis is ongoing, but initial findings are consistent with large quantities of bones exposed to heat[12]. Initially, the Preceramic population appeared to be more focused on hunting and fishing. As resources became scarce, more time was spent collecting shellfish (Martin *et al.* 2009). The preliminary analysis indicates that though there is a high density of shell, only a few taxa are represented. Martin *et al.* (2009) note that over time, the frequency of *Argopecten* decreases while *Chione* increases, suggesting that the decline of scallops is linked to overfishing.

2.5 Cerro Mangote

The focus of this dissertation is the site of Cerro Mangote in Panama. Cerro Mangote is located on the eastern end of the north slope of a hill (*Cerro Mangote)* on the northern (Coclé) bank of the Rio Santa Maria, approximately 10 km from the present

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[11] As the only Preceramic site located on the Panamanian Caribbean, Sitio Lasquita offers insight into the potential groups Cerro Mangote may have traded with, based on the presence of the previously mentioned manatee rib. Sitio Lasquita bears witness to the intensive exploitation of palms and balsam fruits, which were roasted in stone ovens (Griggs 2005). The lithics identified at the site appear to be consistent with other bipolar reductions found at several sites and rockshelters in the area.

[12] The identified taxa include turtles (*Kinosternon, Chelonia spp*.), snakes (including boas), *Iguana iguana*, cormorant (*Phalacrocorax sp*.), opossums (*Didelphidae*), a monkey (the capuchin monkey size [*Cebus capucinus*]), rabbit (*Sylvilagus*), agouti (*Dasyprocta sp*), spiny rat (*Proechimys sp*.), dolphin, and at least two species of deer, extinct in the archipelago. The primate, freshwater turtle, rabbit, and marsupials are of particular interest since these species are not currently present on the Pearl Islands.

active shoreline of Parita Bay (see Figure 2.1). Archaeological evidence suggests that the mouth of the river and coastline was at the base of the hill when the shell midden was formed at Cerro Mangote (Clary *et al.* 1984, Coates 1997). The alvina (tidal flat) is currently spotted with mangroves, stretching 8 km to the mangrove-lined shore of Parita Bay. Portions of the Santa Maria River have been leveled to create pastureland and sugarcane fields, with the hills covered with secondary semi-deciduous forests and remnants of gallery forest still present along the lower reaches of the River Santa Maria (Cooke and Ranere 1999).

The initial excavation of the site occurred as part of a larger survey of the area. McGimsey (1956) relays the story in his initial publication on the site:

> The presence and dimensions of the site can be traced only by the considerable number of shells on the surface of the ground and, in its deeper portions, by a hollow sound under foot (much the same effect as that given by a deep deposit of pine needles and humus). It is probably to this latter characteristic that we owe the discovery of the site, for the sound effects rather than the presence of shell were described by local informants when inquiry was made about sites in the area. Prior to our visit we were, in fact, dubious as to the existence of a prehistoric site for the description of "a large area where the ground sounds hollow" seemed to be in the same category as the persistent Panamanian story of the rich Indian graves to be found just below a floating blue light which is generally seen late at night. (153)

At the time of its discovery, Cerro Mangote was the only Preceramic site identified in all of Lower Central America (Willey and McGimsey 1954, McGimsey 1956, Ranere n.d.). Its antiquity was confirmed by a single ^{14}C date of 6810 ± 110 BP (McGimsey 1957). As no other sites from this time were known, there was little with which to compare Cerro Mangote– though Willey and McGimsey (1954) commented on the similarity of the lithics to the nearby Monagrillo site.

Though other late Preceramic sites have since been identified and explored in both the Santa Maria River Basin and throughout Panama (Cooke 1984, Cooke and Bird 1978), Cerro Mangote stands out due to its location near the active marine shore and for its explicit mortuary function: large numbers of human burials and considerable variety in body placement and treatment across the site.

2.5.1 Cerro Mangote excavations

In the 1950s, Central American archaeology underwent a regional and theoretical shift as research projects increasingly focused on coastal sites and away from inland sites occupied or influenced by Olmec and Maya (see Campbell and Kaufman 1976, Flannery 1968, Linares 1979, Longyear 1969, Sharer 1974, Willey 1959, Willey and McGimsey 1954). As part of a larger National Geographic and Smithsonian-sponsored project in Coclé and the Azuero Peninsula (Ladd 1964), Gordon Willey conducted a foot survey along the Parita Bay marine littoral (Cooke and Martín 2011, Cooke and Sanchez 2004). He found evidence for changes in coastal geomorphology, including the expansion of mangroves. These site locations, vis-à-vis the marine shore, in addition to the presence of abundant marine mollusks, were instrumental in formulating Willey's "Northwest South American Littoral tradition" (Willey 1971).

The site of Cerro Mangote was generally left out of larger discussions of the region until it and its Ceramic neighbor, Monagrillo, were included in the "Northwest South American Littoral tradition" (see Alegria *et al.* 1955, Cruxent and Reichel-Dolmatoff 1965, Rouse 1958, Stothert 1983, 1985, Willey 1971). According to Willey (1971), who coined the term, this tradition was characterized by simple chipped stone tool assemblages and coastal collecting in "a tropical forest, mangrove, or savanna type of coastal country," (Willey 1971:66). Soon after, in the 1970s, this idea of a Preceramic/Early Ceramic sphere of interaction, limited only to a marine littoral area, was challenged by the discovery of coeval deposits found inland both in Gran Chiriquí

(Casita de Piedra, Trapiche shelter and Hornitos) and in Gran Coclé (Cueva de los Ladrones and Aguadulce Shelter)[13].

The first two excavations of Cerro Mangote were in 1955 and 1956 – 1957 (McGimsey 1956, McGimsey *et al.* 1987). Cerro Mangote was initially considered a Ceramic site in conjunction with the nearby Monagrillo site due to sherds at Cerro Mangote, but the sherds were later determined to be a recent deposit, inconsistent with the remainder of the site (McGimsey 1954). Approximately 24 burials were excavated, containing 74 individuals. The lithics recovered included boulder tools and are consistent with milling stones, most likely used as bases with edge-ground cobbles, commonly recovered at both Preceramic and Monagrillo phase Ceramic sites (Cooke 1977, Ranere 1975a, 1975b, 1980, Ranere n.d., Ranere and McCarty 1976, Willey 1971, Willey and McGimsey 1954). Little analysis of the archaeofaunal material collected was performed at the time due to the fragmentary nature of the bones and difficulty of finding a specialist[14]. In addition to the crab and mollusk shell midden, other identified animal bones include Panama white tailed deer, raccoon, small toothed whale, sting ray, and turtle, fish, and bird. The first two excavations did not use screens in collection, relying on workmen to pick up the bones as they excavated, biasing the collection towards larger skeletal elements. The lack of screens used in these early excavations also explains the enormous discrepancies in the number of fish found in the 1979 excavation (discussed below).

The second excavation encountered the still unexplained stacked stone column

[13] Though it is not the focus of this dissertation, it is important to note the ideas of site use at Monagrillo have expanded greatly beyond Willey's initial theories. More detailed information about the Monagrillo site have been derived from Ranere's excavations (1975) and during the geomorphological research conducted by Temple University from 1979 – 1982 (see Clary *et al.* 1984, Cooke 1984, 1992, 1995, Cooke and Jimenez 2004, Cooke and Ranere 1989, 1992a, 1999, Cooke and Tapia 1994, Cooke *et al.* 1996; Cooke *et al.* 2007, 2008, 2013).

[14] The archaeofaunal remains from this excavation were sent to Cooke for later reanalysis and were subsequently published by Cooke (1992). Additionally, a list of deer remains with anatomical identifications and MNI, created by Ralph Medlock (a student at the University of Arkansas, Fayetteville) was sent to Cooke for this analysis.

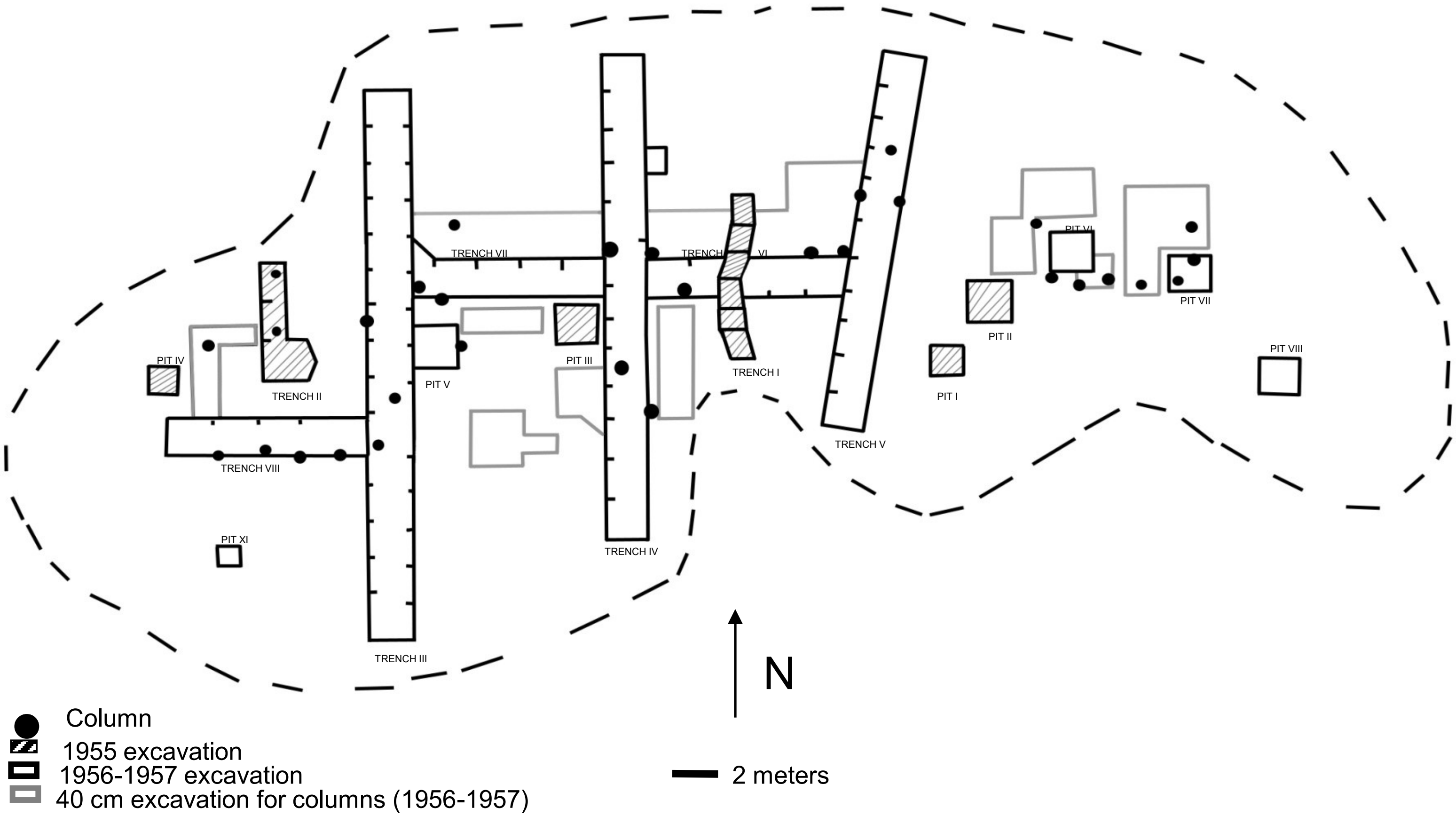

Figure 2.3: Map of Cerro Mangote from the 1955 and 1956 – 1957 excavations.

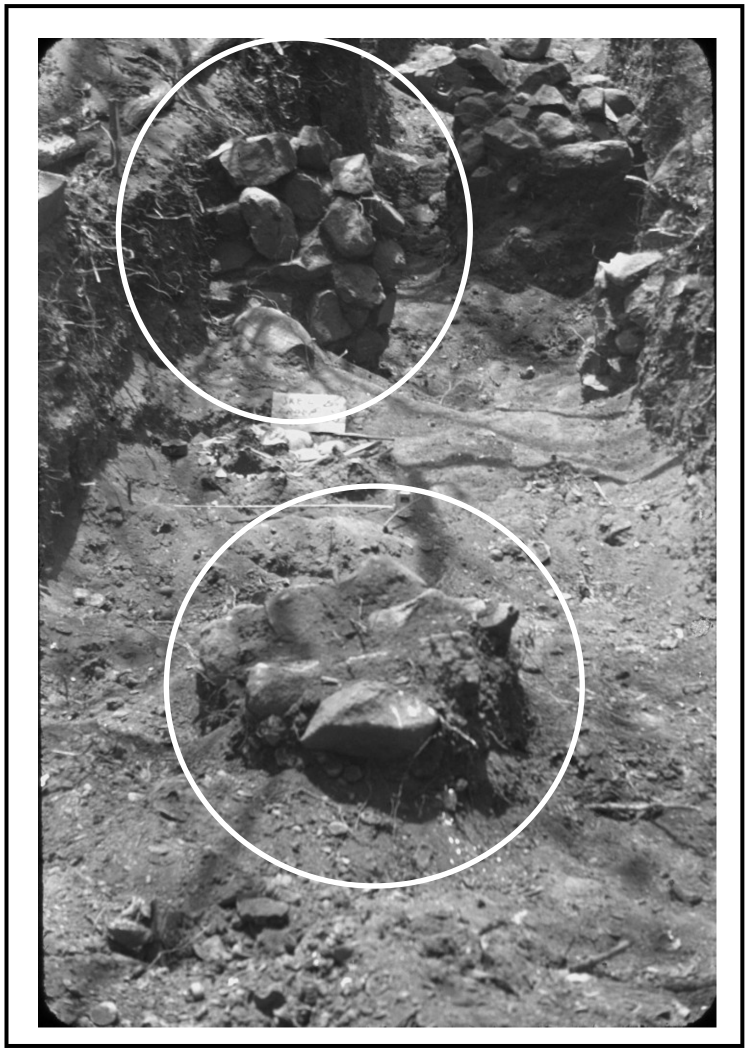

Figure 2.4: Examples of ‘columns’ encountered at Cerro Mangote in Trench V, near Burial Group 16. Stacked stone highlighted by circles. From McGimsey n.d., used with permission.

(see Figure 2.3 for locations, Figure 2.4 for columns). The 25 columns are distributed throughout the site and are approximately 60-70 cm in diameter, 50-80 cm in height and constructed with large river cobbles stacked on top of each other, but do not appear to be supportive and were haphazardly constructed (McGimsey *et al.* 1987). While the columns were not removed, McGimsey’s excavation notes imply the columns did not sit atop anything – the bases of a few of the columns were excavated to ensure they were not concealing a grave or underlying structure (n.d.).

The third excavation at Cerro Mangote was led by Anthony Ranere in 1979 (see Figure 2.5). Before the PSM got underway, Ranere retested three early sites around

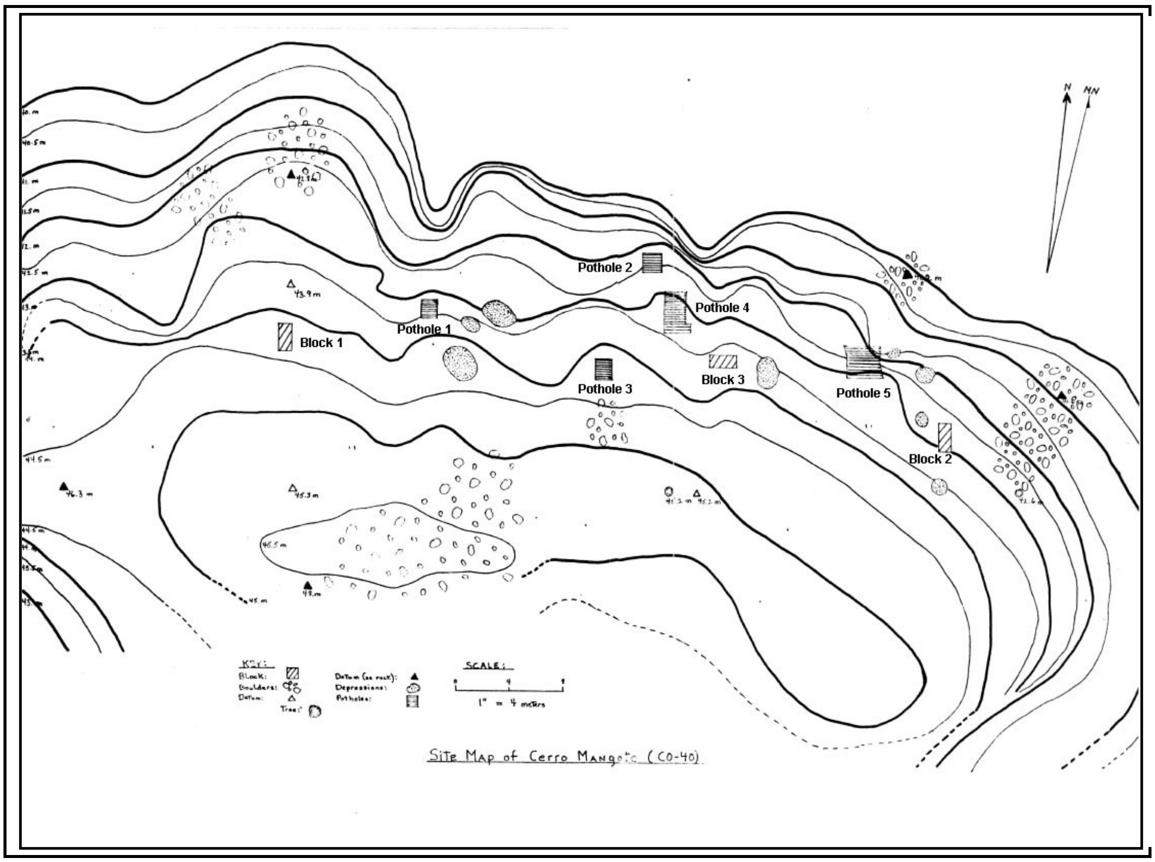

Figure 2.5: Map of Cerro Mangote from the 1979 excavation (Ranere n.d.).

Parita Bay: Monagrillo, the Aguadulce Shelter and Cerro Mangote, using small controlled excavations and screening sediments through nested sieves (Ranere n.d.). Vertebrate fauna remains from these sites have been analyzed by Cooke and are further reviewed in section 2.5.3.2 (Cooke 1992, 1993, Cooke and Jimenez 2008a, Cooke and Ranere 1989, 1992b, 1999, Cooke *et al.* 2007, 2008, 2013).

The lithic artifacts recovered included more edge ground cobbles, edge battered cobbles and boulder milling stones. An additional 16 human skeletons were recovered in 1979 and are curated by the Smithsonian Tropical Research Institute (STRI), Panama (Norr 1991, Ranere n.d.). Supplementary carbon dates from charcoal and shell confirmed the 7000-5000 BP occupation date range (see Table 2.2), though the human skeletons were not initially submitted for carbon dating (Ranere n.d.). The samples submitted in the 1980s yielded dates consistent with the Ceramic period; however, there are inherent problems in the dating of human skeletal material. Appendix 1 outlines these problems of contamination, explaining why the AMS human bone dates are considered erroneous in this analysis. Furthermore, the absence of pottery from all Cerro Mangote burials, and its frequency in graves dating from the time period produced by the AMS assays is taken as convincing evidence that the burials belong to Panama's Preceramic phase, consistent with the antiquity indicated by the conventional radiocarbon dates collected in 1955 and 1979.

Table 2.2: Radiocarbon dated samples at Cerro Mangote

Context	Method	Material	BP	Deviation	Collected
Stratum C, 130-145 cm, just above red clay zone	radiometric	charcoal	6810	110	1955
PH 1, 189-190 cmbd, red	radiometric	*Protothaca*	6710	170	1979
PH 1, Bk. 1, 193-215 cm bd, red zone	radiometric	charcoal	6670	215	1979
PH 1, 180-190 cm bd, red zone	radiometric	*Crassostrea,* outside shell	6370	180	1979
PH-1, 209-219 cm bd, red zone	radiometric	*Crassostrea,* inside shell	5820	130	1979
PH 1, 180-190 cm bd, red zone	radiometric	*Crassostrea,* inside shell	5520	120	1979
PH 1a, 145-155 cm bd	radiometric	*Crassostrea*	5055	150	
PH 1, 180-190 cm bd, red zone	radiometric	charcoal	3555	100	1979
Cat. No. 68E	AMS	Human fibula	2630	60	
Cat. No. 69	AMS	Human femur	2320	50	
Burial 31E, ass. With shell monkey pendant	AMS	Intercostal bone, human	2260	50	1988

Table 2.2 (con't): Radiocarbon dated samples at Cerro Mangote					
Context	**Method**	**Material**	**BP**	**Deviation**	**Collected**
Burial 26	AMS	Intercostal bone, human	1850	45	1987
Burial 69	AMS	Tibia-fibula, human	2220	45	1987
Burial 23A	AMS	Intercostal bone, human	1970	60	1987
Burial 20A	AMS	Intercostal bone, human	2015	50	1987

Finally, Ranere (n.d.) provides a detailed stratigraphy from the excavation (numbers correspond to Figure 2.6):

1. Andesite boulders underlie all sediments at the site; in places these boulders are exposed on the surface, and in other areas they are buried by more than 2.5 m of deposits.
2. A layer of red clay from 25 to over 100 cm thick overlies the andesite boulders. The base of this deposit is culturally sterile, but the upper portion contains the earliest cultural materials at the site.
3. A layer of light red silty clay, approximately 20 cm thick overlies the red clay layer. Occupational debris is more abundant than in the previous layer.
4. A series of horizontally bedded lenses composed in large part of shell, crab, and bone, often badly crushed, overlie the silty red clay layer. This is the densest occupational refuse on the site. It appears that these lenses extended to near the present surface of the site. The enormous number of pits dug at the site by McGimsey, the looters and the prehistoric occupants themselves make this reconstruction somewhat difficult to demonstrate.
5. Although not a single depositional unit, the pit fill sediment at the site can be treated as if they *[sic]* are a single unit for the purposes of this discussion. For much of the site, pits have been excavated into other pits until the upper 80-100 cm of the deposits consist of pit fill of one sort or another. Many of these pits were dug to receive burials and extend into the red clay layer at the base of the site stratigraphy.
6. A layer of silt 10-15 cm thick caps the pit fill zone and represents the post-occupational deposit at the site. (Ranere n.d.:6-7)

As Ranere (n.d.) noted, the third excavation found the stratigraphy problematic due to the two previous excavations, disturbance of the site by looters, and the indigenous practices of excavating and disturbing multiple pits and graves.

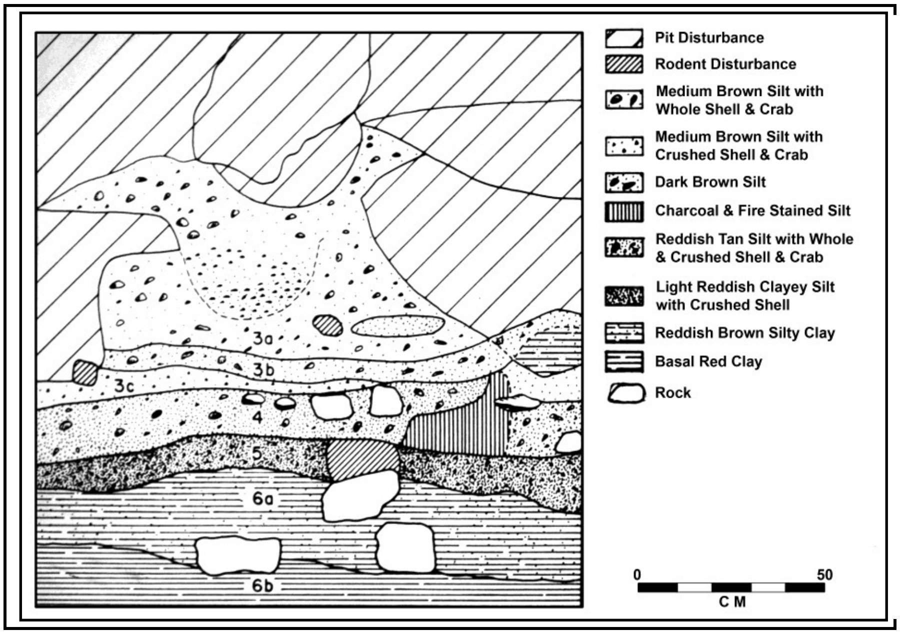

Figure 2.6: Stratigraphy notations from Ranere (n.d.).

2.5.2 Cerro Mangote site description

The site is approximately 70 m by 25 m and hour-glass shaped, situated on a fairly steep slope (48 masl) at the eastern end of the hill, just below the crest of the ridge. The depth of the shell midden deposit is between 1 and 2 m at the center of the site. The midden consists of a basal red zone composed primarily of crab claws (6900-6000 BP) with an overlying brown zone composed of loose gray-brown soil (6000-5000 BP) (McGimsey 1956). The red zone contains much less shell and organic material than the brown zone, suggesting a less permanent occupation (Cooke pers. comm., 2012). Shell midden sites are typically hills with deposits of debris from daily use; in the case of Cerro Mangote, the shell debris was so widespread it covered the entire site.

2.5.2.1 Cerro Mangote burials

To date, Cerro Mangote is the only Preceramic coastal site to have such a large number of burials excavated. The specifics of the burial treatments and patterns are detailed by individual in Appendix 2. Within Panama, early investigations at the Central Pacific Panama Ceramic site of Cerro Juan Diaz indicate similar burial practices (see Chapter 5). Beyond Panama, the mortuary treatments described at Cerro Mangote elicit speculation as to potential relations to South American peoples. Discussed further in Chapter 3, the burials at Cerro Mangote are commonly compared with South American sites (see Stothert 1985, Quilter 1989). The burial practices of the Las Vegas, La Paloma, and Chinchorro have each been compared to the burials found at Cerro Mangote, despite vast geographic separation. Each site, however, does provide clues as to certain characteristics within the mortuary practices observed at Cerro Mangote.

While the burials at Cerro Mangote had few associated grave goods, there were a variety of burial types present: single individual interments, multiple individual interments, primary burials, and secondary burials (McGimsey 1956, McGimsey *et al.* 1987, Ranere 1976, n.d.). The excavation notes describe the two types of primary burials as either tightly or loosely flexed. Flexed burials have been widely documented as commonly used during this time period (see Benfer 1990, Raymond 2003, Stothert 1985, 2003, Quilter 1989). More unusual in the Preceramic period are the two secondary interment types: the disarticulated burials and the bundle burials. In his documentation of the burials, McGimsey (1956) describes one of the bundle burials as follows:

> The entire body was contained in a sharply delineated rectangle approximately 50 cm long and 30 cm wide. The bones appear to have been placed in a flat rectangular container, possibly a basket. The skull was in the center…of the rectangle…The long bones were evenly divided and placed parallel to one another along the east and west sides. Apparently no attempt was made to keep the bones from one side of the body together. The vertebrae and miscellaneous foot and hand bones appear to have been placed in the center. The pelvis

> was at the south end opposite the skull, while the ribs were placed on top of the long bones overlapping in the center. (158)

McGimsey (1956) suggests that possible cut marks found on the remains, particularly the long bone epiphyses, suggest that the individuals were initially buried, then later removed and reburied as either bundles or disarticulated secondary burials (see also McGimsey *et al.* 1987, Ranere 1976, n.d.). The bundle burials were more uniform. Prior to the 1955 excavation of Cerro Mangote, bundle burials or the specific arrangement of the remains had not been documented in Central Pacific Panama. The three excavations reported a total of 13 bundle burials that largely conform to this description (McGimsey 1956, McGimsey *et al.* 1987, Ranere n.d.).

Importantly, it was the prevalence and distinctive arrangement of the bundle burials that lead to potential associations of Cerro Mangote with the earlier Las Vegas (10,000-6600 BP) culture of Ecuador:

> The Vegas burial customs were similar to those reconstructed from the early site of Cerro Mangote, Panama. Both sites had primary and secondary burials, but it is more significant that the neatly arranged bundles of bones occur in identical form at Site 80 and at Cerro Mangote…This form of bundle was sufficiently complex and specific that it was not likely to have been invented by both groups independently. Hence it provides evidence for the relationship between the peoples who lived at the two sites. (Stothert 1985:628)

The arrangement of the skeletal elements at Cerro Mangote is very similar to the secondary burials seen at Las Vegas Site 80 (n=196; formerly OSGE-80), a site on the Santa Elena peninsula (Dillehay 2000, Piperno and Pearsall 1998, Raymond 1998, Stothert 1985, 2003, Ubelaker 1980, 1988) (see Figure 2.7). Unlike Las Vegas sites, most individuals at Cerro Mangote were not buried with any grave goods or offerings. The arrangement of burials within a cemetery may indicate the spatial perceptions of the population. The archaeological framework from excavations can be used to assess

Figure 2.7: Examples of bundle burials. An example from Cerro Mangote is above (McGimsey n.d.), an example from OSGE-80 is below (Stothert 1985:626).

Figure 8. Flexed primary skeleton of an adult, probably female, accompanied by a secondary burial bundle containing the remains of a subadult.

potential intra-cemetery arrangement, particularly searching for burials groupings based on kinship.

2.5.3 Cultural History of Cerro Mangote

2.5.3.1 Paleoenvironment – Archaeobotanical evidence from Cerro Mangote

The paleoenvironment for Cerro Mangote has been reconstructed based on phytolith evidence and geomorphological studies in the Santa Maria delta (Cooke 2005, Cooke *et al.* 1996, Piperno and Pearsall 1998, Ranere 1976, Ranere and Cooke 2003). Phytoliths obtained from sediment cores from both Laguna de la Yeguada and Monte Oscuro, as well as the archaeobotanical record from Aguadulce are used to determine what plants were utilized at Cerro Mangote. While no lowland water bodies have been cored around Parita Bay, Piperno (2011a, 2011b, see also Piperno and Jones 2003) has modeled based on the data collected for mid-altitude areas of the Pacific to include probable distributions in the Parita Bay.

Combined with rockshelter stratigraphy, the evidence shows the same cultigens and techniques in use in the Late Preceramic/Early Ceramic were used consistently in Central Pacific Panama until conquest (see also Piperno and Pearsall 1998, Piperno *et al.* 1992b, Piperno *et al.* 2000, Ranere and Cooke 2003). The majority of the crops in use by 7000 BP include *Calathea allouia* (leren, a domesticated tuber), *Cucurbita spp*. (domesticated squash), *Lagenaria secaria* (bottle gourd), *Maranta arundinacea* (arrowroot), *Zea mays* (maize) and *Manihot esculenta* (manioc) (Piperno *et al.* 1992a, 1992b, Piperno and Pearsall 1998, Ranere and Cooke 2003). In her recent publications, Piperno (2011a, 2011b) reports the presence of maize at Cerro Mangote based on starch analysis from a metate (radiocarbon dates: 6810±110 BP). The presence of maize, combined with the archaeofaunal data from Aguadulce indicates more intense plant cultivation in Parita Bay, more consistent with agriculture than the previously proposed horticulture or gardening (see Piperno and Pearsall 1998).

2.5.3.2 Paleoenvironment – Archaeofaunal evidence from Cerro Mangote

During the late Preceramic, archaeofaunal evidence from Parita Bay area and the Santa Maria River Basin confirmed the changing landscape as the rising post-glacial seas pushed across Parita Bay and actually end up further inland than they are today. Sometime after 7000 BP, the rate of sea level rise decelerates and the coastline begins to prograde as river sediments gradually fill in low-lying areas in the delta (Clary *et al.* 1984, Cooke 2005, Cooke and Jimenez 2004, Cooke and Ranere 1999). The discussion of the archaeofaunal evidence here will consider the broad categories of terrestrial mammals, birds, invertebrates, and fish. Specific species are listed Appendix 3.

The animals hunted or collected are typical of wooded savannas, coastal forests, mangroves, and marine littoral habitats (e.g. the unusual abundance at Mangote of raccoons and wading birds). Combined with the ecological information from the archaeobotanical material, the faunal remains fit the extrapolated biomes. For instance, for species like agoutis and peccaries to remain abundant, dry forests have to be intact (see Cooke 1984, 1992, Cooke and Jimenez 2008a, Cooke and Ranere 1992c, 1999, Cooke *et al.* 1985, 1996, 2007, 2008, 2013, Ranere and Hansell 1978). The Preceramic and Early Ceramic periods in the Central Pacific Panama region indicate a similar set of species observed in these biomes throughout Parita Bay until conquest: an abundance of white-tailed deer (*Odocoileus virginianus*), raccoons (*Procyon lotor*) and iguanas (*Iguana iguana* and *Ctenosaura sp.*), with some species of amphibians and freshwater turtles. The severe dry seasons, though, may have adversely affected the natural abundance of vertebrates that frequent closed tropical forests, such as wild pigs

(*Tayassu peccary*), tapirs (*Tapirus bairdii*), roe deer (*Mazama spp*.), spider monkeys (*Ateles spp*.) and peacocks (*Crax rubra*, *Penelope spp*.). These species are absent or extremely rare in the pre-Columbian archaeofaunal evidence in this region (Cooke *et al.* 2007, 2008).

In addition to the terrestrial vertebrates collected or hunted, the 1979 excavation at Cerro Mangote uncovered probable evidence of domestication. A humerus from a dog (*Canis*) was recovered (see Figure 2.8). The presence of the humerus is significant since it is the only *Canis* element located at a Preceramic site in Panama[15]. Though domesticated dog elements were commonly found at Ceramic period sites, the presence of a domesticated dog humerus at Cerro Mangote suggests the element may represent

Figure 2.8: Photograph of *Canis* humerus, Preceramic element (left), modern comparison (right). Photograph provided by R. Cooke (pers. comm., 2012).

[15] Cooke and Ranere (1992a:37) comment that the bone bears some resemblance that of a modern "collie" (see also Cooke *et al.* 2007).

a type of domesticated dog introduced at a quite early date in Central Pacific Panama (Cooke pers. comm., 2012).

The bird taxa were consistent with mangrove-estuary habitats and dry vegetation formations landward of the high tidal flats, with white ibis and willet being the most frequent species. Other wading birds (*Scolopacidae*) include whimbrel, knot, a large *Tringa*, and "peep" sandpipers (*Calidris mauri* or *C. pusilla*). Great egrets, smaller egrets (*Egretta spp*.), and three species of dove (ruddy quail-dove, species in the Leptotila-Zenaida-Geotrygon group, and ruddy ground dove) also frequent the same habitats. The yellow crowned parrot, which often roosts in mangroves, is locally the most abundant species of *Amazona* along the central Pacific littoral. These taxa would have been available within an hour's walk or so from the site, either in marine coastal habitats or in scrubby and riverine woodlands (Cooke *et al.* 2013).

In addition to the terrestrial vertebrates, the volume of shells at Cerro Mangote is nearly impossible to ignore. While the analysis of dietary intake of invertebrates at Cerro Mangote has yet to be estimated, Martin *et al.* (2009) provide a useful cautionary lesson in their summary of mollusks at Playa Don Bernardo:

> Despite the high density of remains of mollusks, taxonomic diversity is low…Four genera (*Hexaplex*, a snail, *Megapitaria*, a large clam, *Chione*, a small clam *Argopecten* , and a "beetle" swimmer) represent 87% of the specimens collected in the Preceramic layers…Total specimens of these genera weighed 12,612 kilos in an excavated volume of about 0.8 cubic meters. Assuming that the edible tissues of a clam represent 9% of the mass and around 13% of the mass in gastropods - rates based on empirical observations by Cooke in Panamanian waters - the "scallops" (*Argopecten*) would have provided 446 grams of edible wet tissues, the "clams" (*Chione*), 118 g; larger *Megapitaria* clams, 340g; snails *Hexaplex*, 335 g – for a total of only 1.24 kilos (2.7 lbs edible wet tissue). The volume of the remains of mollusks gives an exaggerated impression of his nutritional importance with respect to vertebrates[16]. (122)

[16] Please note Martin *et al.* (2009) is originally published in Spanish. The original text is below. Any errors in translation are purely the fault of the author, not the original researchers.
Pese a la gran densidad de los restos de moluscos la diversidad taxonómica es pobre, lo cual apunta hacia una fuerte selectividad de parte de los residentes precerámicos. Cuatro géneros (*Hexaplex,* un caracol, M*egapitaria,* una almeja muy grande, *Chione*, una almeja pequeña y *Argopecten,* una "conchuela" nadadora) representan el 87% de los especímenes recogidos en las capas del botadero precerámico. El total de especímenes de estos géneros pesaron 12.612 kilos en un volumen excavado de aproximadamente 0.8 metros cúbicos. Asumiendo que

Though the overwhelming archaeofaunal component is shellfish, the volume cannot be directly attributed to dietary significance. The shellfish do provide important information about the site, though. The crab represented at the site is *Carisoma crassum* (not the typically observed *Menippe frontalis*), which is very abundant during the rainy season in Panama Bay mangroves. Additionally, the volume of shellfish, combined with the location of Cerro Mangote, suggests that even if the residents maintained a mixed subsistence, current models will not account for all the potential changes in the muscle attachments and cross-sectional geometry – e.g. lugging baskets of fish, shellfish, turtles, *et cetera* up a steep hill may impact the robusticity of the lower limbs more than the upper limbs.

Cooke and Ranere (1999) made a detailed comparison between archaeoichthyofaunas from the "brown zone" at Cerro Mangote and a refuse lens at Sitio Sierra using the bone fraction taken over 1/8" mesh (3.2 mm). In the stratum at Cerro Mangote 3200 specimens were recovered of which 97 % are telosts (bony fish) all genetically of marine origin. Of these, 51% were taken to genus and 40% to species. Based on the Minimum Number of Individuals (MNI), Cooke and Taipa (1994) determined the top 10 fish identified at Cerro Mangote (Table 2.3). A total of 62 marine species were identified in the "brown zone". Five species represent 27% MNI; brown catfish (*Sciades* [formerly *Sciadeicthys*] *dowii*), spotted sleeper (*Dormitator latifrons*), Seemann's catfish (*Ariopsis seemanni*), toadfish (*Batrachoides spp*.) and Kessler's catfish (*Notarius* [formerly *Arius*] *kessleri*). All are denizens of the middle estuary

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los tejidos comestibles de una almeja representan el 9% del peso de la masa de la concha los de los gasterópodos aproximadamente el 13% - proporciones empíricas basada en observaciones sobre géneros recolectados en aguas panameñas por Cooke -, las “conchuelas” (*Argopecten*) habrían proporcionado 446 gramos de tejidos húmedos comestibles, las “almejitas” (*Chione*), 118 g, las almejas grandes *Megapitari*a, 340 g y los caracoles espinosos *Hexaplex*, 335 g – esto esto es, un total de tan sólo 1.24 kilos (2.7 libras de tejidos húmedos comestibles). El volumen de los restos de moluscos da una impresión exagerada de su importancia alimenticia con respecto a los vertebrados. (122)

Table 2.3: Top ten species, ranked by MNI, at Cerro Mangote (modified from Cooke and Taipa 1994:929)
S. dowii
D.latifrons
A. seemanni
B.boukngeri/pacifici
A. kessleri
P. operculam
"Cathorops" sp. A
C. nigrescens/viridis
C. caninus
O.chalceus

(mangroves and the oligohaline stretches of the river). A detailed analysis of ariid (marine) catfish remains (Cooke 1993, Cooke and Jimenez 2008) corroborates this fishing emphasis. This situation differs greatly from Sitio Sierra located 12.5 km up-river where the three most frequent species represent 50% MNI. These are thread-herring (*Opisthonema libertate*), brassy grunt (*Orthopristis chalceus*) and Pacific lookdown (*Selene peruviana*). These species, which frequent clear water columns seaward of the turbid water plume, are infrequent at Cerro Mangote. Cooke and Ranere conclude (1999) that fishing at this time period at Cerro Mangote concentrated on intertidal mudflats, *Rhizophora* mangroves, alvinas, and the lowest (mesohaline and mixing) sections of the Santa Maria River. This is predictable in the context of historical geomorphology. What is more, Cooke and Ranere also state that the sites' inhabitants would not have had to travel more than 7 km to obtain their fish.

As stated above, the most abundant faunal remains at Cerro Mangote are invertebrates, particularly bivalve and crab shells. All 18 identified species are intertidal mudflat dwellers, consistent with the marine mudflats of the Parita Bay, and whose relative abundance decreases throughout site occupation. As marine mollusks shells decreased, crab shells increased, with the most common crab species representing

Cardisoma, a mangrove dwelling crab (see McGimsey *et al.* 1987, Ranere n.d.). The presence of the mangrove crabs also suggests the site was occupied at least during the beginning of the wet season when this crab is most easily harvested (Ranere n.d.). These inversely related abundances mirror the changing environment as the sea retreated further from the site and the extent of mangrove swamps increased. Ranere (n.d.) suggests in his assessment of the 1979 excavation and earlier analyses that further study should be done. More information is needed to understand not only how shell remains were processed at the site, but also as comparison with other faunal specimens in order to determine how resources were exploited.

2.5.3.3 Previous isotopic studies of diet at Cerro Mangote

As part of a larger study to determine specific components of diet in the region, Norr (1991, 1995) analyzed carbon (C) and nitrogen (N) isotopic values of bone collagen at Cerro Mangote, La Mula (a coastal sedentary site carbon dated to 2370-1970BP, Cooke and Ranere 1992a), and Sitio Sierra. The high C4 and low $\delta^{15}N$ isotopic values of Cerro Mangote were interpreted as indicating a diet based largely on maize. Though physical evidence of maize was not specifically identified at Cerro Mangote at the time of Norr's study, some researchers believe that the presence of estuarine fish at the inland La Cueva de los Ladrones and a relatively high C4 signature in the Cerro Mangote sample suggest the people of Cerro Mangote occupied that site only seasonally, traveling between the coastal site and inland locations (Norr 1991, Norr 1995, Piperno 1984, Piperno *et al.* 1991a, 1992b).

While some (Norr 1995, Piperno and Pearsall 1998) have accepted the hypothesis of seasonal occupation at Cerro Mangote, others (Cooke 2005, Ranere n.d.) have disputed whether the current isotopic evidence actually points to heavy reliance on maize and migratory patterns. Due to differential preservation of foodstuffs in the archaeological record and the particularly poor preservation of plant material at Cerro Mangote (Norr 1995, Piperno *et al.* 1991a, Piperno *et al.* 1991b, Piperno and Pearsall 1998, Ranere n.d.), regional dietary patterns have been assumed to be applicable to Cerro Mangote. As discussed in Chapter 2, the paleobotanical record indicates that maize was grown at Cerro Mangote, eliminating the need to migrate inland. The presence of maize does not necessarily mean it was farmed exclusively or intensively. More recent publications illustrate the impact of a high marine dietary component, particularly euryhaline fish, in the interpretation of stable isotope signatures (Keats 2002, Sealy 2001, VanderZanden and Rasmussen 2001).

Stable isotopes are utilized differently in the body because of their differing weights (due to the increased number of neutrons, e.g. $^{12}C/^{13}C$, $^{14}N/^{15}N$). Due to differential treatment within the body, - isotopes undergo fractionation, the chemical processes that choose and divide elements based on atomic weight. For example, while photosynthetic processes can use ^{13}C, the enzymes (RUBISCO for C3 plants and PEP Carboxylase for C4 plants) select for ^{12}C (Heldt 2004, Sealy 2001). Using atmospheric carbon ratios and plant physiological processes, plants will have an expected ratio of $^{12}C/^{13}C$ based on two different photosynthesis pathways: C3 (Calvin-Bensen) or C4 (Hatch-Slack). C3 plants—many trees, shrubs, fruits, vegetables, and grains that produce 3-carbon compounds first—have low (more negative) $\delta^{13}C$ values. C4 plants, on the other hand, produce a 4-carbon compound first, discriminate less against ^{13}C, and have a higher (less negative) $\delta^{13}C$ value (see Ambrose *et al.* 1997, Sealy 2001, Katzenberg 2008). ^{13}C values are usually negative since the Peedee Belemnite (PDB) limestone standard has more ^{13}C relative to ^{12}C than most other substances (Craig 1953). Marine carbon, however, derives from dissolved bicarbonate, yielding values between C3 and C4 plants (Ambrose *et al.* 1997, Zohary *et al.* 1994). Moreover, research has highlighted the variation of $\delta^{13}C$ in freshwater and euryhaline fish due to the dissolved bicarbonate in marine environments, which will also influence the $\delta^{13}C$ observed in human bone collagen (France 1995, Hecky and Hesslein 1995, Katzenberg 2008, Katzenberg and Weber 1999, Keats 2002, Kiyashko *et al.* 1991, Zohary *et al.* 1994). In the case of Cerro Mangote, the variation from euryhaline fish would result in higher $\delta^{13}C$ values (less negative) and therefore, may be erroneously interpreted as a C4 signature.

Ranere (n.d.) specifically counters the supposition of seasonal occupation due to the confluence of marine diet on nitrogen isotopic signatures (see also Ambrose 1991, Keats 2002, McClelland and Valiela 1998a, Michener and Shell 1994). Nitrogen isotopes indicate the trophic levels of the diet, increasing by approximately 3% per trophic level (Minagawa and Wada 1984, Schoeninger and DeNiro 1984). Herbivores tend to have 3% higher $\delta^{15}N$ values than their diet; moreover, carnivores are an additional 3% higher in $\delta^{15}N$ values than their diet. For ^{14}N, the atmospheric nitrogen standard (AIR) typically has $\delta\ ^{15}N$ values that are usually positive (Papathanasiou *et al.* 2000). Norr's analysis (1991) considers potential marine exploitation, but concludes the nitrogen ratios represent a terrestrial signature. Given that extensive exploitation of marine organisms can result in "terrestrial" nitrogen isotopic values due to nitrogen fixation in the organism, it is possible the nitrogen signature of Cerro Mangote is from marine organisms (Gannes *et al.* 1998, Keats 2002, McClelland and Valiela 1998b, Minagawa and Wada 1984, Ranere n.d., Ranere and Cooke 2003, Waser *et al.* 1999, VanderZanden and Rasmussen 2001). The original data collected by Norr (1991) are reinterpreted using these isotopic ranges (see Keats 2002, VanderZanden and Rasmussen 2001) in Chapter 6, suggesting a marine based diet, not a maize-based diet, for the individuals at Cerro Mangote.

2.6 Summary

This chapter details the evidence regarding groups and how they moved across and within Panama from the Late Glacial Stage through the Early Ceramic period. Past assumptions regarding the characteristics of these groups are revisited in light of new archaeofaunal, archaeobotanical, and lithic data. Technological similarities in stone tools among these groups and also with North American Clovis are striking and suggest rapid north-south movement of Clovis bands entering a probably thinly populated landscape. The Paleo-Indian bands across Central America occupied many different habitats. During the early Preceramic period, cultural regions began to distinguish themselves between the Central Pacific Panama and the Chiriquí highlands. By the late Preceramic period, distinct cultural styles were established and evolving on their own distinct flaked stone tool assemblages by 7800 BP. The archaeological records indicated clarity in the distinctions between the Chiriquí highlands and Central Pacific Panama sites. Through the Preceramic and into the Ceramic periods, settlement size increased (Cooke and Ranere 1992b, 1999, 2003, Dickau 2005); the number of year-round occupied sites increased (Cooke 2005, Ranere and Cooke 2003, Dickau 2005); the size and number of cultivated fields increase, as agriculture grew in popularity (Dickau 2005, Piperno 2011a, 2011b); and technology shifted to increase the amount of food procured (Cooke and Ranere 1992b, 1999).

Early sites in Central America were settled seasonally in order to exploit a particular resource. The sites, particularly the rockshelters, contain evidence for seasonal occupation to exploit a particular resource. The Early Ceramic period sites show temporally longer settlements that include house structures. Most of the sites have no associated cemeteries. Since the few Preceramic sites with burials only have a few skeletal elements present, it is difficult to determine if the skeletal elements encountered are burials with extensive taphonomic damage or a cache of specific skeletal elements (e.g. finding only marrowed bones may point to possible cannibalism [Turner and Turner 1992]). Later Ceramic sites contain distinctive burials with indications of mortuary ritual (see Chapter 3).

In addition to the site structure, the burial patterning suggests the people of Cerro Mangote may have been experimenting with burial rites and rituals. A reconsideration of the columns with the locations of the burials allows for a different understanding of how the cemetery may have been constructed. These columns will ground the spatial-bound model used to consider the relation of family members described in Chapter 5. While previous assertions regarding the individuals recovered from the site are addressed in Chapter 3 (including the claims of cannibalism, the origins of cut marks on the remains, and dietary components of the site), Cerro Mangote appears to exhibit both Preceramic and Ceramic site characteristics.

CHAPTER 3: THEORETICAL APPROACHES TO MORTUARY ANALYSIS

> Indeed, since mortuary rites involve manipulations of material culture, social relations, cultural ideals, and the human body, they represent a nexus of anthropological interests (Rakita and Buikstra 2005:1).

This dissertation will utilize elements from both processual and postprocessual theory. Each approach has its own merits, however, relying solely on one class of theory is problematic due to the relatively few material objects. For example, the location of burials within a cemetery, types of burial positions and treatments are correlated based on different variables, including age, sex, and pathology. Processual theory alone may assume the central burials with secondary mortuary treatment are the most important. Postprocessual theory, on the other hand, cautions against such a linear association, focusing more on the cultural meaning. For instance, the important feature to the living population may not be the location of the remains in the middle of the cemetery, but rather a geological feature, an environmental feature, or an astrological feature. However, burial goods at Cerro Mangote, a central aspect to many analyses, are lacking, which makes analysis difficult beyond the most basic of inferences.

This chapter details the importance of cemeteries in landscape archaeology, through both processual and postprocessual theoretical approaches. The reasons a group would create a cemetery are discussed, as well as the potential reasons for the significance of a cemetery. Next, questions regarding the burial style are considered, highlighting ideas surrounding how burials are posed to represent the living's ideas regarding gender, status, and wealth. Additionally, the importance of secondary burials in mortuary theory and interpretation is discussed, including ancestor worship. The presence of juvenile burials buried with adults implies another component of mortuary ritual at Cerro Mangote. Scott (1997) comments on the special treatment of juveniles to reveal both family power structures and gender relations. At Cerro Mangote, little associated material culture is found with the juvenile burials. To determine the possible presence of familial relationships within the cemetery, the chapter concludes with an introduction to the concepts of biospatial arrangement and its importance in cemetery construction.

3.1 Processual and post-processual approaches to mortuary analysis

Forays into the analysis of mortuary rites date to the origins of the disciplines of archaeology and anthropology. Indeed the earliest 'excavations' of some graves took place soon after burial by those more interested in the value of the cultural material than understanding the societal mores that created the burial in the first place. While most would not classify this type of grave robbing as archaeology, the principle focus of mortuary archaeology began not on the individual, but more so on the objects buried with individuals (see Casella and Fowler 2007). In the nineteenth century, the importance of the grave began to shift from the goods to the entire burial and the context it provided. To better document and describe burials and the objects, archaeologists employed a more systematic approach, eventually developing the principles modern archaeologists rely on currently when documenting a site.

Initial interpretive efforts lead to a highly deterministic model, imposing Western ideals of progress and economic gain as the means of forwarding the needs of a culture while categorizing cultures into types (see Bartel 1973, Binford 1971, Cannon *et al.* 1989, Carr 1995, Casella and Fowler 2007, Childe 1945, Kroeber 1927, Parker Pearson 2000, Tainter 1978). To bridge the gap created by overtly deterministic models, the concepts and methodology of processual archaeology were introduced by Binford. In his article, "Archaeology as Anthropology," Binford (1962) critiqued the past practice of cataloging culture trajectories and outlined a new theoretical framework to consider cultural characteristics using both archaeological and cultural anthropological concepts, based on the scientific method. By integrating data collection with characteristics of living cultures, Binford argued that the previous stories of archaeology would now be grounded in data, hypothesis testing, and observations (see Bartel 1982, Braun 1981, Chapman and Randsborg 1981, Hertz 1960, Ucko 1969).

This study of the Cerro Mangote cemetery focuses more on cultural adaptation inherent in processual theories. Binford and other processualists documented behaviors in living populations, examining how various groups used rituals, how status was considered, how objects were made and disposed, and how each interaction could impact the archaeological record (see Ambrose *et al.* 2003, Brown 1971, 2007, Fried 1967, O'Shea 1984, Pader 1982, Pagoulatos 2009, Peebles 1974, Peebles and Kus 1977, Saxe 1970, Tainter 1971, 1975, 1977, 1978). Burial characteristics and cemetery layout may be particularly important to understand how the cemetery at Cerro Mangote was created and utilized.

While processual models do explain quite a few behaviors, each still implies that the result will always be the same given certain conditions. This purely linear relationship does not tolerate variation well, particularly when applied to the archaeological record. Local variation within graves could be ignored if the archaeologist only considered certain variables and not the overall context of the grave. In his follow-up to the Gatas project, Chapman (1995, see also Chapman 1982) utilizes his own research to illustrate the importance of context. Originally the sample appeared much more homogenous, but after reworking his research using a regional framework he concluded that the original scale was inappropriate for the conclusions. The reliance on certain variables to determine complexity and societal 'type' created a formulaic model that glossed over any variation within the rituals that created the deposition (Chapman 1995).

Soon after the introduction of processualism, archaeologists began to call for further considerations and criticisms of the new paradigm (see Shanks and Tilley 1993). First, there was uncertainty regarding the operational definitions of concepts such as 'optimize' or 'maximize,' which raised questions concerning how the notions may vary based on cultural norms (Hodder 1982). Unlike processualism, the focus of postprocessualism is less on the history of a material artifact and more on the cultural impact and pressures on the individual who created the object[17]. While most burials at Cerro Mangote lack grave goods, there are a few present. The multiple types of burials suggest a possible experimentation in rituals. Further, the cemetery is the only cemetery located in Panama for the Preceramic period. The significance regarding location of the cemetery is further explored next.

[17] For example, Dommasnes (1982, 1991, 1992) explored the meaning of textile tools within Viking burial mounds. If only the types and categories of artifacts were recorded, the presence of textile tools and their importance to the community would not have been acknowledged. However, by considering with whom the artifact was buried, Dommasnes determined that women were the only individuals buried with textile tools. The presence of textile tools in association only with women indicates that while all other activities were shared in the communities, textiles production was a specifically female activity. Textiles may have represented an independent source of income, perhaps reserving a level of independence for women in the society. The meanings behind the artifacts, including the independence derived from a singularly female activity, may have been lost had only the textile production or efficiency been the focus of study.

3.2 Cemetery location in mortuary theory

Saxe (1970), in his widely studied Hypothesis 8, proposed that the presence of cemeteries serves as a reminder of the lineage of a particular group's association with a certain geographical area. He asserts the presence of ancestors is used to affirm land rights, as well as resource control. Goldstein (1981) presented some clarifications to the initial hypothesis, emphasizing the ritualization of resource rights and the ties to bounded cemeteries. She also considered the initial problems of Saxe's hypothesis, noting the deterministic tones of the hypothesis that imply cultures will ritualize aspects in similar forms due to similar characteristics. Goldstein reformulated the hypothesis, states:

> …not all corporate groups that control critical resources through lineal descent will maintain formal, exclusive disposal areas for their dead…But if a formal, bounded disposal area exists and if it is used *exclusively* for the dead, [then] the society is very likely to have corporate groups organized by lineal descent. (Goldstein 1981:8)

Morris (1991) later argued that the implications of Hypothesis 8 should be expanded to include the problems considered by postprocessualists in what he refers to as 'archaeology of the mind'. Morris argues that control over resources cannot exist independent from rituals, which are created and played out over multiple levels of meaning by those who created the cemetery.

In addition to the considerations of context, the mere presence of a cemetery, used over a length of time, does indicate the importance of ancestor veneration to the living (see Jensen and Neilsen 1997, Pader 1982). The relationship of non-bounded cemeteries, like that found at Cerro Mangote, indicate a nuanced relationship with the dead, linked more to veneration than to either resources or corporate rights. The use of secondary mortuary practices also lends credence to the possibility of focus on veneration of ancestors. Secondary mortuary practices are defined as a social act or acts concentrating on endorsed removal of all or part of a deceased individual. Archaeologically, secondary burials are often exemplified by the recovery of incomplete or disarticulated skeletal remains (e.g., bundle burials), due to the removal or movement of the skeletal elements (see Brück 2006, Dommasnes 1982, 1992, Härke 1997, Kujit 1996, Parker Pearson 2000). The removal of skeletal elements of an individual is thought to be a means for social integration, particularly during periods of great stress on the group (see Kujit 1996, Parker Pearson 2000, Polluck 1999, 2007).

Research has highlighted the development of secondary mortuary rituals as powerful communal acts, symbolically and/or physically linking different groups and communities and having implications of social differentiation (see Dunham *et al.* 2003, Kujit 1996, Nelson 2003, Parker Pearson 2000, Veredey 1999). Secondary rites are typically related to the social structure of the group, though the exact meaning within and between groups varies. For example, Parker Pearson (2000) compares English Bronze Age cemeteries with those from Tandory, Madagascar. The patterning of primary and secondary burials at both sites indicates an idealized representation of the groups' notions of kinship and family organization, utilizing the rituals to reify the concept within the living. Dommasnes (1992) utilized secondary burials to explore the roles of females in the family in Norwegian Iron Age sites. Almost no females were interred as primary burials, instead being buried in mounds close to family farms. The location of the mounds and construction of the grave over a central, male burial imply the lineage followed a "founding father" or patrilineal ancestry.

To investigate the notion of secondary rituals emphasizing the importance of ancestors, both living and dead groups have been studied (see Carr 1995, Hertz 1960, Metcalf and Huntington 1991, Palgi and Abromovich 1984, Parker Pearson 1993, 2000), with Kujit (1996) summarizing, "Previous studies illustrate that broader beliefs and world views fundamentally affect and perpetuate secondary mortuary practices through ancestor worship, ties to ancestral lines, responsibility to the deceased, and beliefs about universal orders" (317). Furthermore, the focus of secondary rituals differs from that of primary rituals. Secondary rituals are considered to focus not on an individual, but on a generalized ancestor or ancestors. This generalization allows for two important goals: 1) a simplified message to allow for communal, shared identity through the general ancestor(s) and 2) the funerary rituals to be spread out beyond the randomly timed dead into an organized and meaningful, ritual emphasizing the transition from life to death (see Chisholm 1993, Metcalf and Huntington 1991, Nelson 2003, Pader 1982, Parker Pearson 2000).

The interpretation of the relationship of the living and the dead has shifted over the last 30 years of mortuary archaeology. Particularly in the late 1980s, critiques arose regarding the emphasis on the grave goods and the lack of attention paid to cultural traditions that are not preserved in the archaeological record, in particular, cultural ceremonies regarding the dead (Hodder 1991, Palgi and Abramovitch 1984, Verdery 1999, Williams 2004). These ceremonies are a large part of the group's ideals regarding death and, therefore, are directly linked to the creation of the monument to the dead—whether it is a towering structure or the arrangement of the body and grave offerings (Härke 1997). The consideration for only the choices of the living made for the dead struck post-processualists as a rather one-sided relationship. Proponents of the theory utilized examples to illustrate how a complete understanding of death includes consideration of how the dead manipulate the social and political structure of the living, thereby influencing the rituals (see McAnany *et al.* 1999, McGuire 1988, Parker Pearson 2000).

The interplay of the relationship of the living and the dead impacts the types of landscapes utilized for living sites and cemeteries, as well as how the two areas interact. Goldstein (1981, 1995) emphasizes the importance of understanding the whole of the landscape, moving the focus beyond settlement sites to include the surrounding areas and cemeteries (see also Beck 1995, Binford 1971, Peebles & Kus 1977). Though a typical focus in mound or temple studies, historically other types of cemeteries have not included the same details of spatial arrangement (see Goldstein 1981, 1995, Morris 1991). In her discussion of the trends in mortuary archaeology, Goldstein (1981) discusses the importance of not only the physical locations, but the area between cemeteries and settlements, highlighting either the use or the lack of separation is one element to consider in analysis of how the living view their relations with the dead.

Most Preceramic sites within Panama were utilized for resources and only contain a few burials, not an organized cemetery. The presence of a cemetery at the site of Cerro Mangote indicates the importance of the area to the living population. Also, the cemetery at Cerro Mangote exhibits many of the characteristics of areas with cultural significance, since the cemetery contains not only the remains of rituals for primary and secondary burials, but also rituals as part of resource collection. While many components of the rituals were not preserved within the archaeological record, there are a few clues to important concepts related to identity, a cultural feature explored further below.

3.3 Burials and identity

In addition to the local landscape, the layout within the cemetery reflects the important characteristics valued by the society, indicating the views of the living about the dead. Though interpretations vary, the concepts of how each characteristic of the living society translate into the stratification within a cemetery have fascinated archaeologists since the beginnings of the discipline (Byrd and Monahan 1995, Chapman 1982, Dunham *et al.* 2003, Hardy 1992, Hodder 1982). The variables typically considered include the location within the overall cemetery, number of individuals within a burial, burial position, material goods associated with the burial, and the biological profile of the individuals (particularly the sex and age) (Hodder 1989, Gillespie 2001, Scott 1997). The segregation of space within a cemetery, including the layout and placement of burials, can indicate differentiation of individuals based on many criteria, such as sex (Geller 2005, Sofaer 2006, Geller 2009), age (Baxter 2008, Crawford 2008), and status (Cannon *et al.* 1989, Gamble *et al.* 2001, Hodder 1997, O'Shea 1984).

Sex and gender studies, which now include mortuary practices, illustrate how the living interacted with these two components of identity. Sex determination is based on the biological characteristics of the individual (see Chapter 4 for classification specifics), whereas gender is a cultural creation that is not necessarily linked to biological sex[18]. Studies use the combination of associated material objects and the biological sex of the individual to determine the overall perception of gender in the society (Geller 2005, 2009, Gillespie 2001, Smith and Lee 2008, Sofaer 2006,). Most commonly, objects were grouped as "male" or "female" and therefore associated with predefined assumptions on gender. More recently, however, notions of fixed gender perspectives have given way to a more holistic notion of identity, allowing for a more fluid interpretation of sex/gender in society. Some studies illustrate the variation of gender within a society and the potential disconnect from biological sex (see Geller 2009).

Geller (2005) details a series of burials of pre-Colombia Mayan warriors, comparing material objects and biological profiles of the individuals to reexamine the static concept of gender. She finds material objects commonly associated with male warriors buried with a biologically female individual, introducing the idea that biological female individuals undertook male roles in their society. In Cerro Mangote, there are few burial objects that may indicate gender perspectives and the biological analysis is

[18] The relationship of gender and sex is a complex one. Rubin (1975) proposes the "sex/gender system" to explain the relationship between one's biologically derived sex and culturally constructed gender. Other researchers have argued the term creates a boundary between sex and gender that cannot be clearly defined (see Voss 2000, 2005, 2006).

restricted to sex only (see Chapter 4). With the restriction of the sex/gender relationship to a biological analysis and few associated material remains, only a minimal understanding of gender and identity is possible at Cerro Mangote.

Cemeteries do offer a unique means to understand the living culture's concepts of age in society. Cemeteries have demonstrated stratification by age, most typically seen in the separation of juveniles and infants from adults (see Baxter 2008, Chamberlain 2000, Crawford 2008, Meskell 1999, Parker Pearson 2000, Rega 2000, Sofaer 2006). Early paleodemographic studies, in particular, call attention to the differential treatment of juveniles since many early models were skewed with fewer juveniles than expected (see Bocquet-Appel & Masset 1982, Brück 2006, Chamberlain 1997, Meskell 1999). Many studies highlight the variations in treatments of juveniles, ranging from burials in pots (such as recorded in Irish, Egyptian, and other Middle Eastern cultures), Roman infanticide, Anglo-Saxon juvenile burials associated with buildings, or pre-Hispanic Sicán specialized treatment of juveniles and placement within larger tombs (see Crawford 2008, Mays 2005, Shimada *et al.* 2004).

Early mortuary research typically ignored juvenile burials in favor of adult burials. However, further research indicates the importance of including women and children as active members of a group. Scott (1997) states:

> In many prehistoric and classical contexts infants…are found buried under floors and walls, near agricultural features, with grave goods, and/or associated with ritual features (Scott 1991, 1993). These are not cases of careless women dumping their unwanted bastards into any handy hole in the ground…we might be able to detect complex patterns of ritual and ideological treatment of deceased infants and further be able to contextualize the evidence to understand more of gender relations, power structures within the family and funerary practices in general. (7-8)

Juvenile burials are examined more as a window to equate to the living's rite of passage concepts, rather than members of a cemetery (see Chandler 1991, Rega 2000, Scott 1997). For example, Kamp (2001) highlights the Inca's beliefs regarding juveniles as messengers to the supernatural, with different burials for those sacrificed to create a stronger link to the spirit world.

In the case of Cerro Mangote, juveniles are represented within the cemetery sample. The similar burial treatment of juveniles and adults is common in pre-Hispanic (pre-contact) mortuary settings in Central and South America (see Stothert 1985, Shimada *et al.* 2004, Quilter 1989, Ubelaker 1995, Ubelaker and Jones 2002); furthermore, Quilter (1989) comments that the inclusion of juveniles may indicate the living population saw the infants and juveniles as full members of the group, unlike other prehistoric groups that separated infants and juveniles from the society due to high rates of childhood mortality (see also Benfer 1990).

Also commonly considered is how status is represented within the cemetery, particularly in terms of material remains placed within a burial context (see Almagro and Arribas 1963, Binford 1971, Chapman 1977). The presence of prestige goods within the burial context is presumed to indicate status in life. Chapman's (1977) initial studies at Chalcolithic communal tombs indicate a cluster of burials he called 'prestige tombs' due to the valuables buried with the individuals. In addition to the economic value of the material objects, time and energy expenditure to create the objects, to import the materials, or to create the different tombs all denoted higher status (see also Binford 1962, Buikstra 1981, Giddens 1984, Krober 1927, Pader 1982). While the material culture within a burial is easily identifiable, the larger concept of value and its meaning within the society using the material has been subject to study and criticism.

In their study of Moundville, Peebles and Kus (1977) examine ranked societies through a series of variables to better understand the network of characteristics considered by Mississippian period groups within status. In their classic study, Peebles and Kus (1977) illustrate how position within the mound and within the site reflects status, in conjunction with burial goods and other artifacts. Their study concluded that complexity within burial mounds is linked to the complexity of the society; however, the number of variables that may create that complexity are more than simply socioeconomic stratification. The criteria created by Peebles and Kus for mortuary analyses and other processualist-based studies (see Chapman 1995, O'Shea 1984, Pagoulatos 2009, Renfrew 1986) have been critiqued as being too inflexible and deterministic. The presence of stratification is equated to a particular variable (burial goods, position, artifacts), and the lack of perceived stratification is thereby equated to an egalitarian society (see Chapman 1981, 1990, Howell and Kintigh 1996). Though social categories and stratification are still explored in postprocessual archaeology, a more fluid concept of society is used, which allows for movement and variation within the society (see Hodder 1984, 1991, 1997, Howell and Kintigh 1996, Shanks 2007, Shanks and Tilley 1993).

Renfrew (1986) explored the meaning of gold and its use in a cemetery in Varna, Bulgaria. Located near the Black Sea, the Chalcolithic cemetery contained many burials with gold ornamentation. Renfrew proposed five criteria for determining the value of gold in the population, the prominence of the ornaments, and the significance behind the value and prominence. Renfrew examined the areas of the body adorned, the types of objects typically made from gold, and the characteristics of the material in order to determine how the material is used. However, the analysis on the use of gold at Varna centered on the assumption that gold was used to celebrate the chiefs and their status. Parker Pearson (2000), points out that the assumption of economic value may not be appropriate, since the individuals may have viewed gold as a magical material, not the economic segregator gold has become in modern cultures. By assuming the scepters indicate power and rule, gold therefore is a substance imbuing power and rule; however, if gold was used as a magical substance, are the scepters still indications of rule or, instead, magical wands?

Status stratification does not appear to follow a formulaic standard in postprocessualist views. How a group creates social organization and class varies, illustrating that the categories mentioned above may not translate to material objects or burial context. In their assessment of hierarchy in Panama, Cooke and Ranere (1992b) mention current Native groups of Panama with multiple levels of social position that do not correspond to a differentiation in socioeconomic class:

> Howe (1978) summarizes the dilemma succinctly when he points out how easy it would be for an uninformed observer to interpret the society of the twentiethth (*sic*)-century Kuna of Panama as being far more stratified than it really is: the Kuna recognize as many as thirteen categories of social *position,* none of which refers to social *class!*" (22)

Following the ideas that status is imbued through energy expended or time, Cerro Mangote appears egalitarian, given that there are few burial goods or tombs. Furthermore, Cooke and Ranere indicate no Preceramic sites reflect socioeconomic class in the archaeological record or burials, including Cerro Mangote (Cooke 2005, Cooke and Ranere 1996a, Lange 1979, 1992, Linares 1977, 1980a, Linares *et al.* 1975). The lack of economic stratification is considered evidence for the early hypotheses of McGimsey (1955, McGimsey *et al.* 1987), proposing the site was more likely a smaller settlement used by an extended family which was probably egalitarian. However, postprocessual thought cautions that the lack of evidence of stratification does not necessarily mean there were no social positions at Cerro Mangote.

3.4 Kinship studies in mortuary analysis

During the 1970s, initial steps were made by archaeologists to determine the theoretical framework for identifying and discussing kin groups, quantified using kinship analysis. Kinship analyses are useful for delineating burial practices, reconstructing mating patterns, and analyzing the composition of families, since cemeteries are first and foremost, a biological lineage (see Cadien *et al.* 1974, Konigsberg 1987, 1990a, 1990b). To revisit Saxe (1970), Hypothesis 8 outlines the concept that cemeteries were used by non-state groups as markers of their lineage and claim to lands and resources (see also Goldstein 1981, Morris 1991; for examples, see Allen and Richardson 1971, Eggan 1950, Friedrich 1962, Lischka 1975, Plog 1978, Stanislawski 1973, Watson 1977). The lineage is traced through the presence of a group's ancestors, both as a physical location and a family tree. Mortuary studies can understand the relationships between kinship, mortuary practice, and postmarital residence due to the presence, or absence, of familial relationships.

Postmarital residence studies provide information regarding the integration of regional groups and tests for the presence of a regional network of relations. Schillaci and Stojanowski (2003, 2005) highlight the correlation between postmarital residence and the development and maintenance of trade routes, defense alliances, and solidarity between and within groups. Like kinship analysis, postmarital residence was initially assumed to follow patterns based on sex-specific artifact groupings (see Binford 1962, Deetz 1960, 1965, 1968, Hill 1966, Longacre 1964, 1966, 1968, McPherron 1967, Whallon 1968, Wright 1966). These studies were criticized for their misunderstandings regarding the formation process of cemeteries and problematic association of material objects to residency (see Allen and Richardson 1971, Konigsberg 1987). The use of biological data moved postmarital and kinship studies away from material culture, utilizing the principles of genetic inheritance to better describe population movement through trait heritability (Blangero 1990, Hartl and Clark 1989, Relethford and Blangero 1990, Williams-Blangero and Blangero 1989).

Cemeteries pose methodological challenges for kinship analysis based on size and spatial distribution of the burials. Specific to an archaeological context, the reconstruction of site-formation processes can help determine if a cemetery is kin-structured or if graves with multiple skeletons contain related individuals. Typically, kinship analysis relies on patterns of within- and between-group variance and affinity relative to spatial structure to investigate biological affinity (Alt and Vach 1998, Konigsberg 1987). Studies relied heavily on cranial non-metric traits or craniometrics to assess kinship in a skeletal sample using non-destructive techniques (see Konigsberg 1990a, 1990b, Mays 1999, Parker Pearson 2000, Relethford *et al.* 1997, Stilltoe 1985); moreover, subsequent research confirmed these traits are moderately heritable and therefore useful for genetic variance and biological distance studies (see Cheverud 1988, Corruccini 1985, Konigsberg and Ousley 1995, Sjovold 1984, Susanne 1977).

Konigsberg (1987) formalized a common model to determine postmarital residence patterns situated within population genetics, partitioning standardized genetic variance by female and male subcomponents. To substantiate the assumption that differential migration by males and females can result in measurable variation, Konigsberg (1987) utilized computer simulation to confirm sex-specific, within-group genetic and phenotypic variability. Moreover, Konigsberg (1987, 1988) established that multi-generational gene flow may have homogenizing effects, but these cumulative effects do not impact the variation expressed through postmarital residence patterns (contra Kennedy 1981).

In addition to craniometrics and non-metric traits, dental metrics are currently gaining scientific support. Similar to craniometrics, dental metrics use measurements to quantify the size and shape of molars, using the relationship of inherited genes and tooth size (see Keiser 1990, Konigsberg 2000, Stojanowski 2005, Stojanowski and Schillaci 2006). Previous studies have indicated that, in general, approximately 90% of the total variability is due to genetic variation (see Alvesalo and Tigerstedt 1974, Dempsey and Townsend 2001, Garn *et al.* 1965, Potter *et al.* 1978, Smith 1974, Townsend and Brown

1978). For example, permanent canines and premolars have the most genetic variance in tooth size, thought to be associated with evolutionary pressures (Dempsey and Townsend 2001, Dempsey *et al.* 1995). Further, studies have indicated an average of 6% size variation based on environmental factors. To minimize these effects, researchers have relied on later developing teeth (particularly the molars) and mesiodistal measurements, which have less variance (Dempsey *et al.* 1999, Moorreess 1957, Potter *et al.* 1983, Townsend and Brown 1978).

Alt and Vach (1998) summarized the biodistance analyses using dentition into three types of studies: small grave, unstructured spatial and structured spatial. While each type of analysis utilizes a similar methodology for data collection, each approaches the analysis from a different set of questions. Small grave analysis utilizes a nonspatial model to determine if the individuals buried within an area are closely related (see Adachi *et al.* 2003, Alt and Vach 1992, 1995, Hanihara *et al.* 1983, Rosing 1986, Shinoda and Kunisada 1994, Shinoda and Kanai 1999, Shimada *et al.* 2004, Spence 1971). The second type, unstructured spatial, identifies kin groups without spatial structure or hierarchy within larger cemeteries. The goals of this type of analysis rely on probabilistic modeling to identify likely relatives from the larger sample, based on statistical models relying on nearest neighbor techniques (see Alt and Vach 1991, 1994, Case 2003).

Structured special is the last, and most common type and uses existing spatial structures to examine patterns of inter- and intra-group variance and affinity, based on the degree of homogeneity within burial clusters (see Alt *et al.* 1995, Bartel 1979, Jacobi 2000, Stojanowski *et al.* 2007, Strouhal and Jungwirth 1979). Stojanowski (2005, Stojanowski *et al.* 2007) details the burial organization using dental metrics within church burials in post-Contact Floridian churches, paying particular attention to row and side of the aisle for each burial. The majority of the churches maintained a cross-aisle family-oriented burial row, with sex segregation by side. Stojanowski also illustrates the variation in demographic modeling throughout the cemeteries of Spanish Florida (see Stojanowski 2005). As discussed in Chapter 2, Cerro Mangote has columns that may delineate three areas. There appears to be a visual correlation with the columns and the burial arrangements, which will be further explored in Chapter 6. As the *a priori* groupings at the cemetery, these groups allow for intra- and inter-group analyses in a structured spatial analysis.

3.5 Pitfalls in Mortuary Analysis

The theories of how a cemetery relates to the living provide a framework to consider data. As with other theoretical approaches, there are areas where mortuary theories fail to adequately distinguish or explain certain details or facts. For example, post-processual approaches to mortuary studies hinge on the idea that the dead are buried based on the culture and rituals of the populations living at that time. Since the living make the final decisions on the treatment of the dead, burials are not necessarily a mirror of the society that buried them, but perhaps more what the society idealizes itself to be. Additionally, the same variables considered by processualists are considered within a continuum of behaviors, rather than the presence or absence of characteristics. While rituals and rites of a culture will restrict behaviors, postprocessualists emphasize that examining the end product of a burial cannot be used to back-trace a particular ritual. Postprocessualists argue that questions regarding the reasoning behind behaviors cannot be addressed using archaeological methods, due to all the layers of culture obscuring the past. Instead, research should focus on the overlapping stories and roles of the individuals within the group (see Barrett 1994, Gillespie 2001, Hodder 1982, Lull 2000, Scott 1997, Shanks and Tilley 1993). The interplay of the living group’s desires and intentions colors the rituals in a particular manner and, thus, obscures the individual behind the culture.

3.6 Summary

The mortuary theories presented in this chapter outline the importance of location. The placement of a cemetery suggests ties of the living to a particular landscape for resources, whether material or spiritual. The importance of establishing ownership and lineage within an area gains prominence as societies seek to differentiate themselves from other groups. The Saxe/Goldstein Hypothesis 8 explores how burials are used to establish ancestry and maintain familial links to the landscape.

In addition to establishing a link to specific resources, mortuary theory considers the impact of culture on rituals, the creation of burials, and identity. While the exact nature of the rituals is not known, previous research has indicated the importance of cemeteries in establishing and maintaining resource rights. Also, the secondary burials suggest not only a focus on resource exploitation, but an expansion of mortuary rituals beyond a simple burial to inter the dead. The focus on ancestor veneration implies a need to maintain connection with the individuals and their remains, implying the site was utilized regularly.

The next chapter will detail how these theories connect to the dissertation hypotheses through data. The second hypothesis tests if the cemetery was more likely to be arranged based on familial stratification rather than other characteristics, such as age, sex, or pathology. While these biological relationships do not negate other possible reasons for the arrangement of the burials at Cerro Mangote, it does allow for one avenue of interpretation on how the individuals comprised their local landscape by exploring how ancestry was treated in the burial context.

CHAPTER 4: PALEODEMOGRAPHY AND THE OSTEOLOGICAL PARADOX

In this chapter I evaluate the critiques of paleodemography methodologies, paying particular attention to changes in methodology and theory from the first analysis of the skeletal samples at Cerro Mangote by the University of Texas[19] to this research. First, I consider questions regarding the individual skeletons selected to construct the demographic patterns or reference samples. Particular attention is paid to the importance of preservation, as the cemetery sample underwent various levels of selection and how that influenced the final selection of individuals available to bioarchaeologists. Second, I consider the methodologies employed by bioarchaeologists to determine the age and sex, focusing on how the methodologies were constructed including the original assumptions used in the creation of these methods. Third, I introduce the Gompertz-Markham and Siler hazard-based models as likely models of population structure. I pay particular attention to the theory behind these statistical models and the statistical resolution of skeletal data. Finally, I review the impact of the osteological paradox on assumptions of health in skeletal samples, using Ubelaker's

[19] McKern published a preliminary analysis of the biological profile as part of McGimsey et al. (1987). The analysis was conducted by a variety of students. The original lab notes, overall, do not list the individuals who performed the assessments or the methods used in estimating the biological profile. For brevity, the University of Texas lab is referred to as 'Texas.'

previous interpretations of OSGE-80[20] (Ecuador) as examples. I will use these theoretical platforms to contextualize the paleodemographic information at Cerro Mangote.

While archaeologists traditionally focus on the ritual or ideology surrounding a burial context, bioarchaeologists utilize skeletal remains to reconcile the biological profile of the sample with the larger past population that contributed to the contents of the cemetery. Determining the age and sex of each individual in a death sample allows a larger pattern in a living sample to be inferred. Paleodemography attempts to establish mortality patterns in archaeological samples to better understand the life expectancy and health of past populations. Early models evaluated individuals as either 'male' or 'female' and assigned an age estimate[21] based on the present skeletal markers. These characteristics were then used to calculate life expectancy and morbidity/mortality estimates. However, the association between a living population and a cemetery sample is not as clear-cut as was once assumed in paleodemographic studies. Critics of early paleodemography demanded that the discipline reevaluate the assumptions, methods, models, and context of paleodemographic analyses (see Bocquet-Appel and Masset 1982, Buikstra and Konigsberg 1985, Hoppa and Vaupel 2002, Sattenspiel and Harpending 1983).

Following the calculation of demographic statistics, the health of the skeletal sample is estimated. To determine the demographic patterns, paleodemographic analysis relies on assumptions regarding how health and disease are preserved in the archaeological record and how populations are structured. Evaluation of health in skeletal remains is based on an assessment of the presence or absence of lesions (see

[20] OSGE-80 is a Las Vegas site, commonly compared to Cerro Mangote due to similar burial patterns. Details of the biological analysis are considered here, with the cultural characteristics detailed in Chapter 4.

[21] Depending on the study, the original age estimates assigned to individuals could have been either a range or a point estimate (a single number). For example, the first biological profiles created in 1956 for Cerro Mangote by Texas only included a point estimate for age for the individuals analyzed.

Cohen 1989, Steckel and Rose 2005). Bone may display as many as three types of physiological responses to stress: bone removal, bone formation, or both. The introduction of the osteological paradox into bioarchaeology facilitated further interpretation of the disease process and the importance of risk of death that creates skeletal samples (see Boldsen 2007, Konigsberg and Frankenberg 2002, Konigsberg *et al.* 1997, Wood *et al.* 1992a).

4.1 Paleodemography

Reconstruction of demographic patterns in archaeology and biological anthropology has a rather notorious past. This stems from either inconsistent application of methods and theories, over-representing the accuracy of the tabulations and frequencies of sample characteristics, or both. Early attempts at understanding demographic trends in prehistory remained focused squarely on comparing age and sex distributions of samples in an attempt to tease out the nuances of population structure from cemetery samples but using inconsistent methodologies, making comparisons tenuous at best (see also Angel 1969, Armelagos and Van Gerven 2003, Buikstra and Konigsberg 1985, Konigsberg and Frankenberg 1992, 1994, 2002, Paine 2000). The early focus on population dynamics highlights the importance of understanding population growth rates in these early studies (see Sattenspiel and Harpending 1983). Simultaneous to an increasing focus on the transition to agriculture, paleodemography moved away from strict tabulation of age and sex in favor of life tables, modeled after modern demographic data (see Acsádi and Nemeskéri 1970, Asch 1976, Bennett 1973, Blakely 1971, Buikstra 1976, Howells 1960, Johnston and Snow 1961, Lallo 1973, Lovejoy *et al.* 1977, Ubelaker 1974, Vallois 1960, Weiss 1973). Life tables statistically illustrate the mortality and life expectancy at a given year. The introduction of life tables to paleodemography highlighted population mortality rates based on life expectancies at certain ages (Coale 1957, 1972).

Although the use of life tables did increase standardization in the field, it also illuminated problems pertaining to data resolution, age estimation techniques, and restrictions of skeletal samples inherent in bioarchaeological analysis (see Armelagos and Van Gerven 1983, Bocquet-Appel and Masset 1982, Buikstra and Konigsberg 1985, Howell 1982, Sattenspiel and Harpending 1983). For example, actuarial life tables from living groups use point ages of extremely large demographic samples, whereas paleodemographic life tables use age cohorts of comparatively small samples. The direct application of demographic methods for living populations to skeletal samples was not appropriate for archaeological samples. Moreover, recent studies have reconsidered paleodemography and its contributions to bioarchaeology by examining the limitations and possible interpretations or possible misinterpretations of the data (see Bocquet-Appel 2008, Bocquet-Appel and Bar-Yosef 2008, Boldsen 2005, 2007, 2008, Chamberlain 2006, Eshed *et al.* 2004, Gage 2005, Hawkes and Paine 2006, Hoppa and Vaupel 2002, Milner *et al.* 2000, Wood *et al.* 1992a, Wood 1992b).

Paleodemographic methods and assumptions have been greatly improved by recent efforts to reconsider some of the most deeply-held tenets of the field. Wood (1998) comments that demographers must consider research on small-scale populations (both living and extinct) to more fully understand basic ideas regarding changes in fertility and mortality, economic and environmental impact on population dynamics, and the interrelationship of population size, growth, and health. Though not equivalent to prehistoric populations, modern populations can clarify some notions regarding fertility and its impact on population dynamics (see Bocquet-Appel and Bacro 2008, Bonneuil 2005, Luy and Wittwer-Backofen 2008, Herrmann and Konigsberg 2002, Paine 2000, contra Lovejoy *et al.* 1977, Storey 1992). That said, modern living populations do not undergo the same types of selection present in these ancient cemetery samples; moreover, although these selection processes may not impact population dynamics, they could greatly bias the analysis, as will be discussed below (Gordon and Buikstra 1981, Hoppa and Vaupel 2002, Milner *et al.* 2000, Waldron 1987, Walker 1995, Walker *et al.* 1988, Wiley *et al.* 1997).

4.1.1 Sampling considerations in paleodemography

The dead individuals interred within a cemetery are not a direct representation of the living populations from which they came because the cemetery sample can never represent the total living population. The cemetery is, in actuality, a highly selected subset of individuals (Buikstra and Konigsberg 1985, Konigsberg and Frankenberg 2002, Milner *et al.* 2000,). Figure 4.1 illustrates a basic model commonly utilized by bioarchaeologists and archaeologists to describe selection in a skeletal sample. The first type of sampling is influenced by the heterogeneity in an individual's frailty; in other words, how individuals are selected varies in regard to their "susceptibility to disease and death" (Wood *et al.* 1992a: 345, see also Vaupel *et al.* 1979). Wood *et al.* (1992a) suggest multiple causes in heterogeneity, including genetics, socioeconomic status, environmental variation, and temporal variation (caused from the prolonged use of cemetery accumulations). Therefore, a cemetery typically represents those members of a population who are the most frail, and therefore the most likely to succumb to disease and death.

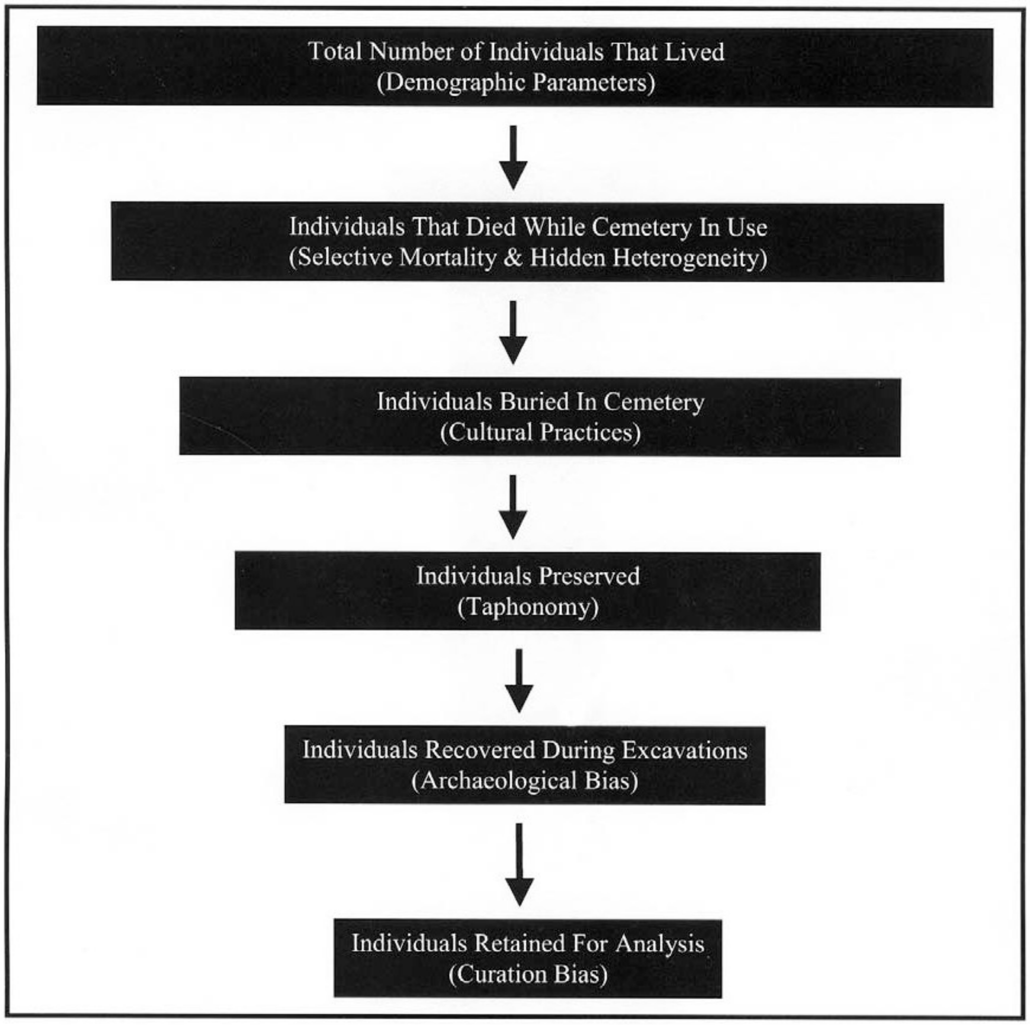

Figure 4.1: A model of skeletal sample formation (from Wilson 2010:96)

Cohen (1994) counters with the idea that heterogeneity of frailty was not, in fact, all that important in small-scale, preindustrial societies. He asserts that prehistoric societies had more deaths from accidents than other causes. In their response to Cohen's article, Wood and Milner (1994) comment on the plethora of examples from ethnographies (including the large number of childhood deaths from diarrhea, attributed to infectious disease) and animal models to illustrate the variety in age-specific hazard rates and survivorship (see also Milner *et al.* 2000). Moreover, Wood and Milner

(1994:635) argue that viewing a cemetery as a random sample of the population is similar to using a hospital as a random sample of health characteristics – since the entirety of the sample is sick, conclusions will always point to a sicker population than actually exists.

The second level of sampling within a cemetery population considers the effect that mortuary ritual and other cultural practices have on the construction of the cemetery. All individuals may not have been treated the same after death, and this mortuary selection may influence who is buried in a cemetery, or how they were interred. Archaeologists may also encounter selective locations, where most individuals were buried in one location, while infants, juveniles, outsiders, or those less desired by society may be buried outside the principle area. Additionally, whole groups can be buried in different locations, a typical practice in socioeconomically stratified societies, where groups may use separate cemeteries depending on occupation or socioeconomic class (see Milner *et al.* 1991). These cultural selection processes can also skew the paleodemographic profile of the cemetery in question.

The third sampling process at work is the differential preservation of certain skeletons or skeletal elements. After burial, the individuals buried in a cemetery experience differential preservation based on taphonomic processes. For example, at Cerro Mangote, soil acidity adversely affected bone preservation (Gordon and Buikstra 1981, Mays 1993, 2010, Waldron 1987, Walker *et al.* 1988, Wiley *et al.* 1997). That is, bones with thinner cortical bone or small bones tended to dissolve in the soil, leaving diaphyses of long bones, cranial vaults, and the teeth of adults. In some cases, the smallest skeletons, such as infants and juveniles, may be underrepresented because over time the acidic conditions completely dissolve most, if not all, of the tiny bones leaving fragments that are too small to collect or, most likely, leaving no trace of their even existing.

The fourth and final level of selection involves the excavation and the curation of remains. Milner *et al.* (2000) highlight the importance of excavation experience and the ability to recognize small bones and infant bones; lack of sufficient experience in the field may result in an underrepresentation of these categories. Excavation techniques and sampling methodologies can also impact the estimated number of individuals located within a particular burial context. Though more common in the past, certain skeletal elements, particularly pathologies or skulls, have been collected, while the rest of the skeleton is abandoned (see Gordon and Buikstra 1981, Milner *et al.* 2000). Finally, identification and/or collection of skeletal remains may be ignored if the primary goal of the excavation is to recover particular artifacts or other archaeological materials and does not specify skeletal remains as part of the primary objective.

These four levels of sampling, from death through mortuary rituals to taphonomic processes and differential excavation and preservation techniques, further disrupt the connection between a cemetery sample and the living population from which it was drawn.

4.1.2 Age and Sex Estimation

In addition to the problems of differential selection, early critics of paleodemography called attention to inconsistencies in the sexing and aging methods available to skeletal biologists (see Bocquet-Appel and Masset 1982, Konigsberg and Frankenberg 1992, 1994). These methods are based on observations of reference samples from modern populations—from marked cemeteries or autopsy collections—with documented medical histories and detailed records on how they lived and died (see Armelagos and Van Gervan 2003, Bocquet-Appel and Masset 1982, Lovejoy *et al.* 1985b). These skeletons are described qualitatively and in great detail to discern patterns in the body as it ages over time. The majority of the adult aging methods track the senescent stages of life through the deterioration of specific areas in the skeletal system. To illustrate the creation of these methods, in addition to their critiques, I will use the pubic symphysis methods as examples.

The development of the methodologies used to age the pubic symphysis illustrates some of the problems with using joint surfaces to age skeletons (the pubic symphysis is the cartilaginous joint that joins the two halves of the pubic bone). Todd (1920) initially introduced the idea of using skeletal characteristics to determine age at death in his study of white male prison inmates. Because of the known ages at death and documented history of the prisoners, Todd had a reference sample from which he could describe the changes in the pubic symphysis face over time. The changes on the surface of the pubic bone are described in a range of terms, from “billowy and ridged” to “grainy and erratic” depending upon an individual’s age (Buikstra and Ubelaker 1994, Buckberry and Chamberlain 2002, Burns 1999).

Soon, issues with the Todd method surfaced. It was found to be accurate only for his study sample, i.e., modern middle-aged white males (Lovejoy *et al*. 1985b, Saunders *et al.* 1992). The problem of how limited an age range a skeletal marker can estimate is still debated by the discipline today, particularly since culture, sex, and time period of the reference sample all can influence changes in skeletal markers (see Bocquet-Appel and Masset 1982, Buikstra and Kongsberg 1985). Specifically pertaining to the Todd method, the influences of sex on the changes in the pubic symphysis were not taken into account in the original methodology[22].

[22] With the publication of the Todd method and ensuing criticism, other anthropologists created variations of the method to try to rectify the issues (Katz and Suchey 1986, Suchey 1979). Other studies still showed some of the same types of error with this method as with Todd’s; in particular, the method underestimated the age of people who died between 17 and 30 years of age, and overestimated those that died after 50 (Angel *et al.* 1986, Bocquet-Appel and Masset 1982, Brooks and Suchey 1990, Hoppa 2000, Kemkes-Grottenthaler 1996, Murray and Murray 1991, Schmitt 2004). Though there has been some fine-tuning of the age at death ranges in the tables based upon

One important addition to aging techniques was the separate aging of male and female skeletons[23]. Essentially, to use aging techniques successfully, the researcher must know the sex of the individual. The determination of sex would seem to be deceivingly straight forward: rather than trying to determine a point age estimate from many possibilities, sex has only two choices, male or female. As Milner *et al.* (2000:475) explain, however, it is not that simple: “The male and female distributions of skeletal features used to estimate sex overlap considerably. Some of these bone features are generally considered more reliable than others, and the degree of sexual dimorphism varies among human populations.” In order to account for the potential variation in robusticity within skeletal characteristics, a scale designating traits as ‘female’, ‘probable female’, ‘indeterminate’, ‘probable male’ or ‘male’ was developed (see Chapter 5). Also, prior to 1970, the methods employed to determine sex tended to estimate too many males due to over-emphasis on cranial features (see Powell 1988, Ruff 1981, Weiss 1973). As an individual ages, cranial features become more robust; in older females, this increased robusticity makes the skulls look masculine, resulting in errors in sexing (Meindl *et al.* 1985, Milner *et al.* 2000, Walker 1995).

In addition to expanding age and sex methodology, subsequent studies considered the statistical rigor of the methods, including discriminant function analysis[24] (see Giles 1964, Stone *et al.* 1996, Robling and Ubelaker 1997, Stone 2000), finite mixture analysis[25] (see Dong 1997, Pearson *et al.* 1992) or Bayesian analysis[26] (see

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culture and other reference samples, the problem of accuracy has never been fully resolved (see Baccino *et al.* 1999, Martrille *et al.* 2007, Saunders *et al.* 1992).

[23] For example, the Suchey-Brooks method analyzes male and female pubic symphyses separately, creating two standardized tables, increasing the accuracy of aging male and female skeletons (Brooks and Suchey 1990, Klepinger and Giles 1998).

[24] Discriminant function analysis predicts categorically dependent variables through continuous or binary independent variables (Tabachnick and Fidell 2001).

[25] Finite mixture analysis is a hierarchical model representing sub-groups within an overall sample, without identifying to which sub-group an individual belongs (Tabachnick and Fidell 2001).

Konigsberg and Hens 1998). The application of Bayes' theorem to aging techniques is particularly relevant given the questions considered in the Transition Analysis method (Boldsen *et al.* 2002). Transition Analysis combines Bayesian inference and maximum likelihood estimation[27] (MLE) to estimate individual age-at-death through assessing changes in skeletal morphology related to age progression[28]. Transition Analysis assigns a score that assesses the likelihood of certain skeletal characteristics transitioning or changing at specific ages, but does not estimate a mortality profile simultaneously (Bethard 2005, Boldsen *et al.* 2002, Hoppa and Vaupel 2002, Kemkes-Grottenthaler 2002, Konigsberg and Herrmann 2002, Love and Müller 2002). Given the small sample size of Cerro Mangote, Transition Analysis is not a possibility; nevertheless, the methodology is an important milestone in biological profiles and should be included in the analysis when a regional study of Panamanian skeletal samples exceeds a minimal threshold making meaningful analysis possible.

4.2 Paleodemographic models

Early paleodemographic models of prehistoric populations suggested that various groups existed well below the environmental carrying capacity (Caldwell and

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[26] Bayesian analysis estimates use prior information to calculate the probability of an outcome (Adams and Konigsberg 2004). Bayesian analysis considers the impact of an improper prior assumption, highlighting that if the initial assumptions are skewed, the resulting analysis will be as well. For example, given that the majority of the original reference samples were biased towards males, it is unsurprising that initial methods were biased towards male in sex assessment (Konigsberg *et al.* 1998, Rogers and Saunders 1994, Williams and Rogers 2006). Bayesian analysis underscores the critique that skeletal indicators correlate poorly with age, resulting in estimates that do not completely reflect either the reference sample or the target population (see Konigsberg and Frankenberg 1992, 1994).

[27] MLE is a logistic regression model that statistically determines the parameters that best fit the given data based on the probable distribution of the dependent variables (Konigsberg and Frankenberg 1994).

[28] These changes in morphology can include many aspects of the skeleton, such as gross morphology, microscopic remodeling (see Kerley 1965, Kerley and Ubelaker 1978, Robling and Stout 2008, Stout 1992, 1998), dental histology (Charles *et al.* 1986, Drusini *et al.* 1991, Gustafson 1950, Lamendin *et al.* 1992, Maples 1978, Naylor *et al.* 1985, Wittwer-Backofen *et al.* 2004), and trabecular bone histology techniques (see Bocquet-Appel and Bacro 1997, Kotting 1977, Shranz 1959, Walker and Lovejoy 1985).

Caldwell 2003, Lee 1979, Lee and DeVore 1986, Sahlins 1968, 1972). Wood (1998) proposed a "MaB" (Malthus-and-Boserup) Ratchet Model, based on Boserup's (1965) exploration of the relationship between population pressure on extant resources and economic change. Finite resources stimulating economic intensification (Lee and DeVore 1986) eventually lead to demographic saturation, where, with minor variation, the growing population reaches equilibrium (Wood 1998). However, the samples Wood studied were cemetery samples, the contexts which formed over many generations. While overall patterns of population growth were relatively slow, local populations experienced cycles of equilibrium, expansion, and contraction during the use of the cemetery, suggesting the populations were always in a state of flux (Bocquet-Appel 2008, Bocquet-Appel and Naji 2006, Buikstra 1997, Dumond 1975, Frankenberg and Konigsberg 2006, Hassan 1981, Keckler 1997, Milner *et al.* 2000, Sattenspiel and Harpending 1983, Wood 1998, *contra* Boone 2002, Paine 1997). This concept of a dynamic population goes against original assumptions of stationarity, with skeletal samples seen as documentation for "life's failures at any particular age" (Wood and Milner 1994: 632). A stationary population is one that is closed to migration, has zero net growth, balanced age distribution, and unchanging fertility/mortality schedules (see Hoppa and Vaupel 2002). To assess population dynamics within the Cerro Mangote sample, the Juvenility Index, Gompertz-Makeham hazard model, and Siler hazard model are used. The theoretical aspects of the Index and hazard models are discussed here, with the particulars of the methods described in Chapter 5.

Juvenility Index. To assess growth in societies, Bocquet-Appel and Masset (1977) proposed the Juvenility Index, which is based on a strong correlation between birth and growth (Bocquet-Appel 2002). The current index, modified from the original, compares the number of skeletons between the ages of five and 19 to the number of all skeletons over age five, written as ${}_{15}P_5$ (Bocquet-Appel 2002, Bocquet-Appel and Naji 2006, Buikstra *et al.* 1986, Kohler *et al.* 2008). The initial ratios included infants and younger children, but research indicated including these individuals biased the ratio due to mortuary practices and preservation (see Bocquet-Appel and Naji 2006, Chamberlain 2009). The ratio indicates the changes in population growth rates through intrinsic shifts in age structure. It serves as a proxy for estimating the strong impact of fertility on population dynamics, compared to the relatively weak effects of mortality. Because the Juvenility Index is calculated for Cerro Mangote without comparative data, it currently only provides an initial estimate of population dynamics and characteristics. With comparative data, the index can describe temporal changes in the birth and growth within the given area.

Hazard Models. Contemporary paleodemographic analysis is first concerned with age-specific survivorship and hazard rates (Gage 2000, Gurven and Kaplan 2007). Hazard models are survival models, relating how the risk of death, or hazard, changes across lifespan. For most species, the risk of death is highest within the first weeks and months of life. Outside the developed world, levels of mortality are higher from birth to one year of age than at any other point in life (Hewlett 1991). After infancy, mortality declines dramatically, to a minimum risk of death between five and 10 years of age (Gage 2000). The risk of death increases slightly until approximately age 30, after which the risk of death increases steadily, though hazard rates never exceed those observed during infancy (Wood *et al.* 2002). Attritional age-specific hazards are typically represented using a U-shaped curve, with the steep sides representing the two phases of higher mortality rate (see Figure 4.2). Mortality profiles also highlight any population-specific features, including early childhood increase in mortality associated with weaning; increase in early adulthood mortality commonly associated with risky behavior and accidents; and a plateau in the risk-at-death for those who have exceptional longevity (see Gage and Mode 1993, Oeppen and Vaupel 2002, Rosetta and O'Quigley 1990).

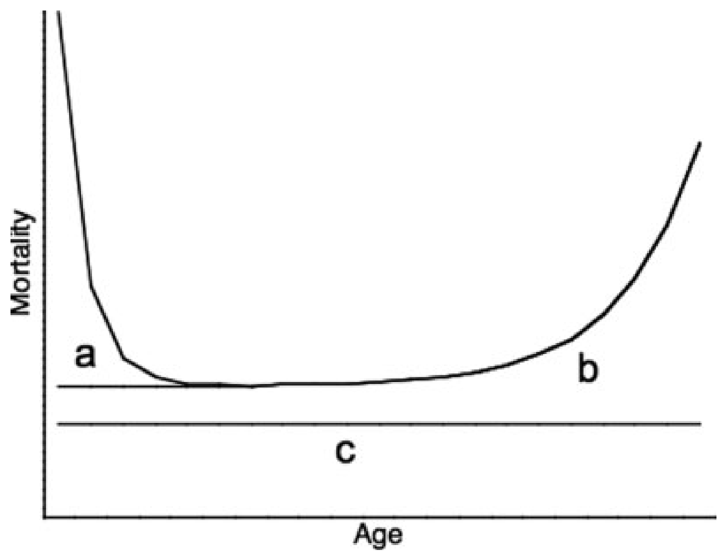

Figure 4.2: Age-specific hazard model (Gage 1991). 'A' represents the immature component, representing the immediate decline in mortality following birth. 'B' represents the senescent component, representing increasing mortality with increasing age. 'C' is the residual component, representing age independent risks.

Hazard models allow for age distributions to be expressed as dynamic processes, including the compounding affects of non-stationarity, varying growth rates, or the changing frailty levels of a particular age cohort (Ahmad and Bath 2005, Bronikowski *et al.* 2002, Gage 1988, 1989, Goggins *et al.* 2005, Halli and Rao 1992, Hinde 1998, Wood *et al.* 1992b, Wood *et al.* 2002). Because age-at-death patterns are applied directly to survivorship and age structure, selecting the best fitting model becomes critical (see Blossfeld *et al.* 1989, Box-Steffensmeier and Jones 2004, Gage

1989, Hoppa 2000, Manton and Stallard 1988, Wood *et al.* 2002). For the purposes of this analysis, parametric hazard models are the most useful, as they smooth the data in smaller samples (samples under 100 individuals), correcting inadequacies in the data. Since 'skeletal' age is categorical rather than continuous, the smoothing minimizes the gaps created by such categorical data (Eshed *et al.* 2004, Frankenberg and Konigsberg 2006, Hoppa and Saunders 1998, Usher 2000, Wood *et al.* 2002).

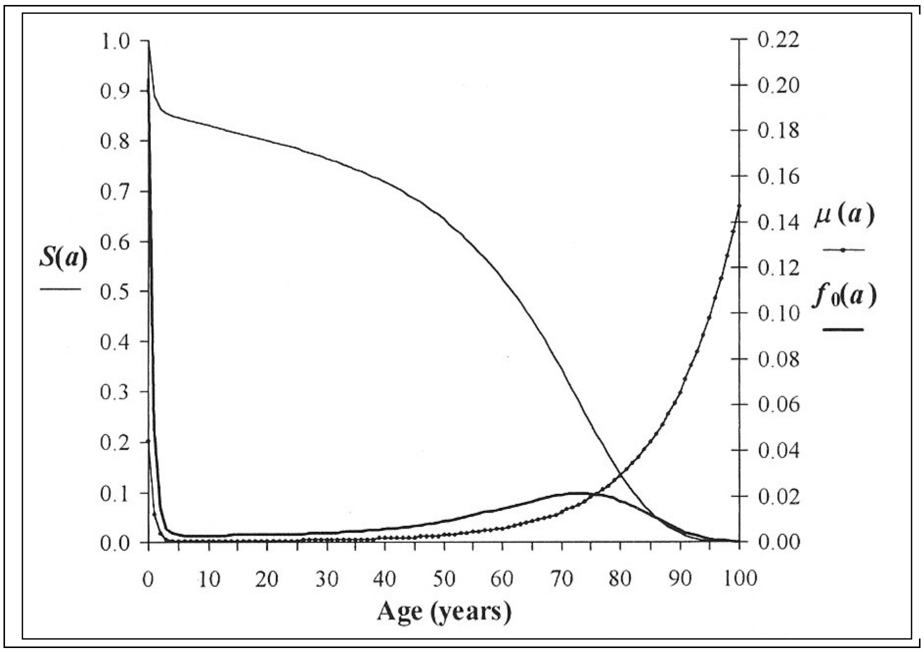

Figure 4.3: Functions used to estimate hazards: force of mortality, $\mu(a)$; survival function, S(*a*); and probability density function, $f_0(a)$ (from Wood *et al.*, 2002: 139).

Hazard models typically estimate three functions: force of mortality, $\mu(a)$; survival function, S(*a*); and probability density function, $f_0(a)$. Since these three functions are related, determining a solution to a single function allows one to estimate the remaining two functions, as depicted in Figure 4.3 (Cox 1962). The force of mortality is a non-negative function on a scale of zero to one, describing an age-specific mortality rate which is “the continuous analog of the central mortality rate” (Wood *et al.* 2002:133), or a mathematical smoothing of the categorical age data into a continuous rate. The force of mortality is higher during infancy, decreases in childhood and early adulthood and increases steadily during old adulthood, creating a U-shape.

The survival function indicates the probability of an individual surviving to a given age, relative to other individuals in the sample, with values close to one suggesting complete survival and those approaching zero indicating those that are less likely to survive. The probability density function estimates the mortality distribution for a sample subject to the age-specific force of mortality rates, from which the likelihood of the variable to occur at that point can be calculated. Combined, the slopes of the force of mortality and survival curves reveal the relative risk of death at a given age, whereas the probability density function estimates the mortality distribution while assuming a particular growth rate, typically zero (Wood *et al.* 2002).

Gompertz and Gompertz-Makeham. Two popular models for small samples are the Gompertz and Gompertz-Makeham parametric models for adult mortality, since they can describe mortality patterns with the smallest number of parameters, although both ignore the juvenile component of the sample (Wood *et al.* 2002). The Gompertz model estimates two parameters, α and β, through optimization where α “sets the overall level of adult mortality”, and β “determines how the risk of death accelerates with advancing age” (Wood *et al.* 2002: 146). Optimization is based on a computer algorithm determining the most likely parameters given the data. The Gompertz model assumes adult mortality is the result of attritional mortality, where the hazard is proportional to the physiological capacity of an individual at a given age (Gage 1989, Gompertz 1825, Wilson 2010). The Gompertz-Makeham model is a modified version of the Gompertz model that includes a third parameter (α1), which describes the residual component of adult mortality. This third parameter considers competing hazards independent of each other and of age, such as infectious diseases, accidents, and risky behavior (e.g., warfare). To include the juvenile cohort of a skeletal sample in hazard analysis, the model must include additional parameters that reflect high infant mortality rates with decreasing hazards as an individual ages.

Siler model. The five-parameter Siler model (Gage 1988, 1989, Gage and Dyke 1986, Gage and Mode 1993, Siler 1979) creates a best fit model that includes the mortality pattern for the entire lifespan of a sample using three competing hazards: immature (juvenile), residual (age-independent hazard from Makeham), and senescent (from the Gompertz model). The immature hazard includes α1 and negative β1, representing infant mortality and decrease in mortality with age. The Gompertz and Makeham hazards are consistent with those described above, but denoted as α3 and β3 for the Gompertz component and α2 for the Makeham component in the Siler model. While each hazard is assumed to be independent, there are similar origins with the three competing hazards and mortality patterns (Gage 1991, O'Connor 1995, Wood *et al.* 2002). That said, it is difficult to determine context, particularly of the juvenile component, because the young are highly susceptible to many hazards, including disease and accidents.

Each of these preceding models has the same weakness: the juvenile individuals are not used in the calculations, removing an important part of the sample (Gage 1989, Vaupel and Yashin 1985a, 1985b, Vaupel *et al.* 1979). Since paleodemographers ultimately seek to understand the interplay of individual frailty and population selective mortality, alternative hazard models, including mixed, multi-state, nested, and continuous variable models have been proposed (see Boldsen 2007, Herrmann and Konigsberg 2002, Milner *et al.* 2000, Milner *et al.* 2008, Usher 2000, Weiss 1990, Wilson 2010, Wood *et al.* 1992a, Wood *et al.* 2002). While these models explore differential frailty, the overall heterogeneity of frailty in living populations is minimally understood. Also, the added parameters of the alternative hazard models create more complex models, which require more data (or over-parametization) and move away from the original standard of a best fitting model (Wood *et al.* 2002). Due to the small sample size from Cerro Mangote, the Gompertz-Makeham and Siler models are considered in this analysis. Future research, incorporating more skeletal samples and regional data, could include nested models, deepening our understanding of temporal shifts in population dynamics in the Central Pacific Panama and Chiriquí highland regions.

4.3 The Osteological Paradox

Examining health in a cemetery sample can be problematic, particularly given that most diseases do not directly impact bone, and given every individual in a cemetery eventually succumbed to a hazard. Paleopathological analysis relies on the complete description and documentation of skeletal lesions. Lesion type and patterning throughout the body can indicate specific diseases or idiopathic conditions. While diagnostic acumen has increased, the interpretation of quality of life based on the lesions has shifted over the past few decades.

Prior to the 1990s, individuals were classified into two categories based on interpretations of lesions: the healthy and the sick. Skeletons with little to no skeletal lesions were classified as healthy, following the reasoning that since there was no bony response, there was no disease (see Steckel and Rose 2005). The second category, the sick, included the skeletons with lesions present, based on the reasoning that the greater number and severity of lesions indicates greater morbidity (e.g. Buikstra 1984, Cohen 1994, Cohen 1997, Ubelaker 1980). The classification of healthy versus sick provided early researchers with an easy means of comparison between different samples, and a simple scale to look at regional and temporal distributions of health. Cemetery samples were modeled as a direct link to the living population, and researchers treated cemetery mortality profiles as equivalent to census data or historical records (Acsádi and Nemeskéri 1970, Lovejoy *et al.* 1977, Weiss 1973).

Wood *et al.* (1992a), some of the first scholars to question these assumptions, proposed a reevaluation of the paleodemographic category of 'health' and its translation in the skeletal record, as well as the importance and limitations of skeletal samples in creating population profiles. They suggested three categories of individuals—those never exposed, the sick, and those who died prior to the expression of skeletal lesions. This new category allowed for the delay in skeletal response after the contraction of a disease, which would result in death prior to the formation of lesions, which were often caused by secondary or tertiary infections. Wood *et al.* argued that by accounting for disease processes, the individuals with the most lesions may have, in fact, been the healthiest, since their immune system had allowed them to survived long enough for the lesions to form (see also Ortner 1998). This reevaluation demanded that the lesion-free skeletons, formerly categorized as 'healthy', be expanded to include both individuals who were never exposed/never contracted a disease and individuals who died prior to developing a skeletal response.

The varying susceptibility of an individual to death is described as 'frailty' (Wood *et al.* 1992a). Though cemetery samples contain the frailest individuals of a living population, the susceptibility to disease and death varies by individual. Determining an individual's frailty is critical in distinguishing individuals who died in the early stages of an illness (before the formation of bony lesions) from individuals who never had the disease. By considering the impact of disease processes on both the individual and population, biological anthropologists can better understand how risk of death and frailty are related to the presence of lesions. However, many aspects of frailty are considered 'hidden.' The concept of hidden heterogeneity of frailty suggests that many factors – culture, age, nutrition, etc. – contribute to an individual's response to a particular pathogen or trauma, creating a pattern of frailty within a given population. While some commonalities exist (e.g. increased frailty among the oldest and youngest individuals), this varying frailty compromises analysis based on lesion frequencies, since presence/absence records are insufficient to determine the extent of the presence of a particular pathogen within a sample or population (see Wright and Yoder 2003).

After the publication of Wood *et al.*'s (1992) article, questions arose regarding the validity of their arguments and the ability to employ the osteological paradox in actual research[29]. Critics assert that the more traditional methods of comparison and interpretation remain valid. Some suggest the paradox can be resolved if multiple indicators of health are considered[30]. Wood and Milner (1994) maintain the indicators are all still the same type, only focusing on lesions that impact the skeleton. Though few researchers have successfully incorporated the concepts of the osteological paradox with methodology, Boldsen[31] and DeWitte[32] are notable exceptions. Their studies

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[29] A few recent publications, particularly in pathogen aDNA, have validated the theories by illustrating hidden heterogeneity. Zink *et al.*'s (2005) research on isolating tuberculosis aDNA in skeletons highlights the techniques for diagnosis and identification of marker IS6110. While the marker was confirmed in all individuals with diagnostic tuberculosis skeletal lesions, it was also sequenced from some individuals without diagnostic lesions, thus identifying individuals who died from tuberculosis prior to skeletal lesion formation.

[30] Of particular interest is the concept of looking at health based on group distribution of characteristics instead of focusing on individuals. By considering cumulative measures of health (such as long bone length) and time-specific measures of health (such as LEHs) it is argued that one can differentiate frailty (see Cohen 1989, 1994, 1997, Goodman 1993, Norr 1984). Contrary to this assertion, Wood and Milner (1994) maintain that reliance on skeletal lesions does not tell the researcher anything about pathogens that do not affect bone or do not create a lesion, greatly limiting the types of assertions one can make on the larger population.

[31] Boldsen (1997) first explored the concepts of differential frailty and selective mortality by examining the relationship between active caries and age at death. Using traditional analyses, no differentiation was apparent by sex; using polynomial logistic regression, the pattern indicated an age- and sex-specific pattern. Boldsen's study advances key concepts of the osteological paradox: first, by comparing active lesions (in this case, dental carries), Boldsen reduced the variance of frailty by excluding individuals who did not have lesions. Second, by analyzing

illustrate how one can consider the osteological paradox within the interpretations of disease in a cemetery sample. These concepts are illustrated next, through the reinterpretation of OSGE-80.

4.3.1 OSGE-80

OSGE-80 is a Preceramic site in Ecuador, occupied from approximately 10,000 – 6600 BP. The details of OSGE-80 mortuary context are discussed further in Chapter 5. Ubelaker (1980) made assumptions of health and population characteristics for the OSGE-80 site well before the theories of the osteological paradox were published. In this section, I seek to reconsider the published data in light of these new theoretical perspectives, particularly within the framework of the osteological paradox. First, the original paleodemographic profile of OSGE-80 was created based on life tables. Second, the assumption that the population was very healthy stemmed from the overall lack of lesions within the skeletal population. The conclusions drawn by Ubelaker (1980) can no longer be accepted without considering the history of the methodologies used to derive each result.

In his analysis of the demographic structure of OSGE-80, Ubelaker (1980) discusses the potential impact of selection, preservation, and excavation on the sample. Additionally, he questions the reliability of aging methods after age 40, limiting the oldest

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lesions by age-at-death, Boldsen revealed a sex difference in the cumulative risk of developing caries. More recently, Boldsen has expanded the concepts outlined in his 1997 study to include an examination of linear enamel hypoplasias, leprosy, and dental attrition (Boldsen 2005a, 2005b, 2007, 2008).

[32] DeWitte and Bekvalac (2010) also explore how dental disease can be used to assess general health in past populations. Using the historical population of St. Mary Grace Cemetery (12th – 14th centuries), in the United Kingdom, the researchers describe periodontal disease and dental caries using a transitional analysis. To determine if the two lesions can indicate differential frailty, the pathologies were analyzed using the maximum likelihood estimation (MLE) on the transitional scores. Their research indicates that periodontal disease and dental caries are associated with an increased risk of death within the sample. Though no attempt is made to associate the lesions with a specific disease, there does appear to be a correlation between the two dental pathologies and poorer health.

ages to 60 years, artificially truncating the growth dynamics of the sample. Ubelaker's original life tables were constructed using the methodologies outlined in Acsádi and Nemeskéri (1970) and Ubelaker (1974, 1978). Ubelaker concluded that, based on these life tables, life expectancy at birth at OSGE-80 was approximately 25 years; at one year, approximately 29 years; and that residents enjoyed a maximum life expectancy of 60. These are comparatively longer than at the later Valdivia sites, a characteristic attributed to the hunter/gatherer subsistence patterns.

Ubelaker created new life tables for the cemetery at OSGE-80 using model life tables. These new life tables were over-parameterized, meaning the variables within each table were calculated beyond the number of parameters estimated for age at death (e.g. a seven variable life table calculated from a five stage aging method). The over-parameterization, therefore, has negative degrees of freedom, meaning each age is as likely to be correct as any other possible age (see Jackes 2003, Frankenberg and Konigsberg 2006, Konigsberg and Frankenberg 2002). Also, the large proportion of infants and juveniles in the OSGE-80 sample impacts the life table parameters. Relatively small variations in fertility can impact age-at-death distributions more than modifications in mortality rates (Buikstra and Konigsberg 1985, Buikstra *et al.* 1986, Johansson and Horowitz 1986, Paine and Harpending 1996, 1998, Sattenspiel and Harpending 1983).

Ubelaker (1980) evaluated the OSGE-80 sample for two types of paleopathological markers: periosteal lesions on long bone shafts and indicators of dental disease. He associated the periosteal lesions with infectious disease, recording most lesions on the lower extremities as remodeling. The rates of infectious disease and dental disease were lower than observed in later skeletal samples in Ecuador; likewise, the sample showed lower rates of dental disease[33] than in later Ecuador skeletal samples. Based on these data, Ubelaker (1980, 1995) concluded that the skeletal sample at OSGE-80 was relatively healthy, especially when compared to later samples. The hunter-gatherer lifestyle was therefore considered to be less stressful on the inhabitants of the site than the increasingly sedentary and agrarian-based lifestyles of later groups.

Taking the osteological paradox into consideration, Ubelaker's interpretations of the skeletal data from OSGE-80 are less sound. The presence of periosteal lesions may not indicate the individuals who are sick, but the ones who survived repeated illnesses and were therefore healthier. The portion of the sample with no lesions is actually comprised of two groups: those who died before skeletal lesions could form and those who were never afflicted. So, the ratios Ubelaker compared to determine health between OSGE-80 and later sedentary sites are misleading, since they do not include individuals who died from infection prior to forming lesions. Moreover, the frequencies he compared to determine health across time cannot be directly compared to each other, since a higher frequency does not directly translate to more sick individuals.

The best evidence for the overall health of OSGE-80 comes from Ubelaker's (1980) observations on linear enamel hypoplasias (LEHs). LEHs are one of the few markers linked directly to stress during development that cannot be remodeled throughout life, unlike, for example, periostitis, which has an unknown etiology and can be remodeled. Less than one percent of the sample at OSGE-80 had LEHs on their permanent teeth. Compared to later Ecuadorian groups, OSGE-80 had many fewer LEHs, indicating that individuals in OSGE-80 were much less likely to have experienced stress during growth than later samples. Overall, the inclusion of the osteological

[33] Dental lesions include caries, antemortem tooth loss, and abscesses.

paradox does not negate Ubelaker's original assumptions on health; it merely adds more layers of complexity.

4.4 Summary

This chapter considered the importance of how skeletal samples are constructed. Chapter 3 outlines the impact of ritual on a cemetery, while Chapter 4 adds the impact of selection after ritual but prior to analysis can have on data. Particular attention was paid to the compounding variables that impact how the composition of the living population, mortuary process surrounding burial, and excavation and analysis impact the sample. Paleodemographers are interested in addressing reliability and statistical rigor problems within the age and sex parameters of osteological analysis. While new methods for determining age and sex have increased the number of individuals included in analysis, they also highlight the overlap in variables. This overlap is due to the variation within and between individuals, moving osteological analysis from discrete categorization to a more continuous system of characteristics.

Age and sex methodologies illustrate the inherent problems of early paleodemographic models and their assumptions. By better understanding these underlying assumptions, more realistic paleodemographic models have been created. Though still restrained by the resolution of the data, hazard models give an overall picture of mortality patterns by showing different types of risks at a given age, smoothing the data to create a mortality profile. These will be of particular use in analyzing the Cerro Mangote data. While no model is perfect, as each has a series of problematic assumptions associated with it, the hazard models best fit the Cerro Mangote data.

This chapter considered the impact of health on a population and the early assumptions of how ‘health’ appeared in a skeletal sample. Early paleodemographic models posited that skeletons with lesions represented sick individuals, while those without lesions represented the healthy. After the introduction of the concept of the osteological paradox, many bioarchaeologists reconsidered these early models in favor of a more complete view of health and the variety of effects that the healing process can have on an individual. In particular, the skeletal analysis at OSGE-80 was used to show the impact of this new thinking on the interpretation of data. The same type of consideration will be made when discussing the lesions observed at Cerro Mangote, with particular attention paid to LEHs as a potential indicator of health.

As discussed in Chapter 2, the excavations at Cerro Mangote included varying levels of selection (e.g., presence or absence of screens, focus of the excavation), as well as the taphanomic processes of the acidic soil. The original biological profiles at Cerro Mangote used parameters to assess the sex and age focused on cranial characteristics and the Todd method of age estimation of the pubic symphysis (McGimsey *et al.* 1987). Each individual was determined to be male or female, using point age estimates. The potential pitfalls of the two methods are discussed further in Chapter 5, since relying solely on cranial characteristics results in an overestimation in the number of males, and the Todd method estimates too narrow an age range. To expand the original skeletal analysis, the Cerro Mangote biological profile is reconsidered in Chapter 5.

CHAPTER 5: MATERIALS AND METHODS

This chapter reviews the methodology used in this dissertation to test the hypotheses detailed in Chapter 1. Since the crux of this research is grounded in skeletal analysis, the elements of the osteological analysis are discussed first. The methodologies include the estimation of the biological profile for each individual, and analysis of paleodemography, and anthropophagy. Next, I outline the methodologies needed to address the hypotheses and themes introduced in the previous chapters. First, the methodologies related to occupation are addressed. The archaeofaunal material is examined for patterns of use, taphonomy, and seasonality. The cemetery composition is explored using both comparative mortuary samples and biodistance. Subsistence patterning methodologies include musculoskeletal stress marker analysis, cross sectional geometry analysis, and a reconsideration of isotopic values. Finally, I describe the analyses used to assess health within the Cerro Mangote sample through differential diagnoses, focusing on infectious diseases and nutritional deficiencies.

5.1 Osteological Analyses

The osteological analyses include the biological profile, paleodemographic analyses, and anthropophagy. The biological profile includes estimations of age, sex, and pathology, with each section summarizing the typical methods utilized in studies and associated background information, following the concepts of standardized methodology and vocabulary. In addition, the methods used to record taphonomy, biometrics, and commingling are outlined. The paleodemographic analyses detail the data used and outcome of the Gompertz-Makeham and Siler models. Next, musculoskeletal stress markers and cross sectional geometry are considered, highlighting past studies that consider dietary patterns and the impact of skeletal growth. The corroborative statistics are also discussed. Finally, I consider the background and methodology of anthropophagy to assess claims of cannibalism at Cerro Mangote.

5.1.1 Biological Profile

5.1.1.1 Sex

Estimations of sex are based on the morphological differences of male and female skeletons. The methods used in this dissertation to determine sex for Cerro Mangote are found in *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). Sex estimations for Cerro Mangote included pelvic features, cranial features, and long bone measurements. Sex estimations are weighted toward the pelvic features to compensate for potential over-masculinization of elderly females (Walker 1995), as well as the more robust facial characteristics of the individuals at Cerro Mangote. For example, most of the mastoid processes, regardless of sex, were quite robust. While some dimorphic characteristics are apparent in juveniles, these can be unreliable as the individual was still growing and maturing (Scheuer and Black 2000).

Juvenile sex is recorded as “unknown.” The three exceptions are CO-40-6A, CO-40-21, and CO-40-31E, all of which are older juveniles (each is approximately 18 years of age).

5.1.1.2 Age

Biological analysis considers ages in categories (or age cohorts), as skeletal markers are restrictive in point age estimations. The age categories used in this study are (in years) 0 – 5, 5 – 10, 10 – 15, 15 – 20, 20 – 35, 35 – 50, and 50+ (Buikstra and Ubelaker 1994). Depending on the osteological markers for age that are available for a particular individual, a smaller range may be possible and was also recorded. Osteological analyses for determining age can be grouped into two main categories: adult and juvenile.

Adult aging techniques. To estimate adult age at Cerro Mangote, more weight is placed on age estimations from the pubic symphysis using the Todd (1920) and Suchey-Brooks (Suchey and Katz 1986) methods[34] and the auricular surface using the Lovejoy *et al.* method than on cranial sutures or rib phases. Overall, the fragmentation of the crania and ribs made these methods less reliable, which are discussed further below.

The surface of the pelvic ilium that articulates with the ala of the sacrum is called the auricular surface. Lovejoy *et al.* (1985a) evaluated over 350 remains from the Hamann-Todd documented collection, the Libben archaeological sample, and a few known forensic cases. It was found that, generally, bone density and porosity increase with age, while billowing, striae, and transverse organization decrease with age. Also, the coarseness of the surface bone texture increases until about age 45, when it then

[34] See Chapter 3 for an overview of the pubic symphysis.

transitions to dense bone. The auricular surface has advantages over the pubic symphysis methods, as age-related changes are independent of sex (Buckberry and Chamberlain 2002). Additionally, the auricular surface survives in the archaeological record better than the pubic symphysis. Although the auricular surface tends to underestimate the age of older individuals (Lovejoy *et al.* 1985a, Buckberry and Chamberlain 2002, Igarashi *et al.* 2005), it seems to be more accurate for younger skeletons than the Todd or Suchey-Brooks methods (Berg 2008, Djuric *et al.* 2007, Kimmerle *et al.* 2008, Mulhern and Jones 2004).

Previous studies of the Cerro Mangote collection have considered the sternal aspect of the fourth rib as an indicator of age (McGimsey *et al.* 1985). The hyaline cartilage that connects the ribs to the sternum ossifies over time. As a person ages, the edges of the rib grow to surround the hyaline cartilage, with the inferior edge margins changing from a V-shape to U-shape, as well as ossification of the superior and inferior margins of the surrounding cartilage. The pattern of ossification is related to age and can therefore be translated into approximate ranges of age at death (Ìşcan *et al.* 1984a, 1984b, 1985, Ìşcan and Loth 1986, 1989, Loth and Ìşcan 1989,).

There are limitations to this technique. First, rib sequencing requires a nearly complete complement of ribs, which may not be available in an archeological context due to poor preservation. Though ribs have similar properties of growth onto the cartilage and shape changes, this process does not occur at the same age on all ribs (see Loth and Ìşcan 1989) and still assumes that the exact rib and side is known. Also, due to the location of the rib in the body, there are age-related and wear-related changes associated with mechanical stress or movement (Kunos *et al.* 2001). This additional wear becomes problematic, as it can cause an overestimation in age of an individual who puts more stress on the junction (Burns 1999, Kunos *et al.* 2001, Kurki 2005). Given these methodological issues and the poor preservation of the Cerro Mangote sample, the sternal rib ends are not analyzed in this study.

Determining age using cranial suture union focuses on the changes to certain sections of the sutures between the vault bones of the skull. As individuals age, the sutures of the skull unite and ossify over time until the sutures are obliterated (see Baker 1984, Mann *et al.* 1987, Todd and Lyon 1924, 1925a, 1925b, 1925c). Most physical anthropologists contend that cranial sutures are too unreliable to solely determine an accurate age at death (Key *et al.* 1994, Masset 1973), but many still use sutures as part of a multi-factoral method of calculating age at death (see Lovejoy *et al.* 1985b). Meindl *et al.* (1985) examined 236 crania from the Todd collection and created a method of scoring 12 points on cranial sutures based upon earlier research done by Todd and Lyon (1924, 1925a, 1925b, 1925c). The points are divided into the vault and the lateral-anterior systems to determine age. The technique and scoring system becomes less reliable for older adults (Buikstra and Ubelaker 1994, Dorandeu *et al.* 2008, Harth *et al.* 2010). Given the fragmentary nature of the crania at Cerro Mangote, cranial sutures are used only as indicators of young, middle, and old adults, with the corresponding age ranges of 20-35, 35-50, 50+.

Juvenile aging techniques. Based on the availability of skeletal elements and my own familiarity with the method, priority is given to dental formation and eruption timing in juvenile age estimation in this study. Schaefer *et al.*'s tables on formation and eruption timing and corresponding ages are especially helpful in this regard, since they have been updated from Ubelaker (1989) to include more cultural variation in eruption timing (Schaefer *et al.* 2009 p. 94-95, see also Ubelaker 1999). Skeletal element union and skeletal element measurements were also used when available, but given the fragmentary nature of the remains, postmortem damage made exact measurements difficult.

Beginning at approximately five months *in utero*, the deciduous dentition begins to form, with the final changes in dentition occurring at approximately age 25 with the completion of the apex (see Hillson 1996, Thevissen *et al.* 2010, Ubelaker 1999). Overall, teeth form in the same pattern, including enamel formation and growth. Each tooth begins to form at the cusps of the crown, with mineralization occurring soon after development. After the crown forms, the tooth continues to grow root-ward, terminating with the closure of the apex. Each stage of development is recorded on a scale of 1 – 14 to describe this progression, and this scale is correlated to an age range (Moorreess *et al.* 1963a, 1963b). Studies have indicated that cultural and nutritional factors can impact the growth of teeth, though formation timing is more reliable and less susceptible to stress than eruption timing (see Hillson 1996, Liversidge and Molleson 2003, Moorreess *et al.* 1963a, 1963b). Furthermore, validation studies show variation in formation and eruption based on ancestry (see Dahlberg and Menegaz-Bock 1958, Garn and Moorrees 1951, Mayhall *et al.* 1977, 1978, Moorrees 1957, Steggerda and Hill 1942). When more samples are available from the region, the estimated ages should be correlated for the sample, following the methods suggested by Owsley and Jantz (1983).

In addition to the formation of a tooth, the eruption of different teeth occurs at specific ages. Eruption occurs when the tooth is moved through the oral epithelium into the occlusal plane. Ubelaker (1989) published a table of formation and eruption stages. Similar to bone union, a greater number of available teeth allows for a narrower estimated age range. Formation begins *in utero* with the anterior deciduous dentition and progresses through to the posterior molars. Eruption of the deciduous dentition also begins with the anterior dentition through to the posterior molars, beginning around nine months. The first permanent teeth to form and erupt are the first molars (forming around nine months and erupting around age six), followed by the incisors (nine months; six years) and canines (nine months; 10 years). The premolars (two years; 11 years) and second molar form and erupt next (three years; 12 years), followed by the third molar (nine years; 18-21 years). Typically, the mandibular permanent dentition erupts slightly earlier than the maxillary.

Osteological aging techniques are most applicable during the years an individual is growing, from before birth to about twenty-five years. Further, the growth period is sensitive to stress. Based on known samples of varying backgrounds, age at death is typically expressed in a range to account for potential environmental influences on the actual age at which bone ossifies, grows and unites. To narrow the range, multiple bones or other ossification centers are used to calculate an individual's age at death (Buikstra and Ubelaker 1994, Schaefer *et al.* 2009).

Skeletal growth focuses on two types of processes: endochondral ossification and intramembranous ossification. Endochondral ossification refers to the process of replacing cartilage at the growth plate. The epiphyses (ends of the bone) will eventually fuse with the metaphysis when the bone reaches maturity. Intramembranous ossification occurs when mesenchymal stem cells differentiate into osteoblasts (bone formation cells), creating bone spicules, which eventually ossify into the flat bones of the skeleton.

The timing of the formation, growth, and the ultimate fusion of these skeletal elements are patterned, even though the exact timing of the ossification and union depends upon many factors, including sex, nutritional status, hormonal status, and individual variation. Typically, a simple scale of open (0), partial union (1), and complete union (2) epiphyses can tell a great deal about the approximate age of the individual at the time of death (Buikstra and Ubelaker 1994). However, this method of aging is only useful if the deceased was less than thirty years old, since the epiphysis of the medial clavicle is united by then (Schaefer *et al.* 2009). After this time, adult aging methods must be used.

In addition to the development and union of bones, another option for determining the age of juveniles is osteometrics, particularly long bone measurements (see Schaefer *et al.* 2009, Tocheri and Molto 2002, Tocheri *et al.* 2005). This method is particularly effective in determining age in neonates and infants. Typically, age is correlated to the length of the diaphysis of long bones, or to the length and widths of other skeletal elements, such as the cranial bones. Hoppa (1992) cautions against direct application of age from other samples, due to variability in population-specific characteristics, and suggests correlating long bone length to dental ages when possible. Schaefer *et al.* (2009) have compiled measurements of fetal and juvenile bones from publications, allowing for comparison of archaeological samples and modern samples to determine age.

5.1.1.3 Paleopathology

Buikstra and Ubelaker (1994:107) introduce paleopathology as follows, "One of the most challenging aspects of skeletal biological study is the investigation of ancient health and disease. Although not all illnesses leave skeletal signatures, the study of abnormal bone can provide important information concerning an individual's health status." Skeletal pathologies are the result of either stress on the skeletal system or genetic abnormalities. The term 'stress' encompasses multiple aspects, including stressors during development, nutritional deficiencies, disease, diet, trauma, environmental factors, and many other details that frame the concept of health. In the following sections, I discuss dental pathologies, highlighting the commonly observed pathologies and interpretations. Then, skeletal pathologies are considered, including the descriptive and quantitative recording methods used. Photographs were taken using a Canon XSI. Radiographs were utilized to diagnose any questionable pathologies. The radiographs were taken using an Ultra-8016HF Portable X-Ray Unit and processed using a Navigator 2500 CR2500 portable digital imaging system. The majority of radiographs were taken at 60/.4 Kv/mA. Any deviation from these settings was recorded on the radiograph.

Dental pathologies. The collection of dental pathological data for this dissertation followed *Standards*, documenting occlusal wear, caries, abscesses, calculus development and linear enamel hypoplasias (Buikstra and Ubelaker 1994). Occlusal wear, or dental attrition, can indicate dietary components, as more dental attrition is correlated to relatively coarser foods (see Murphy 1959, Miles 1962, 1963, 1978, Smith 1984, Powell 1985, Hillson 1996). Moreover, specific wear patterns are caused by habitual behaviors, such as fiber processing or gripping pipe stems (see Cybulski 1994, Dumond 1975, Hillson 1996, Irish and Turner 1987, Larsen 1995). Occlusal wear is scored for incisors, canines and premolars following Smith (1984), assigning a score of 1-8 based on crown wear and dentin exposure. Molars are scored following Scott (1979), visually dividing the molar into four quadrants, assigning each quadrant a score of 1-10, and adding the scores together.

Dental caries, or the "destruction of enamel, dentine and cement" (Hillson 1996:269), have been correlated with the sugar/carbohydrate components of diets. Powell (1985) found that persons with diets rich in sugars/carbohydrates have an increased number of caries, as the bacteria consume the sugar and enamel is destroyed by their acidic waste products (see also Hillson 1996, Turner 1979). Buikstra and Ubelaker (1994) also indicate that as an individual ages, caries become more common, particularly if periodontal disease is involved; thus, they recommend analyzing caries in conjunction with age (see also Boldsen 2007, Lieverse *et al.* 2008, Paine *et al.* 2007, Vaupel *et al.* 1979). Related to caries are abscesses, or localized collections of pus (Hillson 1996). Commonly represented in dry bone as a small hole, abscesses indicate an inflammation of the inner portion of the tooth, or the pulp chamber, most often from severe caries. The bone was resorbed to create a tunnel to allow the pus to drain, typically around the root apex, and usually observed on the buccal aspect (Hillson 1996). Caries are scored 0 (no lesion) to 6 (large caries) based on location and extent following the scoring system in Buikstra and Ubelaker (1994), as well as visually on the provided dental arcade attachment.

The amount and location of calculus, mineralized dental plaque, can help infer diet type. Calculus is formed from accumulated microorganisms on a tooth's surface (Hillson 1996). Calculus can trap particulates that can be analyzed for dietary content, as well as illustrate both relative oral hygiene and carbohydrate consumption (Hillson 1996). The rate of deposit cannot be estimated since it is impacted by other cultural behaviors, such as brushing one's teeth or a gritty diet. Calculus is scored 0 (no calculus) to 3 (large amount) for each tooth, location, and visually recorded on the dental arcade attachment (Buikstra and Ubelaker 1994). Additionally, the location of calculus can illustrate an individual's dental health in life. Periodontal disease, or gingivitis, causes the gums to recede, which is evident postmortem if calculus is below the cementoenamel junction, or CEJ. For this dissertation, periodontal disease was scored as presence/absence.

The final dental pathology considered at Cerro Mangote is linear enamel hypoplasias, or LEH. Chapter 3 discussed the importance of LEH in the assessment of health in populations. Linear enamel hypoplasias are caused by deficiencies in enamel thickness (Hillson 1996). As ameloblasts secrete enamel during the mineralization of a tooth, any interruption or stress results in abnormal formation. Since the histological structure of the tooth is impacted, LEH are different than other types of enamel defects, though commonly confused with incremental lines of development (Hillson 1996, see also Goodman and Rose 1990). Incremental lines are defects in enamel from minor variations in growth, but unlike hypoplasias, tend to be shallow, narrow bands, whereas LEH are much wider and deeper.

Methodology. Dental inventories were created following Buikstra and Ubelaker (1994), consisting of presence, development, wear, type and location of caries, abscess(es), and calculus. Linear enamel hypoplasias were observed using a lighted magnifying glass. The presence of LEH was recorded by tooth, accompanied by descriptions and measurements from the cementoenamel junction to the defect following Rose *et al.* 1985 and Goodman and Rose 1990 (see Buikstra and Ubelaker 1994). Since the definition of hypoplasias is quite subjective, any possible hypoplasias were also described and recorded by tooth in a separate category, but not included in the final analysis. Additionally, to test the agreement of LEH diagnosis, current documentation was compared with Norr 1991. If a disagreement was noted, the defect was rechecked. The most common difference between these two assessments was the assignment of distinct enamel defects as LEHs by Norr (1991).

Skeletal pathologies. Paleopathological studies have utilized abnormal bone formations to explore stress relative to cultural and/or environmental factors (see Cohen 1989, Cohen and Armelagos 1984, Steckel and Rose 2005), history of diseases (Armelagos *et al.* 2005, Aufderheide and Rodriguez-Martin 1998, Buikstra 1981, Ortner

2003, Powell 1988, Rothschild *et al.* 1988, von Hunnius *et al.* 2006), differential diagnosis (Buckley 2000, Buikstra 1977, Ortner 2003), and occupational stress (Jurmain 1990, Kennedy 1989). Each of these types of study rely on consistent and specific descriptions of abnormal bone, including whether bone is formed or removed, where the lesion is located, if there is evidence of healing, and to what extent the lesion is healed/remodeled. The single largest problem in paleopathology is inconsistent descriptive terminology (see Buikstra and Ubelaker 1994, Ortner and Putschar 1985). Disease descriptions within the literature can vary widely, making diagnosis difficult. For the biological profile, the presence or absence of pathology was recorded for each skeletal element. For each pathology present, a description was recorded, along with measurements and photographs.

Some diseases have specific types of lesions or patterns of locations. Two common examples are tuberculosis (characterized by lytic lesions of the vertebrae and dorsal aspect of the ribs) or syphilis (diagnosed by caries sicca on the cranium, along with periosteal lesions on the tibia). However, many pathologies found throughout the skeleton are associated with periostitis, or inflammation of the periosteum, a connective tissue sheath covering the surfaces of bones (Buikstra and Ubelaker 1994). As a non-specific indicator of health, the etiology of periostitis is multi-causal, though it is pervasive in skeletal collections. Considered in light of the osteological paradox, periostitis lesions can indicate chronicity of infection, pointing to overall health in a population as individuals are surviving beyond the initial illness (Buckley 2000, Buzon 2006, Dabbs 2011, DeWitte and Bekvalac 2011). In addition to the above methodology, special attention was paid in the current study to the activity state of the lesion at time of death. If no healing was observed on the lesion, it was recorded as ‘active’; if healing and active portions were observed the lesion was classified as ‘chronic’; if no active portions were present and healing was present, the lesion was classified as ‘healing’.

These descriptions are further utilized as part of the differential diagnoses discussed below.

Arthritis. In addition to infections, osteoarthritis, a joint disease, can leave characteristic markers in the skeleton. Arthritis is considered a typically degenerative process with multiple overlapping etiologies, including age, joint use, trauma, and pathology. Ortner (2003) comments that arthritis has previously been subdivided into two categories: hypertrophic (or osteoarthritis) and atrophic arthritis (or erosive). This dichotomy, however, is restrictive, since most cases of erosive arthritis also have areas of bone growth associated with the lesions, as suggested by Rogers *et al.* (1987) (see also Waldron 1992, Waldron and Rogers 1991). Lesions associated with osteoarthritis include osteophytes (horizontal bony projections that form at joint margins), enthesophytes (bone projections that form at a tendonous or ligamentous attachment sites), and eburnation (degeneration of subchondral bone at the site of cartilage erosion) (definitions from Buikstra and Ubelaker 1994).

For this study, each pathology was recorded by skeletal element using the above nomenclature, along with a description and measurements of the location. Diagnosis of types of arthritis followed the suggestions of Rogers *et al.* (1987), which considers not only the types of lesions (proliferative or erosive), but also the pattern (symmetrical, asymmetrical, mono- or polyarthroses), and locations (synovial joints, vertebrae, axial or appendicular) throughout the individual in differentiating the types of arthritis.

Trauma. Trauma can include partial or complete breaks in bone, displacement or dislocation of joints, disruption of nerve or blood supply, or culturally induced shape changes (Ortner 2003). The types of trauma observed on bone can indicate particular patterns of behavior, including indications of abuse, warfare, or medical treatments. The causes of trauma can range from intentional or accidental violence to cultural modifications. If a bone is fractured, the fracture is classified based on the direction and type of force (e.g. tension, compression, or twisting). If the individual survives the trauma that caused the fracture, his body will begin to heal, which will also be visible on dry bone. How a fracture heals can indicate the degree of medical care present in a society, such as if the bone is set or not.

Any potential trauma in the Cerro Mangote sample was recorded by skeletal element with descriptions, measurements and photographs accompanying each potential trauma. The non-dental pathologies were recorded using the terminology suggested by Buikstra and Ubelaker (1994). Each pathology was recorded by skeletal element, with descriptions, measurements, and photographs accompanying each pathology.

While more emphasis is typically placed the differential diagnosis of a disease, paleopathological analysis begins with distinguishing between pathology and normal variation. Growth, for example, impacts the overall morphology and increases porosity, particularly at the metaphysis. As the ends of long bones unite, the metaphysis becomes more vascularized, occasionally resembling periostitis. Also, postmortem modifications can resemble pathologies. While postmortem changes to dry bone are easier to identify, bone retains collagen for years after death and burial. Postmortem damage to bone with collagen can result in damage that mimics trauma. The taphonomic processes resulting in these pseudo-lesions will be discussed in the next section.

5.1.1.4 Taphonomy

As discussed in Chapter 2, many processes affect skeletal remains between death and excavation. Buikstra and Ubelaker define taphonomy as “the investigation of processes that affect an organism from its death until the point at which study commences” (Buikstra and Ubelaker 1994: 95; see also Behernsmeyer and Hill 1980, Efremov 1940, Gifford 1981, White and Folkens 1991). Previous chapters have discussed the variety of processes that may impact how skeletal elements, both human and non-human, enter the archaeological record. In addition to differential inclusion in the archaeological record, taphonomy includes processes that impact the structure and appearance of the bone. While there are many processes occurring within the depositional environment, understanding changes in coloration, surface changes, and shape changes are particularly important in aiding in the identification and diagnosis of antemortem and perimortem changes, as well as understand the environment in which the individuals were interred after death.

A variety of cultural practices and postdepositional changes can impact the color of untreated bone (Buikstra and Ubelaker 1994). Cultural practices could include exposure to heat or inclusion of metal objects in the burial (see Buikstra and Ubelaker 1994, Devlin and Herrmann 2008, Symes *et al.* 2008). Differential coloration may also be due to soil minerals, bacteria, or plants, sometimes resulting in many different colors on a single skeletal element (Baxter 2004). For this study, color was coded using the Munsell soil color charts.

Causes of surface changes to the cortex of the bone include heat, plant roots, insects, soil characteristics, erosion, scavengers, or human activity. Surface changes are important to consider in differentiating taphonomy from disease processes. Plant roots, for instance, can etch patterns onto bone that mimic vessel paths (White and Folkens

1991). Acidic soil conditions, particularly in the tropics, can compromise bone structure by degrading and leeching the minerals that create the bone matrix (Buikstra and Gordon 1981). Rodent gnawing and carnivore tooth marks from scavengers have been confused with human activity, particularly cannibalism, but characteristics of the parallel grooves from incisors can clarify the origin of these marks (White and Folkens 1991). Human activity can affect bone near the time of death/burial, such as cut marks made during mortuary rituals, or result from excavation, such as damage from a trowel or shovel. For the Cerro Mangote sample, each defect was recorded for presence/absence and type (perimortem or postmortem damage), the location was described, and observations were recorded as to why the defect was categorized perimortem or postmortem damage. Any questionable markings were also measured and photographed for further analysis or consultation.

The analysis of shape changes considers the importance of perimortem and postmortem factors that can cause modifications of the bone (see Buikstra and Ubelaker 1994). Determining the source of fragmentation in the Cerro Mangote sample is of particular interest in this study. The first step in realizing this goal is to note if the changes occurred in dry bone (postmortem) or fresh bone. Galloway (1999) outlines the characteristics of bone, particularly the importance of the presence of collagen in the bone matrix. Collagen, one of the components of bone, gives it the compressibility needed to function, particularly the necessary flexibility to withstand movement. This flexibility can be seen in perimortem (such as spiral fractures or greenstick fractures) and postmortem fractures, prior to the collagen degrading. One common taphonomic change is the occurrence of ‘pressure lesions’; pressure from the weight of the soil on fresh bone can cause it to depress, forming concentric circles that resemble pathology or trauma in perimortem bone (Hagland and Sorg 1997). Examining of the edges of the fractures helps to distinguish perimortem from postmortem damage, since the edges of bone fractured postmortem are much sharper than perimortem breaks.

Recording. For the Cerro Mangote sample, taphonomic changes to bone were recorded following Buikstra and Ubelaker (1994), listing each skeletal element, type of modification, and a description of the modification and location. Particular attention was paid to the presence of excavation damage and rodent damage, since previous observations suggested cannibalism as a possible practice in the living society. Additionally, the soil composition at Cerro Mangote, particularly the high shell component, created lesion-looking adhesions on the bone, making documentation and description critical to separate pathologies from taphonomy (for examples, see Chapter 6). The margins of the adhesions proved to be the most useful diagnostic tool in distinguishing adhesions from pathologies. Under magnification, the edges of pathologies still resembled bone structure, whereas adhesions typically had a much more granular texture, imbedded with various soil elements (sand, stone, shell fragments).

When possible, skeletal fragments were sorted by the most specific terminology possible – in some cases, bones could be identified and sided, but in most cases fragments were recorded by bone type (e.g. long bone, cranial bone, ribs). Fractures were separated into dry bone (postmortem) breaks and fresh bone (antemortem or perimortem) breaks, with dry bone fractures attributed to postmortem breaks and any fresh bone breaks assessed using radiographs. The radiographs are particularly useful in examining the degree of remodeling in fractured bone and diagnosising the fracture type. Radiographs were taken using an Ultra-8016HF Portable X-Ray Unit and processed using a Navigator 2500 CR2500 portable digital imaging system. The majority of radiographs were taken at 60/.4 Kv/mA. Any deviation from these settings was recorded on the radiograph.

Tooth marks were assessed using common morphological traits of potential scavengers. For rodent gnawing, paired parallel markings are common, due to the structure of the incisors of the various species of rodent in the area. Carnivore damage is most commonly observed at the epiphyses of long bones, with a pattern of pitting, scoring, and puncturing, typically from the canine teeth and first molars.

Damage from excavation is most easily differentiated based on the coloration of the bone. Perimortem or pre-depositional cuts are typically the same color as the rest of the bone, whereas postmortem cuts have a lighter color than the rest of the skeletal element. Additionally, the placement of the marks can help distinguish intentional dismemberment from excavation damage. In the former case, it is much more common to see many short cuts near articulation points of limbs or the head. Excavation damage tends to be much more random and leave only a single marking.

5.1.1.5 Biometrics

Cranial and postcranial measurements have been used in bioarchaeological research to describe and compare individuals and illustrate population variation (see Blumenbach 1776, Jantz and Owsley 2001, Jantz *et al.* 1995, Konigsberg 1987, Morton 1839, Relethford *et al.* 1980). Genetic and microevolutionary studies prompted a more uniform measurement standard, encouraging not only consistency within the discipline (Martin 1957, Moore-Jensen *et al.* 1994), but also permitting multivariate statistics. Most studies focus on cranial measurements to highlight variation, morphology, and cultural relationships of groups of people (Blangero 1990, Konigsberg 1988, 1990a, 1990b, Steadman 1997, 1998, 2001, Williams-Blangero and Blangero 1989). Postcranial measurement studies explore genetic influence in addition to nutrition, stature, and activity patterns (see Bridges 1989, DiBennardo and Taylor 1983, Frayer 1980, Iscan and Cotton 1990, Krogman and Iscan 1986, Trotter and Gleser 1958, Ruff *et al.* 1984, Ruff *et al.* 2006b, Ubelaker 1999, Van Gerven 1972).

For the present study, long bone measurements were taken in millimeters following the recommendations of Buikstra and Ubelaker (1994). The measurements recorded in the data forms for maximum tibial length include the malleolus, following the suggestions of Jantz *et al.* (1995), since early publications occasionally omitted the malleolus (see Trotter and Glesser 1952). Measurements were taken using the suggested implements, including an osteometric board, sliding calipers or digital calipers. The long bone measurements of the humerus and femur are used as part of cross-sectional geometry analysis of Cerro Mangote. At this point, stature will not be calculated for the sample since the present formulae for stature are calculated for modern Central and South American populations. Due to the compounding affects of 5000 years of longitudinal growth on skeletal samples, as well as the impact of colonialism and mixed ancestry, living stature calculations would not be accurate for the sample at Cerro Mangote.

5.1.1.6 Commingled remains

Skeletal elements from multiple individuals in a burial are referred to as commingled remains. Commingled remains can occur in a number of contexts, including ossuaries, multiple burials, and secondary burials. Remains may also be commingled during the excavation process, such as the accidental removal of two individuals from closely spaced or stacked burials (Ubelaker 2008). Commingling during or after excavation may lead to misplaced interpretations of the site, since it is often mistaken in subsequent analyses for evidence of mortuary practices (see Chapter 3).

The excavation notes for the 1956 and 1957 – 1958 field seasons at Cerro Mangote typically designated a “main” burial or burials. Commingled individuals were separated during my analysis when additional skeletal elements were encountered. Burials were considered to be truly commingled if they met any of the following three criteria: if a skeletal element was repeated (e.g. two left femurs), if skeletal elements belonged to at least two individuals of clearly distinguishable age groups (e.g. juvenile remains combined with adult remains), or if skeletal elements belonged to at least two individuals of clearly distinguishable sex groups (e.g. a male individual and a female individual). A biological profile was created for each individual, following the methods described above for burials recorded in the archaeological notations. Data were collected for age, sex, measurements, pathologies, and taphonomies.

Since the three excavations at Cerro Mangote used two different accession systems, the system was repeated for the commingled burials. The 1955/1956-1957 excavations assigned a number based on the location in Panama (CO), the site number (40) and the order in which the individuals were found (1, 2, 3). If additional individuals were located after the number was assigned, letters (and sometimes numbers) were assigned to those individuals (e.g. 6A, 6B, 6C; 31A, 31B, 31C, 31-1C). Individuals recovered in the 1979 excavation were assigned the same location and site number (CO-40), but were labeled based on pit number (68, 69) and occasionally their location within the pit (E (east), C (center), W (west)).

For commingled burials recovered during the 1955 and 1956-1957 excavations, individuals are denoted by which burial the elements were associated with, to ensure documentation of the original location of the individual (e.g. CO-40-25-1, CO-40-22B adult, CO-40-22B juvenile). In some cases, based on previous analysis, the identification numbers were not assigned in alphabetical order. For example, after the destruction of burial 19 in the field, the majority of the remains were labeled “19G” in the first laboratory analyses. To avoid confusion, none of the discrete individuals were labeled CO-40-19G, resulting in intentional gaps in the lettering. The majority of burials encountered during the 1979 excavation were multiple burials, with no designation of a “main” burial. To create biological profiles for these individuals, the burials were identified using the assigned field number and age (e.g. CO-40-68E/fetal, CO-40-68E/child6yo, CO-40-68E/adult).

5.1.2 Paleodemographic analysis methodology

Using the biological profiles from the preceding analyses, paleodemographic analysis was conducted to construct population structures. Mortality estimates were plotted on the R statistical programming environment (Version 2.13.1, http://www.r-project.org/). The estimates for age-at-death were assessed using the Kaplan-Meier survival function to assess the goodness of fit. The data were then analyzed using parametric hazard models, specifically the Gompertz, Gompertz-Makeham, and Siler hazard models. The “optim” function in R was used to find the best fit of the parameters, with finite scaling used to maximize the hazard parameters. Based on the negative log likelihood values –where lower numbers (more negative) mean a better fit of the model – the success of hazard models is measured based on convergence, or minimization for the model’s parameters. Negative log-likelihood values are measures for the fit of competing models by stressing if data are known and should be used to test against competing hypotheses (Edwards 1972, Fisher 1922, Hilborn and Mangel 1997). The

Gompertz and Gompertz-Makeham models proved to be inappropriate, as only individuals over age 15 can be used, greatly reducing the Cerro Mangote sample.

The Siler model proved to be the best fit for the current study, as the model utilizes the whole sample (all ages), and is particularly useful for smaller samples (see Gage 1994, 1989, Vaupel and Yashin 1985a, 1985b, Vaupel *et al.* 1979, Wood *et al.* 1992a, Wood *et al.* 1992b, Wood *et al.* 2002). The force of mortality equation for the Siler model is:

$$\mu(a) = \alpha_1 e^{-\beta_1 a} + \alpha_2 + \alpha_3 e^{\beta_3 a}$$

and the survivorship model is:

$$f0(a) = (\alpha_1 e^{-\beta_1 a} + \alpha_2 + \alpha_3 e^{\beta_3 a}) \exp\left[-\frac{\alpha_1}{\beta_1}(1 - e^{-\beta_1 a}) - \alpha_2 a + \frac{\alpha_3}{\beta_3}(1 - e^{\beta_3 a}) \right]$$

where μ is a distinct set of competing causes of death[35]. The force of mortality equation illustrates the rate of mortality at a given age. Survivorship approaches zero with increasing age, with the distribution illustrating the overall pattern of age distribution in the sample. Since these models depend on a point estimate for age, rather than the range accepted by Buikstra and Ubelaker (1994), point age was estimated as the median value of the absolute age range. For example, individual CO-40-1D represents a child between 0 – 5 years. The dentition formation is consistent with an absolute age range of approximately 3 – 4 years. The age used to represent CO-40-1D was therefore 3.5 years.

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[35] As discussed in Chapter 4, the three components in the Siler model are the immature hazard (includes α_1 and β_1), the Gompertz hazards (α_3 and β_3), and the Makeham hazard (α_2).

5.1.3 Anthropophagy

Background. Anthropophagy, commonly called cannibalism, or the practice of eating human flesh, has had a widespread stigma in history and archaeology (see Arens 1979, Salas 1921). While used as propaganda against natives of some countries, archaeological evidence corroborates the act of anthropophagy in the past (see Caceres *et al.* 2007). Fernandez-Jalvo *et al.* document anthropophagy in the Pleistocene in their study of the Gran Dolina site (1996, 1999), as well as in Neandertal populations (see Russell 1987). Researchers considered anthropophagy practices in two main categories – one focusing on the social relationship of those consumed (endo- and exocannibalism), and the second focusing on the motivations behind it (gastronomic and ritual cannibalism) (see Pickering 1999, Villa *et al.* 1986, White 1992).

For the most part, archaeological evidence for anthropophagy is based on taphonomic damage, making the systematic identification of taphonomic changes due to cannibalistic practices critical to establishing its existence. Turner (1983) initially proposed 14 criteria to indicate anthropophagy, later prioritizing the list to five:

1. deliberate bone breakage,
2. cutmarks,
3. evidence of cooking (including pot polishing),
4. abrasions caused by anvils, and
5. absence or crushing of vertebrae (Turner 1983, Turner and Turner 1992).

Critics comment on two main mistakes in the criteria. First, these five criteria do not include the presence of human toothmarks, which would be a more direct link to anthropophagy (see Botella and Aleman 1998, Botella *et al.* 2000, Caceres *et al.* 2007). Caceres *et al.* (2007) point to the common association of toothmarks with crushed cancellous bone as an indication of cannibalism. Additionally, other studies have questioned the reliance on cutmarks as definitive evidence for cannibalistic practices

(Caceres *et al.* 2007). While the original and revised standards proposed by Turner are unclear, methodology in later publications (Caceres *et al.* 2007, Turner and Turner 1992) imply the evidence are to be used as corroborating evidence, and do not individually indicate anthropophagy. In the case of Cerro Mangote, initial commentary suggested that cutmarks and fragmentation are consistent with anthropophagy, a claim that is further investigated in Chapter 6.

Methodology. To assess anthropophagy, the skeletal elements of Cerro Mangote are compared to the prioritized criteria in Turner and Turner (1992). Based on the fragmentation of the collection, particular attention is paid to the characteristics of the bone at the time of damage – either from dry bone (and therefore taphonomic) or living bone (and therefore perimortem). The determination for dry or living bone are made following the same criteria described in section 5.3.1.4 regarding taphonomic changes in bone. Based on the characteristics of the bone, perimortem or postmortem fractures and perimortem or postmortem cut marks can be assessed. The margins of the fractures and cut marks are also assessed and described. In addition to Turner and Turner's criteria, the presence of toothmarks and crushing are assessed, following suggestions of Caceres *et al.* (2007). The presence/absence of each criteria were recorded for each skeletal element, with any present anthropomorphic modifications recorded through measurements of the location (if applicable), photography (using the Canon XSI digital camera), and sketches.

5.2 Archaeofaunal analysis in the Neotropics

The archaeofaunal record provides an opportunity to examine the interrelationship of human populations and the environment. Reframed through historical ecology (Stahl 2008), archaeofaunal investigations can focus on “cultural and historical production of landscapes which shape cultural experience by retaining the material manifestations of human action” (Stahl 2008:7). Since these changes did not have a specific goal or trajectory, the interplay between the environment and humans were not isolated from each other, but varied in response to the other (see also Balee 1989, 1992, 2006, Crumley 1994, Heckenberger *et al.* 2007, Scoones 1999). The faunal record at Cerro Mangote, in combination with the regional faunal record of Parita Bay, helps indicate how resources were utilized at Cerro Mangote, and potentially if the resources were exploited seasonally or year-round. However, some caution is necessary.

Despite the considerable biodiversity of the region, Borrero (2008) states that compared to other biologically diverse regions across the globe, the Neotropics are far less understood due to uneven study in the region (see also Gutierrez *et al.* 2007, Mengoni Gonalons 2004) and differential preservation of skeletal elements can affect their identification and relative abundance in archaeofaunal samples[36].

Grayson (1981) cautions against the use of taxa as variables and proposes using taxa as attributes, where the presence or absence is recorded. He states the simplicity of the analysis is the key to its success – the present taxa need certain conditions to live,

[36] A complete understanding of the formation of an archaeofaunal deposition, particularly in the Neotropics, is difficult to evaluate, as the number of processes creating the deposit varies widely. Stahl (1995:155) suggests archaeofaunal deposits are the result of a series of complex, interrelated variables, including (but not limited to), “indigenous cultural strategies of food acquisition, transport, distribution, and consumption; how disposed bone is subsequently altered; and how microvertebrate remains accumulate in burial contexts.” Each of these concepts is further complicated by variations in abundance, differential preservation of skeletal elements, and recovery methods used in archaeological excavation (see Lupo 2007, Lyman 1982, Lyman and Fox 1989, Stahl 1995, 2008). As stated above, the multiple excavations at Cerro Mangote are an excellent example of selection from archaeological methods. Initially, fish was not considered, since the archaeofaunal remains “were not present” – clearly, the 1979 excavation illustrated that the lack of fish was not selection by the inhabitants, but by the lack of screens used in excavation. Finally, although the acidic soils of the Neotropics are typically blamed for skeletal material loss, Stahl (1995, see also Borrero 2008, Stahl 2008) stresses that the relationship of deposition and loss are not nearly as linear as they may appear.

which can be used to interpret the paleoenvironmental meaning. Grayson (1981: 35-36) warns of the pitfalls of the presence/absence assessments, particularly the assumptions of environmental stability, the assumptions that current understandings of organism needs are transferable to the needs of past taxa, and problems within the archaeological context (including transport and stratagraphic mixing) (see also Axelrod 1967, Bailey 1936, Cody 1974, Graham 1976, Grayson 1977, Haury 1976, Findley 1964, Lack 1968, Reitz and Wing 2008). Additionally, the commonly calculated measurements of abundances, NISP (number of identified specimens) and MNI (minimum number of individuals) are not actual abundances, but estimates (Grayson 1979). Further, these estimates are based on the final accumulation of taxa and cannot show fluctuations in abundance throughout the accumulation. In other words, the taxa studied are the final result, with an infinite number of possible combinations creating that result.

For example, larger mammals tend to be relatively rarer in neotropical environments (Eisenberg 1978, Eisenberg 1990, Hershkovitz 1972), and when consumed by humans, their skeletons are processed much more than smaller vertebrates (see Stahl 1991). Though accounts vary, if a larger animal is killed, the animal may be butchered at the kill site (leaving the less desirable portions at the kill site), divided between the hunters, selectively returned to the site for consumption, processed and preserved to prevent spoilage, and finally disposed of after consumption (see Bianchi 1988, Hames 1979, 1980, Hames and Vickers 1982, Jones 1984, Stahl 1995, Vickers 1980). Rather than focusing on the relative abundance of larger mammal bones to reconstruct subsistence, Stahl (1995) suggests attribute-level analysis of the spatial and temporal variation of geophysical and environmental characteristics to ascertain the assortment of niches present in the paleoenvironment (Grayson 1981a, 1981b, 1988, Lyman 1986, Lyman and Livingston 1983, Pearsall 1995).

In order to examine site use based on present archaeofaunal material, I assembled a list of the identified species based on excavation notes, previous publications, and personal communications with the researchers. These species are listed in Appendix 3. For each species, I summarized the relevant characteristics regarding habitat or migration routes through Panama. The interpretations of the data are framed within the current understanding of the taphonomic patterns observed within the Neotropics. The presence of particular species are addressed, but abundance or frequencies are not, given the above reasons.

5.3 Cemetery organization

To assess the questions and hypotheses regarding the cemetery, the overall organization is considered, when compared to other Ceramic and Preceramic sites. The comparative sites, Las Vegas, Ecuador; La Paloma, Peru; Chinchorro, Chile; and Cerro Juan Diaz, Panama, were chosen based on their location and time of occupation/use. Additionally, Las Vegas, La Paloma, and Chinchorro are commonly utilized in comparison in other research (see Quilter 1989). Next, the methodologies considered in biodistance are used to describe the specific spatial organization of Cerro Mangote. Finally, the methodologies for recording activity markers and the reinterpretation for isotopic signatures are explored to describe the impact of subsistence patterning on occupation is explored using and isotopic markers.

5.3.1 Cerro Mangote Sample

Prior to assessment, the skeletal sample of Cerro Mangote was estimated between 70 – 90 individual, with approximately 70 individuals recovered in the 1955 and

1956 – 1957 excavations, and approximately 12 individuals from the 1979 excavations. The skeletal material is highly fragmented, with many individuals still commingled after the initial separation by Texas[37]. For the most part, the archaeofaunal material and material culture artifacts are curated separately from the human skeletal material. In addition to the skeletal remains, I had access to the original, handwritten notes from all three excavations, field photographs, and maps. The handwritten notes included not only details on the stratigraphy and location, but also burial position and any associated artifacts. In some cases, data collection forms for Norr's analysis and Texas's analysis were present, but the majority of the data sheets consisted of summary forms or cover pages. The methodology and notes from Norr's and Texas's analyses were not present for assessment.

5.3.1.1 Cerro Mangote material culture

The most common artifacts recovered at Cerro Mangote were chipped stone tools and flakes. The chosen material for the flakes and cores varied widely, including cryptocrystalline silicates, petrified wood, quartz crystal and andesite. Ranere (n.d.) indicates that the tools were constructed on flakes removed from irregular or bifacial cores by hammerstone percussion (see also Linares and Ranere 1980, Ranere 1979a, 1979b, 1980). After creation, these flakes are used for a variety of tasks, but rarely modified or retouched. Ranere (n.d.) also noted that the post-depositional modification of the flakes had destroyed the majority of wear characteristics – due both from thermal alteration from hearths as well as heavily weathered surfaces.

The tool types found at Cerro Mangote are consistent with assemblages found at partially coeval Aguadulce and Ladrones, and are considered typical of central

[37] See footnote 26 for discussion as to why the initial researchers are referred to collectively as "Texas".

Panamanian Late Preceramic sites (Griggs 2005, Ranere 1980, Ranere and Cooke 1995, 1996). The Central Panama lithics sequence differs from that of highland Chiriquí. For example, whereas the Talamanca Phase tool kits used many diagnostic tools, e.g., large bifacially flaked splitting wedges and large unifacially flaked scraper-planes (Ranere 1980, n.d.), central Panamanian industries tend to have few diagnostic tools in the Late Preceramic (for the full tool kit description, see Chapter 2.3.1).

In addition to flaked tools, a number of cobble and boulder tools were recovered at Cerro Mangote. The edge-ground cobbles (also called edge-grinders) have one or more of the edges of the cobbles used as a working surface (Ranere 1975, n.d., 1980, Ranere and Cooke 1996). The boulder tools are consistent with milling stones, most likely the bases for the edge-ground cobbles, commonly recovered at both Preceramic and Monagrillo phase ceramic sites (Cooke 1977, Ranere 1975a, 1975b, 1980, n.d., Ranere and McCarty 1976, Willey 1971, Willey and McGimsey 1954). Based on starch grains recovered from edge ground cobbles and boulder milling stone bases from Late Preceramic sites in both Central and Western Panama, these tools were used to process a variety of domesticated and wild species, including maize, manioc, arrowroot, yam, leren and *Zamia* cf. *skinneri* (Dickau et al. 2007, Piperno et al. 2000). Use of these tool types at Cerro Mangote for food processing is reinforced by Piperno's (2011a) finding of maize starch on a metate.

Very few of the tools collected were made from bone. Both the 1956 – 1957 and 1979 excavations collected some examples of worked bone, but only the 1979 excavation recovered shaped and polished awl fragments. McGimsey *et al.* (1987) reported five fish vertebrae that appeared to be worked to form bead-like disks, but only one showed evidence of perforation. Much more common were shell ornaments and tools. McGimsey (1956, McGimsey *et al.* 1987) reported only shell ornaments[38], the majority of which were found in direct association with burials (an individual), and the remainder found within 15 cm of burials (recorded as 'burial groups' in the excavation notes) (McGimsey *et al.* 1987:130). The first type of bead was found with Burial 19C and in association with burial group 1. Burial 19C had a necklace of 53 beads with holes drilled from both ends. A single shell bead was identified with Burial Group 1 (see Appendix 2). The second type of bead was included in a necklace of 361 beads, associated with Burial 19F, and was made from a univalve, thought to be *Terebra robusta Hinds*. Finally, shell pendants, cut from bivalves, were found with Burial 31B' (seven pendants), Burial Group 22 (three pendants), and Burial Group 1 (one pendant).

Ranere (n.d.) found both shell ornaments and tools in the 1979 excavation. The latter consisted of similar material found in McGimsey's excavations, including both bone and stone. None of the ornamentation appears to be in association with an individual, however, the majority of the burials were disturbed prior to the 1979 excavation (Ranere n.d.). In addition to the shell beads, Ranere described a distinctive shell tool made from the column and spiral, of *Hexaplex regius* (large gastropod). With the outer shell removed, the remaining interior resembled a handle or shaft of a pestle (Ranere n.d.). In addition to the worked shell, many shells were broken in a manner inconsistent with simple access to the meat. While Ranere (n.d.) called for further analysis on the modification, nothing has been published to date.

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[38] McGimsey *et al.* (1987) also reported finding artifacts most likely not part of the original settlement at Cerro Mangote, including a curly-tailed monkey pendant and 30 pottery sherds. Identified by Lothrop (1937), the curly-tailed monkey pendant is associated with Sitio Conte, a polychrome pottery site in the Parita Bay (450 – 900 AD) (see Lothrop 1937). The ceramic sherds were consistent with the local Monagrillo style pottery but, due to the proximity to the surface, McGimsey *et al.* (1987) concluded the evidence "strongly indicates that they are all late arrivals, perhaps the result of a trip by a single individual to the hilltop centuries after its abandonment" (132).

5.3.2 Comparative Samples

Since there are so few comparative cemeteries from the Preceramic time period, most researchers compare the burials to any available sites (see Stothert 1985, Quilter 1989). While some sites are separated by many miles, comparison across the entire South American continent within the Preceramic period is common. In the case of Cerro Mangote, the sites of OSGE-80, La Paloma, and Chinchorro, discussed below, do offer additional information on broad patterns regarding the treatment of the dead. For a comparison within Parita Bay, the recently excavated site of Cerro Juan Diaz offers some interesting comparative characteristics. The Ceramic site (2350 – 350 BP) burials have a few characteristics in common with Cerro Mangote, suggesting a possible cultural connection between these two sites.

5.3.2.1 Las Vegas, Ecuador (multiple sites)

The Vegas period of coastal Ecuador (10,000 – 6500 BP), was characterized by mixed subsistence, including hunting, gathering, fishing and horticulture (Piperno and Pearsall 1998, Piperno *et al.* 2000a, Stothert 1985, 2003). Phytoliths from two of the larger Vegas sites, OGSE-80 and OGSE-67, indicate both wild and domestic types of *Cucurbita* (squash), were exploited by 9,000 BP, with clear cultivation and selection, demonstrated by a pattern of increasing phytolith size, throughout the Las Vegas period (Piperno and Pearsall 1998, Piperno and Stothert 2003).

The Las Vegas culture of Ecuador includes at least 30 sites on the Santa Elena Peninsula, on the southern coast of Ecuador. The radiocarbon dates indicate an occupation from approximately 10,000 – 6,600 BP. Overall, the archaeological evidence suggests the Las Vegas people were hunters, gatherers, and generalized horticulturalists, since both bottle gourd and early forms of maize phytoliths have been identified at the site (Piperno and Pearsall 1998, Stothert 1985). While the majority of the sites excavated are processing sites, a few suggest semi-permanent or permanent sedentism (Raymond 2003, Stothert 1985). Additionally, Stothert (1976) notes the similarities in the chipped stone tool assemblages to those described at Cerro Mangote (see McGimsey 1956, McGimsey *et al.* 1987, Ranere n.d.). Based on the landscape, stone tool assemblages, and burials (see Chapter 3), Stothert (1976, 1985, 2003) proposed a sphere of interaction between northern Peru, Ecuador and Panama (see also Ranere n.d., Richardson 1978).

Of particular interest is OSGE-80 (or Las Vegas 80), as it has both living structures as well as the interments of 192 individuals. Four direct radiocarbon dates from skeletons suggest that the majority of the individuals died in the late Las Vegas period (8,250 – 6,600 BP) (Stothert 1985, Ubelaker 1980). The biological profile of the sample indicates 55 males and 63 females, 122 adults and 70 subadults, with an age range from approximately nine months to over 60 years (Stothert 1985). There are no indications of cranial modification, calluses from kneeling, or dental modification in the Las Vegas sample, which are typically present in later skeletal samples in the region (see Ubelaker 1979, 1995, 2003; Ubelaker and Jones 2002). The observed pathologies consist of mainly lower leg lesions which were interpreted as evidence for a pre-agricultural society (Ubelaker 1980). In comparison to later, agrarian skeletal samples, Ubelaker (1980, 1988, 1995) concludes that the sample indicates a relatively healthy population with few pathologies, no indications of vitamin deficiencies or trauma, and few dental pathologies. Finally, demographic extrapolations from the sample suggest a greater life expectancy at birth at OSGE-80 than later sites in the region (Ubelaker 1980, 1995). As discussed in Chapter 3, the conclusions regarding the health and demographic profiles of OSGE-80 were created prior to acknowledgement of the osteological paradox. The conclusions assume that sicker individuals in the population had skeletal lesions, and utilize life tables to construct paleodemographic models.

The individuals were excavated from 65 burial features within approximately 200m^2. The types of interments varied, with primary, secondary, individual and multiple burials, as well as ossuaries present at the site (Stothert 1985, Ubelaker 1980, 1988, 1995). While few artifacts were found in direct association with burials, Stothert notes the number of stones collected with each burial. Throughout prehistoric Ecuador, archaeologists have noted the importance and presence of stone offerings with burials; moreover, the most commonly referenced examples occur at OSGE-80, as well as the later Valdivia site of Real Alto (Raymond 1998, 2003, Stothert 1985, 2003). Stothert (2003) comments that:

> …stones have various meanings in burial contexts. At Site 80 [OSGE-80], the large stones recovered from the top of an infant burial and the grave of the Lovers of Sumpa[39] indicate a magico-religious gesture meant either to shield the dead from evil spirits or protect the living from the dead…the stones were placed over the major anatomical joints, considered by some Native Americans to be the bodily source of vitality. (376)

Raymond (2003) suggests, based on the apparent correlation between burial orientation, age, and sex, that OSGE-80 may have been a ceremonial center, potentially explaining why OSGE-80 is one of only a few Las Vegas sites with burials, and by far, the greatest concentration of burials. He drew parallels with the later Valdivia culture, inferring that the close association of burials with the houses suggests the Las Vegas practiced ancestor worship, and that the recovered stones were offerings. Stothert (1985) also commented that the burial types imply cultural affiliations extending to Preceramic

[39] The “Lovers of Sumpa” refers to a burial encountered at OSGE-80 of a man and a woman, with age estimations between 20-25 years. The burial is described by Stothert (1988) as “carefully buried in the following way: the man with his right hand on the woman’s waist (the right femur above the pelvis)…and one arm above his head. Both skeletons were oriented to the east, something unusual for a man in the Vegas cemetery. Another unusual aspect is that six large, unmodified stones were placed over the couple once they were buried” (137, translation mine). Stothert (1988) goes on to comment that while the use of stones is not unusual, the meaning is unknown. Further, the stones appear to have been placed after death, as the observed fractures were consistent with postmortem damage, not fresh bone.

groups along the coasts of western Panama, Colombia, and northern Peru (see Chapter 3 for the comparison of Las Vegas burials and Cerro Mangote burials).

5.3.2.2 La Paloma, Peru

La Paloma is located on the Pacific coast of Peru, near the Chilca River, on the edge of the lomas and the Quebrada de los Perdidos portion of the Chilca Balley drainage system. Uncalibrated dates suggest the site was occupied between 5700 BC – 2800 BC (Benfer 1990, Quilter 1989). At the time of occupation, the Pacific Ocean was about 3 – 4 km west and the river 7 – 8 km south of the main portion of the site, suggesting drinking water would have been scarce at the desert site. The site contained approximately 42 reed huts and 150 individuals. Excavated from 1973 – 1979, the archaeologists (from 1973 – 1975, excavated by Engel; from 1976 – 1979 excavated by the University of Missouri, led by Benfer) confirmed three subdivisions of time through stratigraphy and radiocarbon dating (7000 – 5500 BP, 5500 – 5200 BP, and 5200 – 4600 BP). Surrounding the huts were pits, possibly used for food storage, hearths, and burials (see Benfer 1990 and Quilter 1989 for descriptions).

No clear pattern of village organization was found, so extrapolations of population size at the time of occupation are difficult. Consensus suggests between one to 10 families occupying the site at any one time (Benfer 1990, Quilter 1989). Benfer (1986, 1990) proposes two groups occupied the site with a second group settling the area between 5500 – 4600 BP, indicated by the introduction of semi-subterranean stone structures (such as pits lined with stone). The burials were relatively well preserved, with the majority of individuals flexed with the hands covering either the face or the pelvis. They were buried beneath the floor of the house, with the location attributed to age and sex, since the center was reserved for a male, thought to be the patriarch of the family.

There were a few burials found outside the house structures, that were associated with outsiders/peripheral members of society or individuals who died while away (Benfer 1990, Quilter 1989).

For the most part, few burial goods were found in association with burials, particularly during the earlier occupation periods. The exceptions to this were infants, who were buried more often with objects made from non-local material, and both unmodified and modified shell. Quilter (1989) discusses the marked difference between other prehistoric societies that bury infants outside the normal social rites of the group and the burials of infants at Paloma. Quilter suggests the unique treatment of infants at Paloma seems to indicate that the population believed infants were full members of the group. Also, the number of offerings increased, including hearth rocks, other fire related objects, and complete destruction of the house over the central male burial (Benfer 1990).

The paleodemography of the site was reconstructed using life tables, and suggested a high infant mortality rate (42%), a general life expectancy of 20-35 years, and twice as many females dying after 30 years (Benfer 1986, 1990; Quilter 1989). Across the two occupations, Benfer (1986) called attention to the change in infant mortality, as the second occupation had a lower infant mortality rate; subsequently, Benfer (1986, 1990) suggested the change in infant mortality indicated an improvement to the population’s adaptations to the desert site, even though there was no increase in the life expectancy of adults. The rate of females dying after or around age 30 has been used as evidence of delayed childbirth in the population (Quilter 1989). Finally, Barjenbaruch documented cases of tuberculosis, carcinoma, broken feet and “ailments also related to cultural practices, especially in regard to subsistence economies” (1977: 20-21). However, the details of the “ailments” are not listed, making comparison difficult. The most likely candidate is arthritis, which is further discussed by Rhode (2006) in terms of potential activities. For example, osteoarthritis of the lower back was documented in adults of both sexes, and is attributed to carrying heavy loads for long distances. The musculoskeletal stress markers documented in the sample indicate the primary source of food was marine, with plants from the lomas as a secondary source (see Benfer 1990, Rhode 2006, Quilter 1989).

5.3.2.3 Chinchorro, Chile

While other cultures within the Andes practiced mummification, few cultures have received as much attention as the mummies from the south central Andes in Chile. The Chinchorro mummies are the oldest example of artificial mummification in the world, with types of preparations including defleshing, cleansing of the bones, wrapping in fibers, refleshing and the application of artificial substances, such as pigment and animal fur (see Alison *et al.* 1984, Guillén 2005, Quilter 1989, Uhle 1919, 1924, 1974).

Dating between approximately 8000 – 3500 BP (calibrated), there are approximately 1500 burials associated with the Chinchorro culture of the Atacama area. The harsh desert conditions had few seasonal resources or springs, but the nearby sea contained vast resources; moreover, archaeological evidence suggests the cultures alternated between hunting grounds and coastal settlements. The majority of the cultural materials associated with the Chinchorro culture include fishhooks (made from shell, cacti, and composite materials), harpoons, lithic knives, throwing sticks, darts, and reed fiber baskets, all used as burial offerings (see Arriaza 1995, Guillén 2005). Arriaza (1995) also notes that an “absence of ceramics, woven textiles, and metal artifacts typifies the Chinchorro Culture” (36). There are proposed separations within the long occupation periods of the area, typically based on technological change and burial treatment types, but the finer differentiations of the periods are still under debate (see Arriaza 1993, Bird 1943, Rivera 1975, 1991, Standon 1997, Quilter 1989).

The burials of Chinchorro were recovered from almost a dozen sites. Initially, burials were naturally mummified through desiccation from the arid desert winds. Through time, different types of artificial mummification have been described, including Black, Red, Bandage and Mud-Coated (see Arriaza 1995). While artificial mummification began at approximately 7000 BP, by 5500 BP, all members of the group, including juveniles and fetuses, were mummified in some manner, suggesting that by this time, the practice of mummification was not based upon status or gender (Standen 1997).

Since artificial mummification does not appear to be in association with status, questions as to how it originated in the culture and the reasons for mummification are of interest. Arriaza (1995) suggests that the ecological occurrence of natural mummification in the early periods of occupation may have encouraged experimentation with the process, hence the wide variety of mummification treatments over time. Schiappacasse and Niemeyer (1984) propose that artificial mummification began with children and then progressed into other burial practices. While the origin of the process is still under investigation, most researchers agree that the reasons for mummification are based in ancestor worship (see Guillén 2005). Cockburn and Cockburn (1980) proposed that artificial mummification in other cultures exists based on the belief that the soul will not survive if the body is not preserved. Chinchorro illustrates the wide variety of manners a culture can practice ancestor worship, a concept further explored in section 6.1.

5.3.2.4 Cerro Juan Diaz, Panama

Cerro Juan Díaz, a Ceramic period Central Pacific Panama site, is believed to have covered at least 100 ha, stretching across both banks of the Río La Villa (Cooke

2005, Haller 2004, Isaza 2004). The site was occupied continuously between approximately 2400 – 350 BP; the success of this site is attributed to its location (Cooke *et al.* 1998). An important agricultural settlement, the seaside hilltop setting allowed for not only a strategic advantage, but also access to coastal resources (Cooke *et al.* 2000, 2003; Díaz 1999). As part of the *Proyecto Arqueológico de Cerro Juan Díaz,* the site was excavated from 1991 – 2001, led by Richard Cooke. The goals of the project included the reconstruction of the social organization, economy, and community relations at the site during occupation (Cooke *et al.* 1998, 2000; Díaz 1999).

While some of the archaeofaunal analysis is pending, Cooke *et al.* 2007 summarizes some of the findings from the theses created from the excavations (see Carvajal 1998, Jimenez 1999, May 2004). There is a higher proportion of rats[40] than at other sites, which can be attributed to the higher amounts of stored food at the site. Additionally, the hunting patterns include deer and iguana, more closely resembling early ceramic sites than later ceramic period occupations (Cooke and Martin 2010, Cooke *et al.* 2007). Similar to Cerro Mangote, Cerro Juan Diaz contains faunal material native to the Caribbean side of Panama, suggesting direct or indirect contact with the groups settled across the Continental Divide (Cooke and Martin 2010, Cooke *et al.* 2003).

Dog remains are found both in domestic and funerary contexts, with a higher abundance at the site than agouti or peccary. Initial observations suggest the size of these dogs is comparable to modern breeds (see Cooke 2003, Cooke and Ranere 1992a, Ichon 1980). Cooke *et al.* 2007 detail the variety of ways dog bones are utilized, including the teeth and paws in jewelry. These decorations are considered amulets, suggesting the living population greatly valued the dogs for their abilities in hunting and protection. The site contains many examples of worked bone for decoration, typically

[40] The rats at Cerro Juan Diaz belong to the Heteromyidae and Muridae families.

necklaces. Found in burial contexts, these necklaces imply different statuses for individuals. For example, Cooke *et al.* (2007:582) state, "At Cerro Juan Díaz, a necklace of teeth of puma (*Puma concolor*) and one with tusks of this species and jaguar (*Panthera onca*) were found associated with people whose attire suggests they were healers or shamans (Cooke 1998d, Cooke *et al.* 2003)[41]." These two types of talismans are common in later ceramic cemeteries.

Excavations encountered a series of burials documenting a sequence of cultural changes, as burials became more elaborate throughout time. The later time periods also indicate an increased importance in status, with differentiation of burials based on grave goods (for descriptions, see Cooke and Sanchez 1998, 2004, Díaz 1999). Of particular interest to this study, though, are the earlier burials. The earlier phases of burials include those cut into the bedrock, creating a circular, stone lined feature. Each of these burial shafts contain a number of individuals, with both primary and secondary burial treatments. The stone shaft arrangement is unique to Cerro Juan Díaz (Cooke *et al.* 1998:136), however, the secondary burial treatments bear a striking resemblance to the bundle burials of Cerro Mangote (see Figure 5.1). The arrangement of the skeletal elements appears consistent with McGimsey's (1956, McGimsey *et al.* 1987) description, but the burial goods are a marked difference between the two sites. In the pit illustrated in Figure 5.1 indicates multiple interments over multiple ceramic periods, since Cooke and Sanchez (1998) record worked puma and jaguar canine teeth, a decorated gold plate, four *Spondylus* beads, five pieces of polished agate, and a worked gastropod (*Calliostoma*), which is native to the Caribbean coast. The juxtaposition of the

[41] Please note Cooke *et al*. (2007:582) is originally published in Spanish. The original text is below. Any errors in translation are purely the fault of the author, not the original researchers. "The En Cerro Juan Díaz, un collar de dientes de puma (Puma concolor) y otro con colmillos de esta especie y del jaguar (Panthera onca) se hallaron asociados con personas cuyo atuendo sugiere que eran curanderos o chamanes (Cooke 1998d; Cooke *et al.* 2003)."

burial offerings with similar burial style illustrates a possible reworking of the rituals observed at Cerro Mangote.

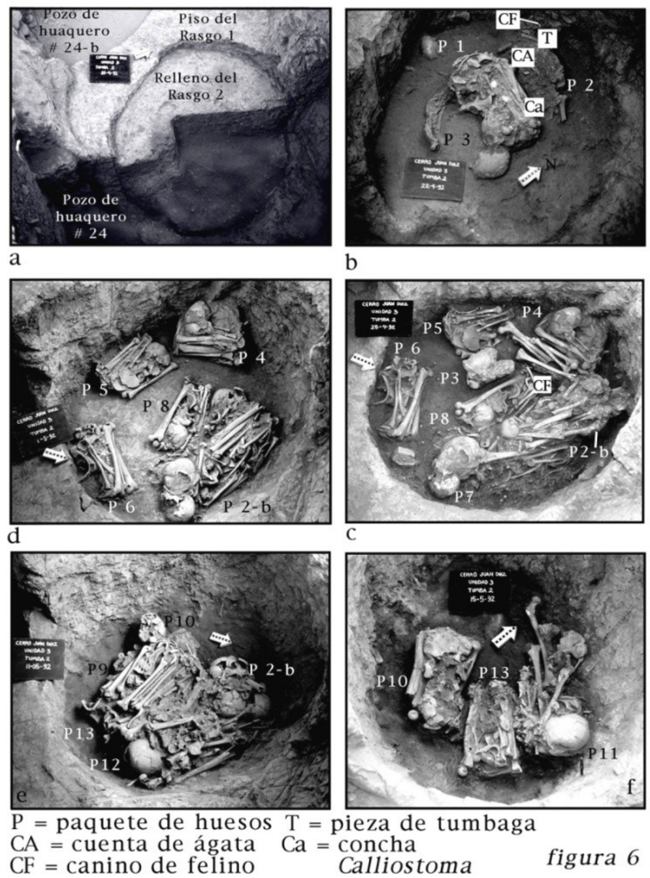

Figure 5.1: Examples of secondary burials at Cerro Juan Diaz from Resago 2 (photograph from Cooke pers. comm. 2012).

5.3.3 Biodistance and dental metrics methodology

Biodistance studies analyze patterns of morphological variation, based on microevolutionary theory, or relatively small changes to the genetic pool of the population, to reconstruct population history. Population history denotes the relationships of ancestors and descendants, inferred from evolutionary histories based on morphological features to recreate historical connections (Relethford 1996). The rates of gene flow are determined by the reproductive population size, calculated by the distribution of genetic patterns within a subgroup or sample (Chakraborty 1990, Konigsberg 1987, 1988, Relethford 1991, 1996, 2004). The importance of biological distance studies was first highlighted by Buikstra (1977), who considered biodistance an essential tool in bioarchaeology to provide contextual information regarding population structure, diet, and disease in a community (Buikstra 1977, 1984, Larsen 1997).

Biodistance studies stem from the concepts considered in postmarital residence studies, which examine where males and females settle after marriage, creating a sex-specific pattern of inheritance illustrated by morphological variance (see Kennedy 1981, Konigsberg 1987, 1988, Lane and Sublett 1972, Relethford and Blangero 1990, Spence 1971). In within-group analyses, such as the present study of Cerro Mangote, the sex with the greater mobility is the sex with greater dental variability (see Schillaci and Stojanowski 2003). Schillaci and Stojanowski (2003) provide the following example:

> For example, a situation of greater male variability is consistent with the in-migration of largely unrelated males coincident with a matrilocal residence pattern, assuming nonprescribed group exogamy. The nonmobile sex is theoretically composed of related individuals that tend to exhibit similar phenotypic variance and covariance for all genetically determined traits due to common descent. (7)

Thus, the most variation indicates either virlocality (residence with the husband's relatives) or uxorlocality (residence with the wife's relatives) (Konigsberg 1987, Lane and Sublett 1972).

Biodistance studies have utilized osteological indicators to illustrate biological relations, including dental metrics, dental morphology, non-metric cranial traits, and cranial metrics, (see Adachi *et al.* 2003, Bondioli *et al.* 1986, Byrd and Jantz 1994, Howell and Kintigh 1996, Konigsberg and Buikstra 1995, Steadman 2001, Stojanowski 2001, Stojanowski and Schillaci 2006, Strouhal 1992). Researchers have utilized dental metrics as a measurement of genetic inheritance since the 1800s, as indicators of evolutionary processes through phylogenetic relationships (Alt *et al.* 1998, Brace 1967, Cocilovo and Rothhammer 1999, Cope 1874, Greene 1972, Scott 1979, Smith 1977). Though some studies have tried to quantify the amount of genetic, cultural, and environmental influence on dental metrics (see Dempsey *et al.* 1995, Kieser 1990, Lundstrom 1948, Potter *et al.* 1978, Potter *et al.* 1983), most researchers agree that dental metrics have "moderate to strong genetic control" (Stojanowski 2001:158).

There are five primary assumptions in biodistance analyses that must be considered in the interpretation of the results. First, skeletal samples are not natural biological populations, but temporal lineages. Similar to the concepts of paleodemography, Cerro Mangote and other cemeteries cannot be equated to a living population, as the cemetery represents individuals who lived and died over a long period of time, not contemporaneously. Biodistance considers the environmental effects on variation within populations to be minimal or randomly distributed among individuals, since all the individuals are considered to be equally exposed to the hazards. In terms of genetic changes, biodistance studies asserts that changes in allele frequencies result in measurable changes in skeletal traits and that the variation inheritance is additive, since multiple genes each have a small effect on the trait, resulting in strong resemblance among relatives. As stated above, the relationship between dental metrics and genetics has been well documented, so these assumptions imply that, given dental measurements, those most similar to each other indicate the individuals who are most similar, or related, genetically. Finally, if mutation rates and selection effects are held constant, then genetic drift and gene flow affect neighboring populations sharing similar environments. This final assumption will become more important for the Cerro Mangote sample when regional comparative data is available. It assumes that these regional samples will display similar genetic changes since they are all in the same environment (see Stojanowski and Schillaci 2006, Stojanowski *et al.* 2007).

Kinship analysis. Kinship analysis is based on the premise that members of a family are more phenotypically similar to each other than to unrelated contemporary individuals (see Alt and Vach 1998, Stojanowski 2005, Stojanowski *et al.* 2007). Kinship analysis seeks to identify members of family groups based on two criteria: the shared presence of rare or anomalous phenotypic traits or greater metric similarity among presumed relatives. Overall, the dental morphology at Cerro Mangote exhibits few of the non-metric traits considered by Buikstra and Ubelaker (1994). Thus, dental metrics provide a main avenue to explore relationships within the cemetery structure. Metric variation manifests as similarity in size and shape of skeletal elements, including dentition. This phenotypic similarity results from family members sharing genes that are identical by descent, since close relatives are more likely to share traits (Konigsberg 2000, Thompson 1986). Dentition size has been consistently correlated with mitochondrial DNA sequences (Kieser 1990, Stojanowski 2001, 2005).

Intra-cemetery studies consider postmarital residence practices and patterns of kinship relationships (see Corruccini and Shimada 2002, Shimada *et al.* 2004) to determine social organization through these biological signatures (see Stojanowski and Schillaci 2006). Intra-cemetery research counters recent critiques of biodistance analysis, which claim biodistance analyses are typological models, merely classifying skeletal features by characteristics and nothing more (Armelagos and VanGerven 2003, Houghton 1996; contra Stojanowski and Buikstra 2004). Since intra-cemetery research does not specify the exact nature of genetic relationships among individuals, it does not reduce traits to essentialized categories, instead providing a framework to consider relationships within a bound model (see Knudson and Stojanowski 2008).

Cerro Mangote. In-group assessment of kinship analysis is based upon three groupings of burials, delineated by columns (see Figure 5.2). Since membership to these

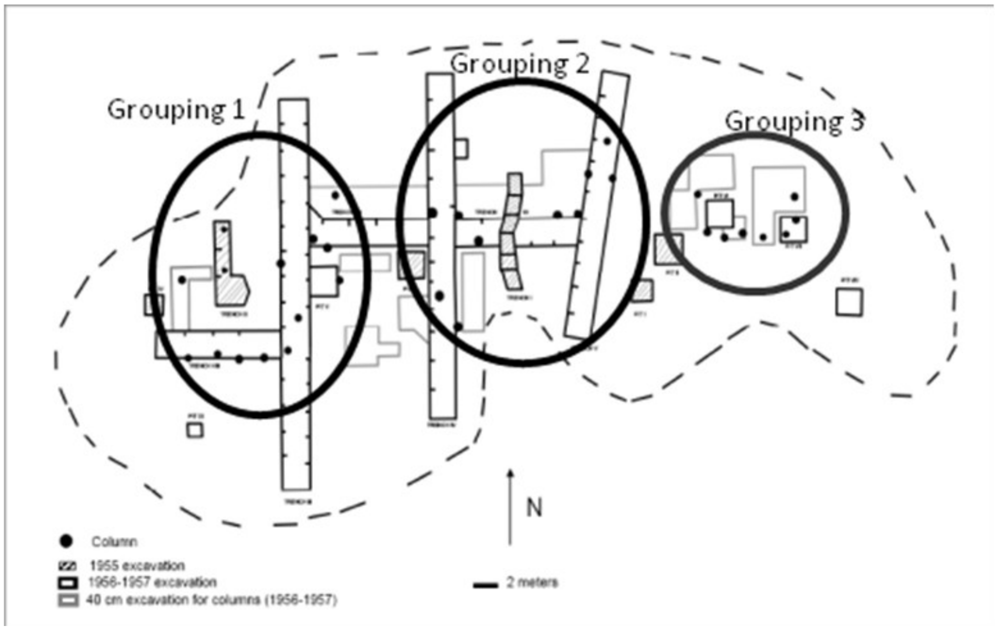

Figure 5.2: Three column groupings use in biospatial model

three groupings is defined *a priori*, principal components models investigate the homogeneity within the burial groupings (see Alt *et al.* 1995b, Howell and Kintigh 1996, Jacobi 1996, 1997, 2000, Stojanowski and Schillaci 2006, Stojanowski *et al.* 2007). Preliminary analysis of the cemetery indicated a variety of burial treatments (e.g. primary, secondary), orientations (e.g. common cardinal direction or orientation of skull), locations, and demographic characteristics (see McGimsey 1956, McGimsey *et al.* 1987, Ranere n.d., n.d(b).). McGimsey *et al.* (1987:133) believed that the array of behaviors may suggest the burial of multiple "social groups" who used the site. However, the burial techniques do not necessarily translate to multiple groups, since it is difficult to surmise the ritual followed by the population when burying individuals (see Chapter 3 for variation in cemetery).

One possible commonality between the burials is the overall location in the cemetery. As illustrated in Chapter 2, all of the burials at Cerro Mangote appear to be in association with a series of stone columns. McGimsey *et al.* (1987) first described these columns in their article as more of a curiosity than structural artifacts:

> One other type of "artifact" remains to be described. This is a series of 25 piles of stone (we hesitate to dignify them with the term "column"), which were found scattered through the site. These piles or columns are constructed of head-size river cobbles (some are metate fragments) stacked each upon the other much after the fashion of a New England stone wall without noticeable benefit of any care being taken for fit or great stability. The columns are 60-70 cm. in diameter, are based on or in the general vicinity of the top of the crab claw stratum…and rise to a height of 50-80 cm. … When the soil is completely removed from around them the piles do stand without collapsing, but it is almost inconceivable that they could have supported much weight or withstood any great pressures. (132-133)

While these columns most likely did not support structures, there does appear to be some relationship with the burials. To assess the possibility that the cemetery at Cerro Mangote arrangement was based on familial groups, the columns are used as boundaries to ground the biospatial analysis. Since membership to these three groupings is defined *a priori*, the specific assumptions of biospatial analysis are considered in Chapter 6, along with the relationship of mutations and selection, how genetic affinities are detected by dental metric analysis, as well as areas of contention within biodistance analysis (typological modeling).

Methodology. Dental measurements were collected for all individuals with permanent teeth at Cerro Mangote (n=55), following Buikstra and Ubelaker (1994). Missing data were estimated using the expectation-maximization (EM) algorithm in

Systat v.13 to imputate less than 15% of the data. Univariate data were evaluated for age-dependent size differences using *t*-tests for left and right sides of the adult cohort. Multivariate assessment of age-specific tooth size differences required several preanalysis data treatments. Sides were collapsed to one value for each tooth type (see Table 5.1 for abbreviations), choosing the maximum value if both sides were represented (see Stojanowski *et al.* 2007). The descriptive statistics for the maxillary and mandibular measurements are included in Tables 5.2 and 5.3. Since many variables were poorly represented, with some individuals represented by only a few measurements, any variable without 85% of the data present was eliminated, and any individual without 75% of the data present was eliminated. Mandibular dentition was not used, since fewer measurements were available; after assessing with a Pearson's correlation, the mandibular and maxillary variables did not correlate well enough to allow for collapsing into one variable, as suggested by Stojanowski *et al.* (2007).

The Cerro Mangote dataset was reduced to 20 of the best preserved individuals for this analysis (from 63 individuals). Principal components were generated for four different datasets reflective of functional units of the posterior (premolar and molar) dentition: mandibular mesiodistal, mandibular buccolingual, maxillary mesiodistal, and

Table 5.1: Dentition used for analysis	
M2M	Second Molar mesiodistal
M2B	Second Molar buccolingual
M2C	Second Molar crown height
M1M	First Molar mesiodistal
M1B	First Molar buccolingual
M1C	First Molar crown height
P2M	Second Premolar mesiodistal
P2B	Second Premolar buccolingual
P2C	Second Premolar crown height
P1M	First Premolar mesiodistal
P1B	First Premolar buccolingual
P1C	First Premolar crown height

	Table 5.2: Descriptive statistics and t-tests for maxillary data by age cohort												
	Right						Left						
	Sub			Adult			Sub			Adult			
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	p-value
M2M	5	9.50	0.14	10	9.92	0.80	2	9.48	0.06	16	9.43	2.65	0.774
M2B	5	10.35	0.30	10	11.42	0.83	2	10.20	0.06	16	10.57	2.92	0.795
M2C	5	6.87	0.68	10	5.79	1.18	2	6.76	0.49	16	6.04	1.83	0.844
M1M	13	10.83	0.74	15	11.04	0.84	9	10.59	0.56	16	10.91	0.69	0.979
M1B	13	11.00	0.76	15	11.57	0.57	9	10.91	0.46	16	11.48	0.35	0.727
M1C	13	6.81	0.61	15	5.55	0.89	9	7.00	0.62	16	6.21	0.93	0.971
P2M	4	7.27	0.16	11	6.97	0.70	2	7.39	0.28	12	7.04	0.64	0.983
P2B	4	9.33	0.43	11	9.39	0.60	2	9.45	0.88	12	9.09	0.58	0.988
P2C	4	6.40	0.43	11	5.94	1.93	2	7.22	0.4	12	5.87	1.3	0.956
P1M	4	7.42	0.51	12	7.66	0.87	5	7.57	0.53	11	7.4	0.69	0.984
P1B	4	9.38	0.33	12	9.17	0.88	5	9.00	0.62	10	9.1	0.68	0.982
P1C	4	7.35	1.06	12	6.42	1.47	5	7.30	0.81	10	6.38	1.36	0.969

	Table 5.3: Descriptive statistics and t-tests for mandibular data by age cohort												
	Right						Left						
	Sub			Adult			Sub			Adult			
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	p-value
M1M	13	11.60	0.68	13	12.02	0.70	11	11.79	0.80	13	11.8	0.80	0.993
M1B	13	10.27	0.74	13	10.69	0.47	11	10.42	0.60	13	10.73	0.51	0.992
M1C	13	7.16	0.81	13	5.72	0.94	11	7.18	0.83	13	5.34	1.22	0.990
P2M	5	7.28	0.52	12	7.32	0.66	2	7.38	0.47	10	7.73	0.42	0.925
P2B	5	7.58	0.56	12	7.92	0.79	2	7.75	0.52	11	8.10	0.57	0.954
P2C	5	7.02	0.51	12	6.04	1.28	2	7.19	0.05	11	6.05	1.83	0.928
P1M	3	7.53	1.23	12	7.30	0.80	3	7.50	0.81	10	7.21	0.66	0.977
P1B	3	7.44	0.86	12	7.73	0.56	3	7.65	0.64	10	7.39	10.0	0.985
P1C	3	7.28	0.73	11	6.79	1.80	3	7.50	1.20	11	5.87	2.36	0.810

maxillary buccolingual. Principal component loadings were used to examine correlations between raw variables, and *t*-tests tested for significant differences in factor scores between juveniles and adults.

Size was corrected by dividing each measurement value by the arithmetic mean of all variables for that individual following Corruccini's (1973) adjustments for shape (see also Powell 1995). Analyses were based on the original, non-size corrected dataset as well as a size-corrected dataset. Principal components were then extracted from the data matrices and factor loading scores were used for analysis. The principal components were generated using two different datasets (mesiodistal and buccolingual), with buccolingual measurements explaining approximately 60% of the variation. Similar to Stojanowski *et al.*, the maxillary dentition were the main portion of the data, reducing the influence of developmental variation. Table 5.4 contains the components of the analyses and eigenvalues for both the raw data and data controlled for size. The mesiodistal principal component increased from one component to two components upon size correction because the size correction highlighted the difference between adult and juvenile dental measurements.

Table 5.4: Principal components analysis of Cerro Mangote

	Raw data			Size-corrected data			
	Buccolingual		Mesiodistal	Buccolingual		Mesiodistal	
Var	PC1	PC2	PC1	PC1	PC2	PC1	PC2
UM2B	0.818	-0.255	0.719	0.653	-0.291	0.577	0.37
UM1B	0.797	-0.442	0.849	0.71	-0.537	0.864	-0.042
UP2B	0.78	0.336	0.76	0.683	0.49	0.481	0.072
UP1B	0.725	0.289	0.588	0.328	-0.864	0.453	-0.62
NM1B	0.476	-0.819	0.821	0.861	0.22	0.835	0.049
NP2B	0.889	0.211	0.693	0.883	0.255	0.599	0.192
NP1B	0.839	0.348	0.562	0.754	0.14	0.1	-0.875
Eigen	4.158	1.293	3.633	3.593	1.493	36.882	19.032
% Var	59.397	18.478	51.894	51.329	21.335	2.582	1.332

5.4 Resource exploitation

Food procurement patterns can be explored in preserved human skeletons using two types of skeletal markers: musculoskeletal stress markers (MSM) and cross-sectional geometry. The internal and external structures of long bones can indicate which muscles have been used frequently, or rarely, during life. The combinations of muscle group use and disuse as inferred by the relative robusticity of muscle attachment can be interpreted to suggest particular activity patterns by individuals (see Bridges 1989, Eshed *et al.* 2004, Jurmain 1990, Molnar 2006, Weiss 2007). Prior research has not only interpreted more pronounced MSM as a direct result of muscle use in daily and repetitive tasks, but in some cases, it has also inferred lifestyles or activities (Kennedy 1989, 1998, Rhode 2006, Ubelaker 1979).

Rhode (2006) proposes populations utilizing either a marine-based diet or a farming-based diet can be differentiated through MSM, as marine food procurement results in more robust upper limbs than lower limbs and farming based food procurement results in more robust lower limbs than upper limbs (Hammel and Haase 1962, Franquemont *et al.* 1990, Michaels and Voorhies 1999, Moseley and Feldman 1988, Reitz 1988, Rhode 2006, Rostworowski 1981, Steward 1946, Stewart 1977, Trinkaus 1993, Wilson 1999). Rhode's (2006) model for subsistence patterns is based on *a priori* assumptions of synergistic muscle groups observed through MSM. Rhode determined that there was a statistically significant separation between subsistence strategies based only in fishing or only in farming, and a corresponding overlap of MSM values within the mixed subsistence strategies (see Table 5.5).

Table 5.5: Discriminant score subsistence scale (modified from Rhode 2006)

Female				
Farmer	? Farmer	Unknown	? Fisher	Fisher
< - 0.10	- 0.10 to 0.25	0.25 to 0.60	0.60 to 0.95	> 0.95
Male				
Farmer	? Farmer	Unknown	? Fisher	Fisher
< -1.03	-1.03 to -0.75	-0.75 to -0.48	-0.48 to -0.20	> -0.20

Though previous models have successfully paired repeated behavior with modifications to the bone, Cerro Mangote lacks a sufficient sample size. The combination of musculoskeletal stress markers and cross-sectional geometry allows for more data in a small sample. Musculoskeletal stress markers model reconstruction on the cortical surface of the bone, whereas cross-sectional geometry examines internal changes. The combination of the two sets of data creates a profile of patterned movement in individuals at Cerro Mangote, based upon common subsistence patterning.

5.4.1 Musculoskeletal stress markers

Background. Musculoskeletal stress markers are essentially enthesophytes—areas of ossification created where the muscle, tendon, or ligament inserts into the periosteum and attaches to the bone via Sharpey's fibers (Hawkey and Merbs 1995). As a bone experiences forces from muscle used throughout life, the bone must respond to prevent breakage. The bone is remodeled to maintain strength since muscle usage places stress on specific areas of bone, typically resulting in increased robusticity. Robusticity is defined as "strengthening or structural buttressing of a skeletal element through addition of bone tissue, and is usually assumed to be a response to higher mechanical loadings although not always – see Kennedy, 1985, 1991" (Ruff *et al.* 1993:21-22). For long bones, robusticity typically means the external breadth of the diaphysis. However, robusticity is also used to describe the relative size of articulations, muscular attachments, or cortical thickness (Ruff *et al.* 1993).

Some studies have been criticized for over-interpretation of MSM (see Jurmain 1990, Jurmain 1999, Robb 1998, Stirland 1998), without considering age or sex difference (see al-Oumaoui *et al.* 2004, Molnar 2006, Wilczak 1998), through inconsistent consideration of the impact of body size on muscle attachments (see Weiss 2007, Zumwalt 2005, 2006). Zumwalt (2005) reviews the complexity of three-dimensional force, as well as the endless combination of morphological changes that can a result in muscle attachment expression. As with other qualitative descriptions, the statistical rigor of the methods can be problematic, as a single score describes a combination of actions of a muscle attachment[42] (see also Robb 1998, Stirland 1998, Wilczak 1998).

When standardized for age, sex, and body size, MSM can correlate with patterned activities (see Weiss 2007). Standardizing for age is critical in eliminating the potential accumulations of activity – the older the individual, the potentially more pronounced the musculoskeletal stress marker (see Molnar 2006, Nagy 1998, Nagy and Hawkey 1995, Robb 1998, Wilczak 1998). Additionally, because males have higher muscle marker scores than females in most skeletal samples (see Cohen 1989, Hawkey and Street 1992, Steen and Lane 1998), both aggregated muscle markers and separate muscle markers are required to control for body size using z-scores (Weiss 2004, 2007, Zumwalt *et al.* 2000). To estimate synergist groups of muscles, aggregate muscle markers, or a combined score of multiple muscle markers, are used in addition to single locations (see Appendix 5 for the list of synergist groups considered).

Z-scores are calculated for the humerus and femur to determine if MSM are correlated to body size. Humeral size is an aggregate variable based on z-scores of the humeral length, humeral vertical head diameter, and humeral epicondylar breadth (using Buikstra and Ubelaker 1994). For femoral size, the aggregate variable combines the z-scores of maximum length, epicondylar breadth, and maximum head diameter (using Buikstra and Ubelaker 1994). Since these six areas do not remodel as much as shaft

[42] While quantification of the musculoskeletal attachment site through dimensional scaling can overcome the issues of statistical rigor, the method is restrictive for use in the field due to the technology needs (see Zumwalt 2005).

dimensions, the measurements are considered good proxies for body size (see Ruff *et al.* 1991, Weiss 2003, 2004). These z-scores are then added to the muscle marker scores to create the body-size standardized data.

Methodology. Following Hawkey (1988, Hawkey and Merbs 1995) three principal types of muscle attachment changes are observed—robusticity markers, stress lesions, and enthesopathies. Robusticity markers (RM) are considered the initial periosteal reaction due to stress and are described as roughened or irregular textures at sites of muscle, tendon, or ligament attachment. RM are thought to be the initial periosteal reaction due to stress. The second type of muscle marker is the stress lesion (SL). Initially, Hawkey and Merbs scored stress lesions separately from robusticity markers, but subsequent consideration found more of a continuum between the two markers, where stress lesions are a more extreme form of robusticity markers (1995). Overuse of a muscle, ligament or tendon taxes the enthesis, resulting in chronic inflammation; furthermore, the cortical inflammation causes localized bone necrosis, resulting in a pit, furrow, or groove (Hawkey and Merbs 1995). Figures 5.3 and 5.4 illustrate examples of robusticity markers and stress lesions[43].

On the proposed scale, RM are scored from 1 to 3 (Hawkey and Merbs 1995). A score of 1 denotes a faint or trace enthesial surface that may not be visible but is palpable. A score of 2 specifies a visibly roughened or elevated surface at the site. A score of 3 indicates a marked elevation, irregular texture, and/or sharp crest at the site. Stress lesions are scored 4 to 6 (continuing from the robusticity markers), based on the

[43] Hawkey and Merbs (1995) identified a third type of marker, the ossification exostosis (OS). They assert that OS differ fundamentally from RM and SL since OS are triggered by abrupt trauma and not habitual activities. With OS, the traumatic event causes a portion of the muscle, tendon, or ligament to ossify as the body attempts to repair the injury, eventually producing an elevated bony spur, or exostosis (Hawkey 1988, Hawkey and Merbs 1995). Later analysis, though, links the definitions of OS and myostitis ossificans (MO), complicating the assessment (see Ortner 2003). For purposes of this analysis, OS were not recorded.

Figure 5.3: Example of a robusticity marker (Deltoid Tuberosity): 0 (normal), 1 (trace), 2 (moderate), 3 (severe). From Rhodes (2006:343)

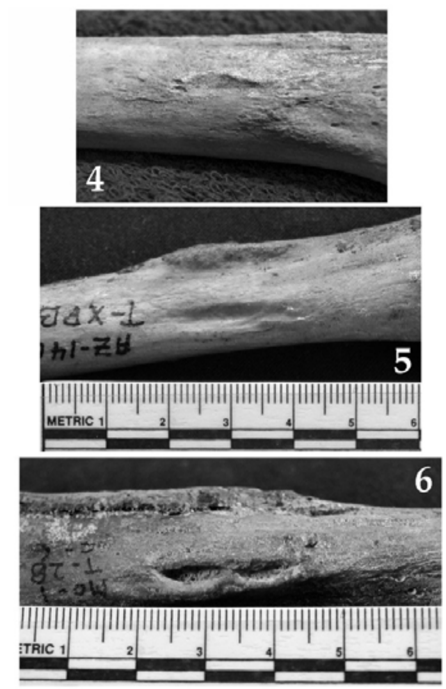

Figure 5.4: Example of a stress lesion (Teres major): 4 (trace), 5 (moderate), 6 (severe). From Rhodes (2006: 353)

depth, but not length, of the lesion. A score of 4 represents a shallow groove or furrow, less than 1 mm in depth. A score of 5 indicates a deeper, more defined furrow, between

1-3 mm in depth. A score of 6 denotes a groove deeper than 3 mm at the enthesis. Musculoskeletal stress marker data were collected from the Cerro Mangote sample (n = 43) using a combination of the scoring systems proposed by Hawkey (1988, Hawkey and Merbs 1995, Hawkey and Street 1992). In total, the two scoring systems document 47 muscle origins and insertions (92 combined left, right, and unilateral variables) from the upper and lower body (see Appendix 4 and 5). To allow for variation between scores, additional scores of 0.5 was used to more accurately describe the MSM (as suggested in Hawkey 1988). Due to the poor preservation of the Cerro Mangote sample, MSM of the trunk was not assessed[44].

Table 5.6: Musculoskeletal stress markers from habitual use

Robusticity Markers (RM)		Stress Lesions (SL)	
0 = absence of expression			
1 = robusticity grade 1	faint or trace enthesial surface	**4** = stress lesion grade 1	shallow groove of less than 1mm
2 = robusticity grade 2	visibly roughened or elevated surface	**5** = stress lesion grade 2	Deeper furrow, between 1-3mm
3 = robusticity grade 3	marked elevation, irregular texture, and/or sharp crest	**6** = stress lesion grade 3	Groove deeper than 3mm

5.4.2 Cross-sectional geometry

History. Cross-sectional geometry reflects the same mechanisms of bone remodeling as MSM: the type and directionality of stress will influence the overall shape and size of the bone (see Figure 5.5). While MSM can indicate specific muscle use, long bone cross-sectional geometric properties can better quantify overall variation in long bone size and shape (see Stock 2002, Stock and Shaw 2007, Stock *et al.* 2005, Wanner

[44] Ossification exostoses data were collected, as previous studies (Rhode 2006) have collected the data as a part of analysis; however, the data were not included in analysis since the purpose of the study is to assess habitual activities, not traumatic events. As mentioned in Chapter 4, ossification exostoses are created when the area becomes ossified as the body tries to repair an abrupt trauma to a muscle, tendon, or ligament.

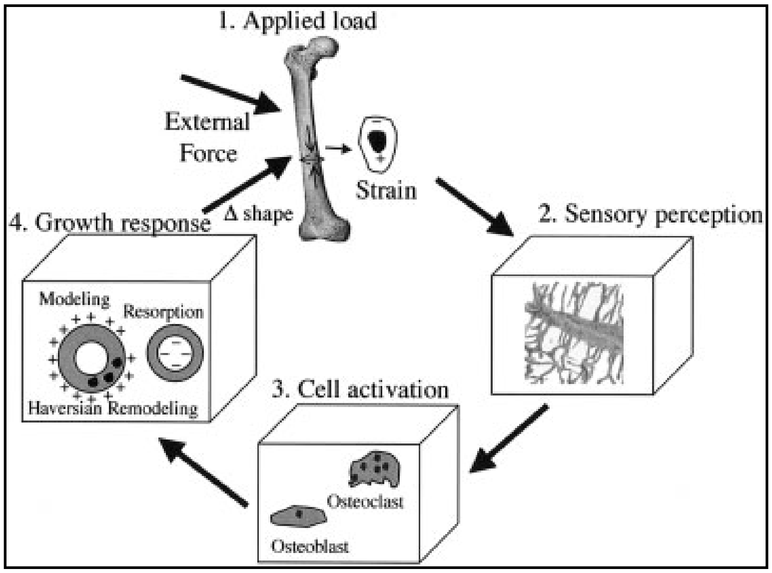

Figure 5.5: Model of bone growth as a response to loading (from Pearson and Lieberman 2004:65)

et al. 2007). Cross-sectional geometry has illustrated differences in subsistence strategy and physical activity (Bridges 1989, Ruff *et al.* 1984, Stock and Pfeiffer 2001), age (Bouxsein *et al.* 1994, Feik *et al.* 1997, Lazenby 1990, Ruff 1981, Ruff and Hayes 1982), sex (Feik *et al.* 1996, Mays 1999), and body size (Ruff 1984, Ruff *et al.* 1993).

Initial criticism of cross-sectional geometry stemmed from the use of Wolff's law as a model for bone response to mechanical loading. Pearson and Lieberman (2004) and Ruff *et al.* (2006) comment on the incorrect application of Wolff's law which was meant to describe trabecular bone arrangement and not cortical bone robusticity. Pearson and Lieberman (2004) assert that the majority of cross-sectional geometry represents adolescent mechanical loading as the impact of mechanical forces on modeling is much greater than the later remodeling of long bones in adults. They call for more animal models and for activity patterning studies to move away from the tendency to directly associate a cross-sectional pattern with a specific force, emphasizing instead that environmental influences are too complicated for a one to one association.

Temple *et al.* (2011) expands on these concerns, focusing on the impact of ontogeny on cross-sectional geometry of long bones. Ontological implications of cross-sectional geometry suggests that observed variation in bone morphology is a result of growth and development and not a particular activity (see Ruff 2007, Ruff and Walker 1993). Temple *et al.* (2011) consider brachial[45] and crural[46] indices within an ecogeographic context. There is a shift in the intralimb indices throughout development, but the relative relationships Temple *et al.* (2011) observed in adults are set at an early age and are maintained throughout growth. There was a difference between the conservation of the relationship between the limbs, where the humeral relative to radial length is less correlated than the tibial relative to femoral length. Temple *et al.* (2011) suggest that the difference in correlation is due to fact that the brachial index is under more evolutionary pressure, and therefore more likely to change, whereas the crural index is more developmental constrained.

Ruff *et al.* (2006), however, do not paint such a bleak picture for the usefulness cross-sectional geometry. While they do concede that mechanical forces received during modeling in childhood have a greater impact on the cross-sectional shape of bone than post-adolescent remodeling, Ruff *et al.* (2006) utilize examples of bone remodeling in athletes to illustrate adult remodeling as a response to chronic fatigue from bone strain (see Figure 5.6). Ruff *et al.* (2006) contest that bone restructuring from chronic fatigue does not fall under Wolff's law. They therefore suggest the application of Wolff's law is inaccurate and favor the more general term of bone functional adaptation. Since the individuals assessed at Cerro Mangote are adults, Ruff *et al.*'s findings are particularly relevant in how the shape of the adult long bone was achieved.

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[45] The brachial index is: HL * RL *100, where HL is the humeral maximum diaphyseal length and RL is the radial maximum diaphyseal length. All lengths were measured on an osteometric board.

[46] The crural index is: FL * TL * 100, where FL is the femoral maximum diaphyseal length and TL is the tibial maximum diaphyseal length. All lengths were measured on an osteometric board.

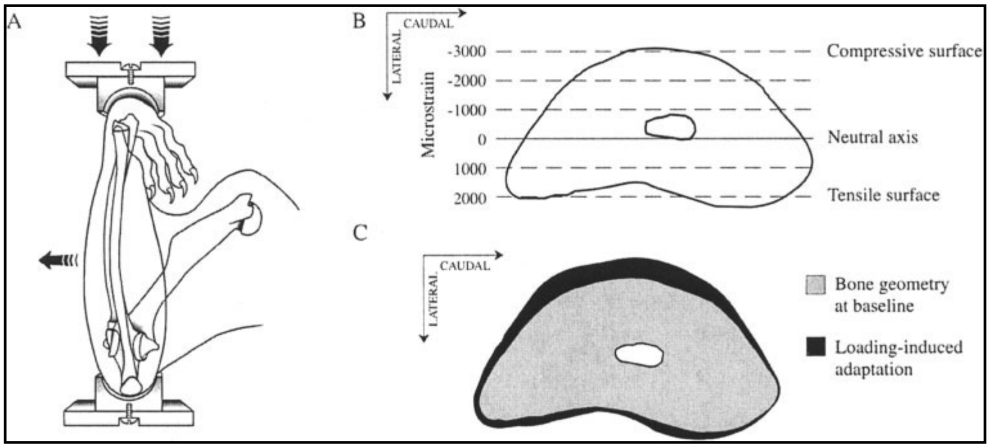

Figure 5.6: Image of cross sectional geometry, from Ruff *et al.* (2006:486). The figure illustrates the results of overloading an ulna. A: Experimental setup to create lateral bending. B: Strain distribution near midshaft. Maximum strain on the medial (compression) and lateral surfaces (tension). C: New bone formation (at 16 weeks), with bone preferentially added in regions of highest strain.

Methodology. The three main methods for determining cross-sectional geometry are direct sectioning[47], bi-planar radiography[48], and computed tomographic imaging[49]. Food procurement patterns will be explored using cross-sectional geometry of the humeri and femora (Ruff 1987, 1992, 2000, Ruff *et al.* 2006a, 2006b, Trinkaus and Ruff 1989). There are only 10 adults in the sample who have at least one well preserved humerus and/or one well preserved femur. For this analysis, the age range of "adults" is

[47] Direct sectioning of the long bone diaphysis is the simplest of the methods to determine the cross-sectional geometry (see Feik *et al.* 1996, Stock 2002, Lieberman *et al.* 2004, Stock and Shaw 2007). For the most part, the destructive nature of this method limits its use.

[48] Bi-planar radiographic calculations measure the cortical thickness to calculate the impact of forces (see Nagurka and Hayes 1980, Biknevicius and Ruff 1992, Ohman 1993, Marchi *et al.* 2006, Stock and Shaw 2007, Marchi 2008).

[49] Computed tomographic imaging (CT) can be an excellent method for determining the cross-sectional properties of the bone, however, it can be more expensive and depends greatly on the scanner settings for the proper clarity of contours (see Ruff 1981, Bridges 1989, Bouxsein *et al.* 1994, Mays 1999, Ruff 2000, Sladek *et al.* 2006, Galtes *et al.* 2008). CT provides a noninvasive approach for taking these measurements by reconstructing cross-sectional geometry, as well as allowing one to accurately subtract the medullary area from calculations of cross-sectional area.

defined by fusion of all epiphyses, but under the estimated age of 50, to avoid the possibility of osteoporosis affecting bone measurements.

Measurements of cross-sectional geometry of the femoral midshaft and humeral midshaft were taken using a CT scanner (PHILIPS Brilliance 16 slice CT Scanner) at Wilson Medical Center (Johnson City, New York). Examples of the cross-sections are included in Figure 5.7. To ensure standard orientation, both the femora and humeri were oriented following Ruff's (1981) suggestion to orient the long bone on the frontal plane in order to minimize curvature of the diaphysis (see Figure 5.8).

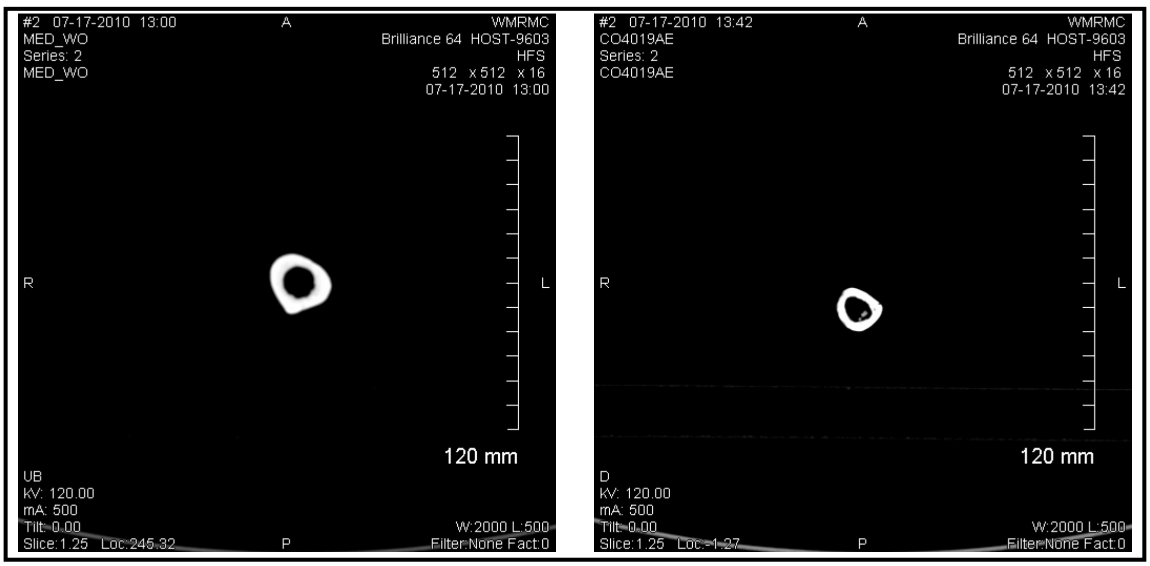

Figure 5.7: Examples of cross-sections. Left: CO-40-19A femur midshaft cross-section. Right: CO-40-19A humerus cross-section at 40% distal length.

After the measurements are taken of the cross-sectional area, forces are calculated using the major bone axes. The three axes, the longitudinal axis of the diaphysis (z), the anteroposterior axis (y), and the mediolateral axis (x), are used to calculate the cross sectional properties of the midshaft. Three scans of each bone were

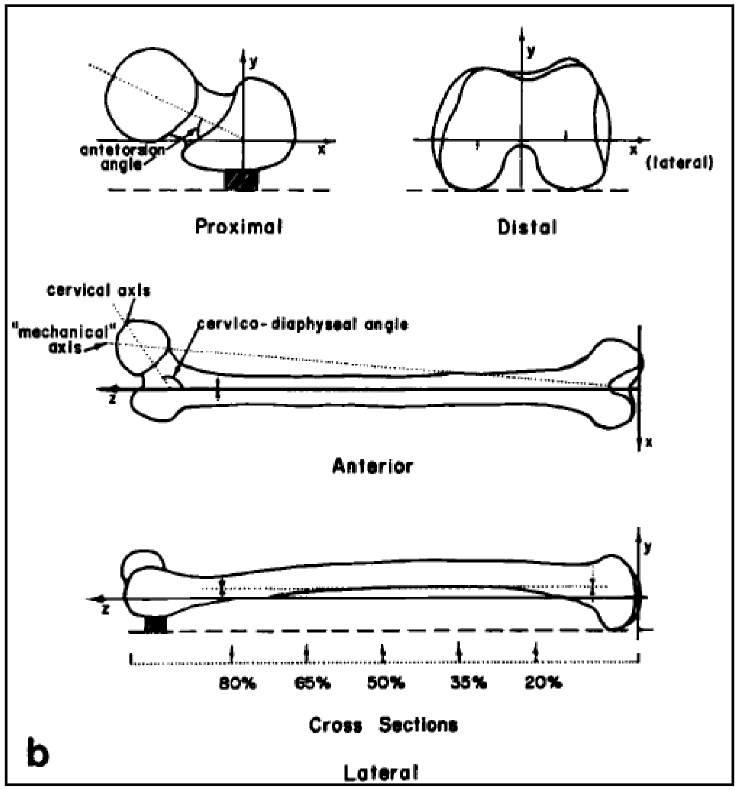

Figure 5.8: Orientation of femora for CT scans, following Ruff and Hayes 1983:364.

taken. For the femur, these occurred at the midpoint, 1mm above the midpoint and 1 mm below the midpoint. For the humeri, the scans included the proximal 60% of shaft (just below the deltoid tuberosity), 1mm above and 1 mm below deltoid tuberosity[50].

Once digitized, the cross-sectional properties were calculated using ImageJ (Abramoff *et al.* 2004) with MomentMacro (www.hopkinsmedicine.org/fae/mmacro.htm). The variables calculated include the total periosteal area (TA), cortical area (CA), I_{max} (maximum second moment of area), and I_{min} (minimum second moment of area). Torsional rigidity (J) is the addition of I_{max} to I_{min}. To illustrate the shape of the cross-section, the ratios of second moments of area (I_x/I_y and I_{max}/I_{min}) describe the distribution

[50] For example, the total length of CO-40-26's humerus is 301 mm, so the scans were taken at 120 mm, 121 mm, and 122 mm.

of bone in two perpendicular axes. This procedure was carried out manually, as in previous studies (see O'Neill and Ruff 2004). Based on the findings of Rhode (2006) on marine food procurement patterns, the humeri of Cerro Mangote should indicate more robusticity through increased bending strength (values approaching 0 for the ratios of second moments area) in the humerus in comparison to the femoral cross sections (Weiss 1998).

Body size is controlled by using long bone length, following Ruff *et al.* (1993). Ruff *et al.* (1993) used their resultant values to standardize cortical area, total area, and the moments of inertia and polar moments values, using either humeral or femoral length. Cortical and total areas are standardized by dividing the result by length cubed and multiplying by 10^8. Moments of inertia and polar moments of inertia are standardized by dividing the result by the $\text{length}^{5.33}$ and multiplying the result by 10^{12}. The results are log-transformed to convert to z-scores. The variables, including maximum length and length', were compared by sex for statistical significance using t-tests in SYSTATv13.

5.4.3 Drawbacks and limitations

Replicability in MSM is one of the more problematic components of the methodology. Following Buikstra and Ubelaker (1994), approximately 20% (n = 9) of the sample was scored twice to assess single observer variation in the scoring process. Since the scores were only collected by the author, assessing intra-observer error is critical; unfortunately, another researcher was not available to provide data on inter-observer error. Each technique was calculated for each marker and averaged for the nine individuals. Following Rhode (2006), averages of the techniques are presented in Table 5.7, grouped into three categories: deviation, reliability, and correlation. Since the data are ordinal, only non-parametric analyses were used. Rhode's (2006) analysis included paired comparisons (Sign Test and Wilcoxon Signed Ranks). The paired comparisons did not indicate significant difference in Rhode's (2006) analysis, indicating the values between the first and second scorings are similar enough to combine the values. The Sign Test and Wilcoxon Signed Ranks were calculated for this data set; however, like Rhode, no significant differences were found and are therefore excluded from the table.

Table 5.7: Intraobserver error and Replicability Statistics

	Average	SD
Deviance		
Mean Difference (MD)	-0.05	0.28
Method Error Statistic (MES)	0.02	0.05
Mean Absolute Difference (MAD)	+/- 0.12	0.25
Technical Error Measurement (TEM)		
Reliability		
Cronbach's	0.995	0.01
Correlation		
Spearman's r	0.990	0.03
Kendall's τ_b	0.985	0.05

Deviation. Mean difference is the average of the difference of the scores between the first and second estimation of the muscle marker. The low average suggests the scores were relatively consistent between the two estimations, with the second estimation scores slightly higher than the first estimation. Method Error Statistic is the squared difference between the first and second estimation, divided by the squared number of comparisons. The benefit of the method error statistic is that it amplifies any error. The average method error statistic is similar to the mean difference, indicating the scores estimated were unaffected by systematic errors. Mean Absolute Difference is the average absolute difference between the estimations of scores. The absolute difference is larger than the mean difference or method error statistic, but, is still lower than the minimum MSM coded score of 0.50. So, while there was variation between the two estimations of scores, overall, the intraobserver error is low with high replicability. Technical Error of Measurement is the square root of the sum of the squared score differences, divided by two times the number of observations. Like the mean absolute difference, the technical error measurement is well below the minimum coded score for musculoskeletal stress markers, indicating some variation in score, but a relatively low intra-observer error rate.

Reliability. Cronobach's α is a coefficient of reliability or consistency, measuring inter-item correlations through latent construct, with values between 0 and 1. The larger the α, the more uni-dimensional the structure (more similar). Santos (1999) states that values over 0.70 or greater are generally acceptable for social science studies. The value of 0.895 means 89% of the scores were consistent between the two estimations. The error interval in the observations for Cerro Mangote is similar to the error intervals determined by Hawkey (1998) as an acceptable level of variation (who suggested less than 20%, based on Santos 1999).

Correlation. Spearman's rank order correlation coefficient (or r_s) compares the similarity of two ranked variables. The strength of the relationship ranges from -1 (perfect negative relationship) to +1.0 (perfect positive relationship) (Sokal and Rohlf 1995, Thomas 1986). The average r_s = 0.990 is a high positive correlation value, with little variation between the two scoring sessions. Kendall's Tau (Kendall's τ_b) is the other non-parametric correlation, which is similar to Spearman's r, but adds a factor to correct for any statistical dependence in the ranked data (Thomas 1986, Kendall 1970). The average τ_b = 0.986, indicating a high positive correlation with few variations between the first and second estimations of muscle attachments.

The majority of MSM methodologies include averaging the two sides to resolve missing data, including Rhode (2006), however, the statistical reliability based on bilateral asymmetry is a concern. While Rhode did not look for correlations between the two sides, it was included as part of this analysis, following suggestions of Weiss (2007). She concluded that with a high Pearson correlation of 0.67 – 0.84 (mean = 0.73), collapsing the left and right sides into one category was acceptable, which are similar values to this study (0.55 – 0.93, mean = 0.79). The sides were collapsed for each variable into one category, taking the more robust value if the two sides differed.

After the sides were combined, the variables and individuals were assessed for data completeness, to further reduce complications from missing data. Rhode (2006) eliminated any variable with less than 10% completeness and any individual with less than 50% completeness. For this analysis, variables with less than 10% completeness were eliminated, and individuals with less than 40% completeness were eliminated. Due to low sample size, it was necessary to include more individuals with less completeness (n = 24). This missing data had to be supplemented using missing data analyses with SYSTAT v.13, potentially causing homogenization of the data. Table 5.8 contains the age and sex distribution for individuals included in the Cerro Mangote analysis after combination of sizes and completeness assessments.

After missing values were replaced, z-scores were added to the humeral and femoral muscle markers to size correct, following Ruff *et al.* (1991) and Weiss (2007). Size correction measurements are not available for all musculoskeletal markers,

Table 5.8: Age and Sex distribution of MSM data

	F	F?	?	M?	M
15-20				2	
20-35	4	1		2	3
35-50	1			1	7
50+	2				
U			1		

however, the majority of the synergist groups (see Appendix 5) involve at least one marker from either the humerus or femur. These synergist groups were defined and used by Rhode (2006) to increase the degrees of freedom for the analysis, as well as consider the anatomical function of the muscle groups to perform a particular motion (see also Jenkins 2002). Since Rhode (2006) did not size correct his data, the analysis includes both size corrected and raw data.

A preliminary PCA illustrated that Rhode's (2006) data had a linear relationship with age, with the first factor clearly based on age. His sample considered individuals less than 30 years, 30 – 40 years, and 40+ years, with n = 230. The Cerro Mangote data contains mostly individuals between 27 – 45 years, with n = 24 (Table 5.4). Principal components analysis on the Cerro Mangote data does show separation of the most extreme ages (15-20, 50+), but not the middle ages. Additionally, the separation may be more a factor of too few individuals representing the age groups than separation based on age. The Cerro Mangote data were age-corrected using least squares regression as used by Rhode (2006), but loading did not change the Cerro Mangote data significantly. Rhode's (2006) initial analysis indicated that the best separation of variables occurred using discriminant function analysis.

5.4.4 Isotopes

As discussed in Chapter 2, Norr (1991, 1995) analyzed carbon (C) and nitrogen (N) isotopic values of bone collagen at Cerro Mangote, La Mula (Cooke and Ranere 1992a), and Sitio Sierra. Norr suggested the C4 and $\delta^{15}N$ isotopic values calculated for Cerro Mangote were consistent with a diet based on maize. More recent publications illustrate the impact of a high marine dietary component, particularly euryhaline fish, in the interpretation of stable isotope signatures (Keats 2002, Sealy 2001, VanderZanden and Rasmussen 2001). The original data collected by Norr (1991) are reinterpreted using these isotopic ranges (see Keats 2002, VanderZanden and Rasmussen 2001) in Chapter 8, suggesting a marine based diet, not a maize-based diet, of the individuals at Cerro Mangote.

For the most part, the research agrees that marine and euryhaline environments impact the isotopic signatures by increasing the $\delta^{15}N$ values, although exactly what values indicate 'increasing' seems to vary by study. Since nitrogen is associated with trophic level, or position in the food web, an agreed range is problematic. Most studies seem to agree the range for increased marine consumption is between 7.3 – 11.5 $\delta^{15}N^{0}/_{00}$ (see Ambrose *et al.* 1997, Keats 2002, VanderZanden and Rassmusen 2001). While carbon is considered in the assessment of dietary components, the values are closely tied to C3 (more negative values) or C4 (less negative values). Keats (2002) suggests that euryhaline environment may affect the carbon values, her study focused on organisms from much lower tropic levels (specifically, fish and insects) and does not provide an easily adaptable scale for humans. She suggests focusing on the ratios of carbon and nitrogen, with a range of 3.0 – 3.5 correlating with euryhaline environments. Ambrose *et al.* (1997), though, correlate this same range with diets with a large marine component.

Methodology. The nitrogen values found at Cerro Mangote are compared to the suggested range of 7.3 – 11.5 $\delta^{15}N^{0}/_{00}$. The ratios (C:N) will be compared to the suggested range of Keats (2002) of 3.0 – 3.5. However, given the potential problems with comparing organisms from extremely different trophic levels, more weight will be given to the nitrogen ratios and Norr's (1991) original interpretations of her results.

5.5 Health

As discussed in the biological profile, the records of pathologies in skeletons can assist in the diagnosis of diseases in individuals. First, dental pathologies are considered, using the recording described in the dental pathologies section above. Typically, the caries, calculus, and abscesses, the higher the carbohydrate content of diet. This is associated with poorer health (see Ubelaker 1995). Boldsen (2005) associate a higher number of LEH with increased frailty and therefore, poorer health. The ratios of dental pathologies and LEH are compared with other regional samples to determine the relative health of the Cerro Mangote sample.

The next component to the health questions and hypothesis consider relative frequencies of disease in the sample. To determine what types of diseases may be present, I created a differential diagnosis for different individuals. First, the documentation created for the biological profile pathologies was used. The location, pattern, type of lesion, and activity level (active, healing, healed) are all important in determining the possible diseases. Due to the age of the sample and location, two major groups of diseases assumed in the sample were treponemal diseases and scurvy.

5.5.1 Differential diagnosis: Treponematosis

Treponematosis actually encompasses four different syndromes: syphilis (and congenital syphilis), bejel (endemic syphilis), yaws, and pinta. Though pinta does not affect the skeleton, it is unclear if the four varieties are caused by one bacterium with many manifestations, multiple bacteria with one manifestation, or a combination of bacteria and manifestations (see Ortner 2003). Beyond questions in etiology, there is continuous debate on differentiating syphilis, bejel, and yaws. Though treponemal bacteria favor skeletal elements with minimal overlying soft tissue (such as the cranial vault, facial bones, tibial crests), Ortner (2003) notes that there is much overlap between the three varieties and skeletal element expressions. Most differentiation is more based on the environment than lesions:

> The geographic distribution of the nonveneral syndromes tends to be limited to specific climatic zones. Yaws is a disease usually associated with tropical indigenous populations. Bejel is found mostly among indigenous populations in drier areas of subtropical North Africa, the Near East, and temperate Asia but is not found in the Americas…Syphilis is a sporadic disease that, because of its venereal mode of transmission, can occur in any human groups. (Ortner 2003:274)

Given that Cerro Mangote is in a tropical Central American location, the focus for differential diagnosis is on yaws and syphilis.

Yaws is typically acquired in childhood, so the more active lesions are expected in the young and adolescents, with healed lesions in adults. Since the disease is acquired in childhood, the healed lesions could be completely remodeled prior to death. As such, the frequency of yaws in the sample is most likely greater than represented by the skeletal lesions. Syphilis is transmitted through sexual contact (acquired syphilis) or transplacentally (congenital syphilis). Typically the skeletal lesions do not develop until the tertiary stages of the disease. Ortner (2003) notes, however, that the rather extreme expressions used to create the scales for tertiary syphilis seem to be restricted to late

19th century European medical samples. The expressions seen in archaeological collections and samples are less severe.

Common skeletal changes associated with yaws and syphilis include the bilateral saber tibias, destruction of phalanges, and chronic lesions of the vault, though none can differentiate diagnostically between yaws and syphilis (Ortner 2003). Since most crania in the sample are fragmented, more attention is paid to the long bone lesions. Ortner (2003) defines gummatous and nongummatous osteoperiostitis as an important aspect to long bone lesions, particularly the tibia. Nongummatous lesions are not considered diagnostic, but the localized, plaquelike lesions are still suggestive of the disease (Ortner 2003). Gummatous osteoperiostitis is characteristic of treponemal disease, with an almost tumor-like enlargement, “marked hypervascular periosteal bony buildup surround[ing] a scooped-out defect, extending into the cortex” (Ortner 2003:286, see also Hackett 1976). While the hypervasuclarity of the lesion can resemble osteomyelitis, the lack of a cloaca differentiates the two expressions. Finally, dental defects in deciduous incisors and dentition are considered diagnostic in combination with gummatous lesions. The incisors develop at approximately seven months in utero, and the hypoplastic defects are associated with stress and congenital disease (Ortner 2003).

5.5.2 Differential diagnosis: Scurvy

Ascorbic acid is used in the formation of collagen fibril polypeptides, and too little ascorbic acid can result in malformations in the bone matrix and blood vessels, increasing the tendency to hemorrhage (see Ortner 2003). The cranial lesions considered include porosity in the superior orbits, squamous portion of the temporal, maxilla, mandible, and greater wing of the sphenoid. Currently, porosity on the greater wing of the sphenoid is considered diagnostic for scurvy (see Bauder 2009, Brickley and

Ives 2006, Ortner and Eriksen 1997, Ortner *et al.* 1999; contra Melikian and Waldron 2003). Though the porosity of the orbits may be consistent with subperiosteal bleeding, Walker *et al.* (2009) note that other nutritional deficiencies, most notably anemia, can have similar lesions (see also Gerber and Murphy 2012). Ortner (2003) re-emphasizes the other cranial locations with porosity. While the orbits may be affected by hemopoesis, the maxilla, mandible, temporals, and sphenoid have little diploic space and are less involved in the process. The porosity is attributed to hemorrhaging due to mastication and the proximity of blood vessels to the affected bones, resulting in a bony response from hemorrhage.

5.6 Summary

The questions in this dissertation address issues of site use and the biological profile of the sample. The integration of the cemetery and resource collection is examined to determine year-round or seasonal site use. The osteological analysis is used to consider the hypotheses regarding characteristics of cemetery arrangement and patterns of stress and health in the sample. These characteristics are considered within the framework of the paleodemographic profile and previous assumptions of anthropophagy. Further, the biological profiles are compared to other samples to assess possible patterns in rituals within Central and South America. The cross-sectional geometry and MSM are combined to assess which muscle synergists are used to infer subsistence patterning. The archaeofaunal evidence is examined based on previously published information on use, in addition to compiling information regarding availability of resources throughout the year. The next chapter discusses the results from each of these analyses.

CHAPTER 6: RESULTS

This chapter reports the findings of the various analyses used on the skeletal sample at Cerro Mangote. It will summarize the biological profiles and burial data, with the complete tables in Appendices 1 and 4. Included in the biological profile are the paleodemographic models for the sample. The second section highlights the findings regarding distribution and seasonal availability based on the previously published archaeofaunal inventories. The cemetery organization and findings of the potential familial relationships at Cerro Mangote through biodistance are also reported. The fourth section of the analyses focused on resource use patterning. Musculoskeletal stress markers at Cerro Mangote are compared with Rhode's (2006) model, with additional data from the cross-sectional shapes of the femora and humeri cross-sections. Norr's isotopic data of Cerro Mangote are reconsidered in light of new standards and interpretations. Finally, the dental pathologies and patterns of trauma, arthritis, and disease are reported.

6.1 Osteological Analysis Results

This first section summarizes the age and sex distributions in the Cerro Mangote cemetery. The specific data is reported in the tables of Appendix 6. Table 6.1 summarizes age and sex distributions at Cerro Mangote. Any individual whose age could not fit into the categories used by Buikstra and Ubelaker (1994) were included as U (unknown). Appendix 1 includes more details, such as skeletal markers that distinguished specific adults and juveniles.

Table 6.1: Age and sex distribution at Cerro Mangote

	F	F?	?	M?	M	U	Total
0-5	0	0	0	0	0	31	31
5-10	0	0	0	0	0	11	11
10-15	0	0	0	0	0	1	1
15-20	1	1	0	2	0	0	3
20-35	4	3	0	5	4	0	16
35-50	4	0	0	4	12	2	22
50+	4	0	0	0	1	0	5
U	0	2	1	0	3	14	5
Total	13	6	1	11	20	59	110

As discussed in Chapter 5, the components of the biological profile are used in different analyses. Therefore, the results for the analyses are discussed where each is utilized. For example, the patterns of age and sex for Cerro Mangote are considered in section 6.1.2 through the tools of paleodemography. The fertility patterns of the sample are calculated using the Juvenility Index, with a higher number indicating a higher yearly growth rate in the living population. The distribution of ages and risk of death are described using hazard models. Section 6.1.3 and 6.3 highlight the wide variety of taphonomic patterns observed on the skeletal remains, and considers the importance of rodent gnawing and postmortem damage given the early assumptions of cannibalism at the site. Finally, section 6.5 discusses specific examples of pathology described in the Cerro Mangote sample, focusing on the differential diagnosis and patterns of dental pathologies, periostitis, trauma, and osteoarthritis.

6.1.1 Paleodemography of Cerro Mangote

The population structure of Cerro Mangote is examined through the Juvenility Index, the Kaplan-Meier hazard, and the Siler competing hazard models. The Juvenility Index (summarized in Table 6.2) considers the impact of fertility on the population structure of samples, which is more influential on population structure than mortality. The ratio of 0.239 suggests a growth rate between 0.5% and 1% (Bocquet-Appel 2002, Wilson 2010). The lower end of the range is a reasonable estimate, a concept further explored in the next chapter. Furthermore, the ratio will be useful in comparison to any future sites to assess growth in the region. The Kaplan-Meier survivorship plot (Figure 6.1) illustrates the lifetime survivorship of the sample, with the magnitude of the step indicating the changing risk of death relative to age-at-death, and the length of the step indicating missing data. The dotted lines denote fairly wide error intervals that coincide with gaps in the data, impacting the resolution of the data, a concept further discussed in the next chapter.

Table 6.2: ${}_{15}P_5$ death proportions at Cerro Mangote

0-4 yrs.	5-19 yrs.	> 5 yrs.	n	${}_{15}P_5$
33	16	67	110	0.239

Figure 6.2 illustrates the force of mortality component of the Siler model. Since there were a few neonates in the sample (n=4), the function does not start at “0” as the

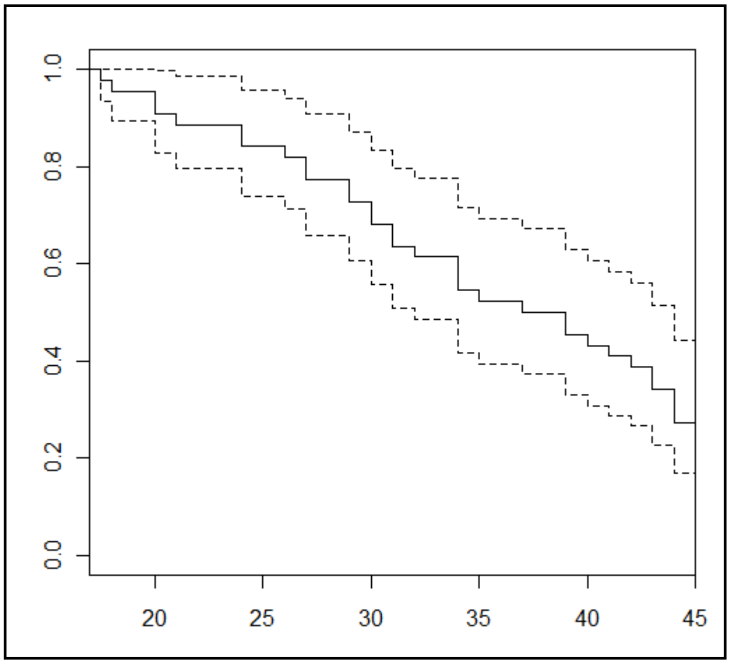

Figure 6.1: Kaplan-Meier survival plots of Cerro Mangote

theoretical model does (see Chapter 6, Figure 6.3). Additionally, as older adults can only be aged as “50+”, the line ends abruptly in comparison to the theoretical model. Figure 6.3 shows the survivorship curve for Cerro Mangote. Combined with the ${}_{15}p_5$ death proportions, the survivorship curve illustrates a high risk of death prior to age 15, with approximately 50% of the sample dying before age 10. Like the force of mortality graph, the line is truncated compared to the theoretical model due to the restrictions of determining elderly age using skeletal markers. Typically, survivorship frequencies level off after infancy, but due to sample size restrictions, there is no leveling.

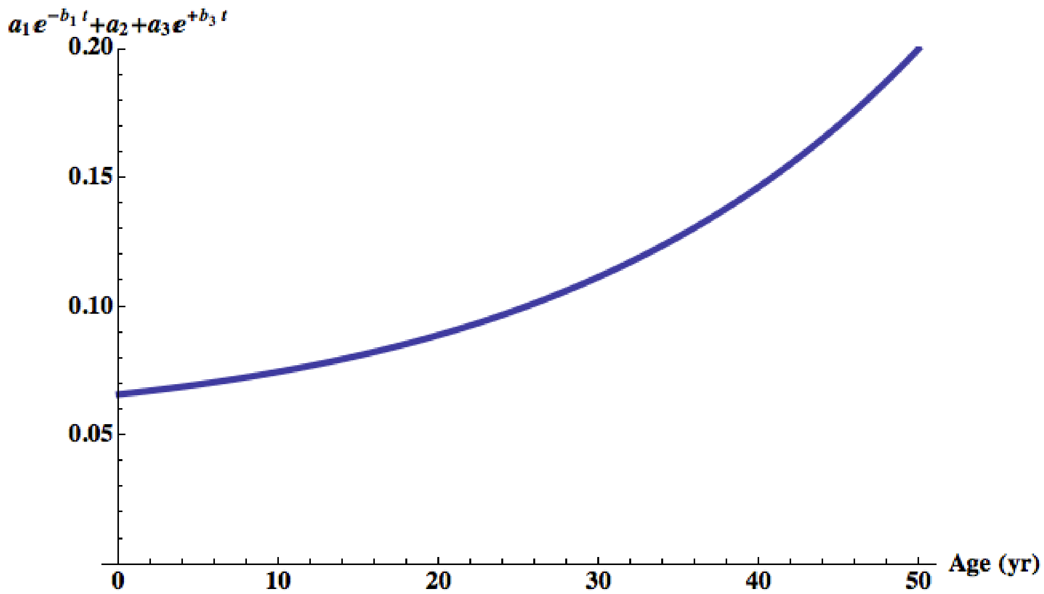

Figure 6.2: Force of mortality calculations at Cerro Mangote

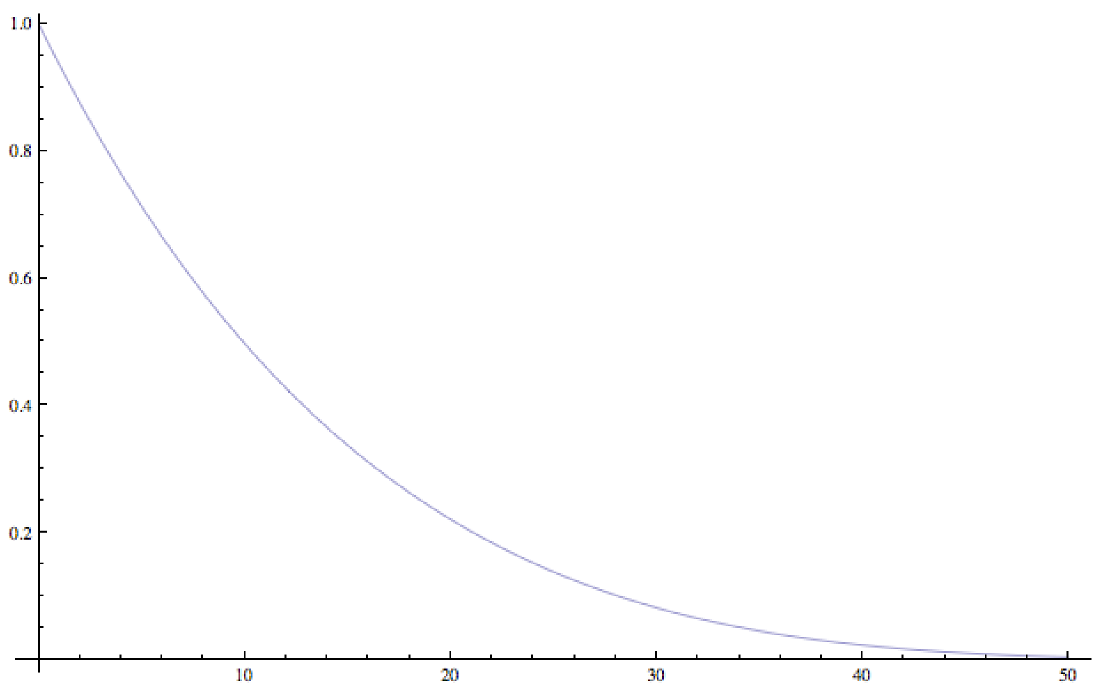

Figure 6.3: Survivorship curve for Cerro Mangote

6.1.2 Anthropophagy

Early analysis suggested that some of the remains, particularly the bundle burials, had markings consistent with cannibalism and/or tool marks (see McGimsey *et al.* 1987, Norr 1991, Ranere n.d.). Ranere (n.d.) proposed that the presence of tool marks on the bundle burials may be consistent with disarticulation for transport if the population occupied Cerro Mangote seasonally:

> One possible explanation for the occurrence of both primary and secondary burials at the site is that the former represent persons who died at the site and that the latter represents persons who died when the group was residing elsewhere. In the case of a death away from a cemetery, the skeletons would be [de]fleshed (*sic*) and the bones packaged for eventual transport to Cerro Mangote and subsequent burial. Rex Gonzales (personal communication) pointed out that this pattern has been documented for migratory populations in Argentina. (14-15)

My analysis has examined the markings on the remains, and I feel it is unlikely that the described grooves present on the bones are consistent with disarticulation by a tool (Dominguez-Rodrigo and Jose Yravedra 2009, Greenfield 1999, Haglund and Sorg 2001). While the collection is highly fragmented, none of the cut mark morphologies are consistent with the expected U-shaped grooves with irregular margins formed by stone tools[51] (Blumenschine *et al.* 1996, Dominguez-Rodrigo and Jose Yravedra 2009, Greenfield 1999, Olsen and Shipman 1988, Potts and Shipman 1981, Shipman and Rose 1983, Symes *et al.* 2002, White and Toth 1989). The overall patterns observed on the skeletal remains are consistent with postmortem damage, most likely from metal tools used in excavation (as many of the cutmarks were also lighter or white in color), root damage, or rodent gnawing (see Figure 6.4).

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[51] Since Cerro Mangote predates metal tools, only stone tools are considered in this analysis. Additionally, Greenfield (1999) compared metal and stone tool cut marks, concluding that "metal tools have steep and smooth V-shaped profiles, while stone tools have two distinctly different sides – a smooth and a rough side. The smooth side rises steeply and smoothly; the rough side rises more gradually, with multiple striae from the various facets left over from production" (804). These characteristics vary distinctly from possible stone tool markings.

Furthermore, utilizing the criteria discussed in Chapter 5, there was no evidence of cooking of bone and no evidence of abrasions from anvils. The only polishing present on any skeletal elements is consistent with eburnation and arthritis, not cooking. Additionally, there is no evidence of tool marks used during the perimortem interval on any skeletal elements.

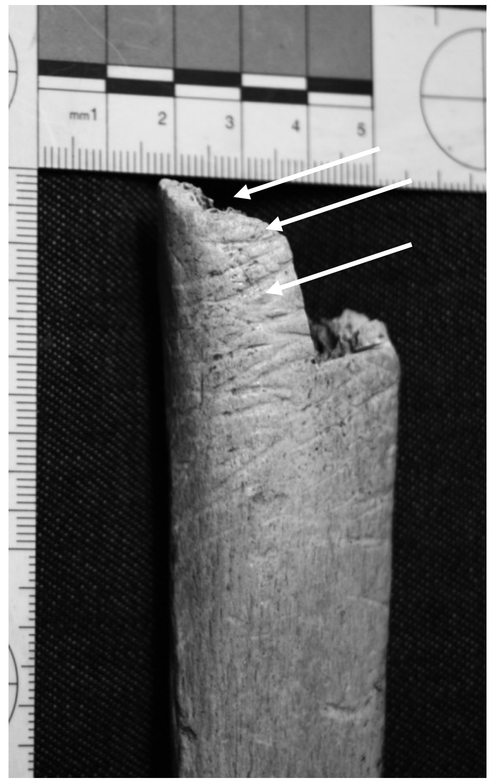


Figure 6.4: Examples of rodent gnawing from CO-40-26. L humerus above, L tibia right.

The remaining criteria documented at Cerro Mangote for possible cannibalistic activity were the presence of crushed vertebrae and crushed bone. Turner and Turner (1992) emphasize that the skeletal elements were "deliberately" crushed as an indication of cannibalism. The skeletal fragments at Cerro Mangote were assessed for indications of perimortem fractures. Though the perimortem interval can extend for years after death (and/or burial), none of the skeletal elements present showed characteristics of perimortem breaks (see Galloway 1999). The damage observed in the sample is consistent with dry bone breaks or postmortem crushing. Additionally, the damage was not limited to disarticulated or bundle burials, providing further evidence against the theory of cannibalistic practices present at the site.

6.2 Archaeofaunal results

Information regarding distribution and migratory patterns were found using a variety of faunal sources (see Table 6.3). All data collected regarding known distribution and migratory patterns are based on modern species and inferred for the archaeological specimens. Only specimens identified to the species level were considered, since the distribution of individuals at the genus or species level was, in most cases, too widespread to offer clues into site use at Cerro Mangote. The distribution and seasonality for each species are reported from previously published data. At the current level of detail in this dissertation, the information gives an indication as to the presence or absence of certain species. For example, there are 1880 elements representing white tailed deer (*Odicoileus virgineanus*). These 1880 elements are a count of skeletal elements that are identified as deer, not necessarily representing a certain number of individuals. The elements may represent hundreds of deer, or one fragmented skeleton.

Table 6.3: Species distribution and seasonality

Species	Distribution; Season in Panama	Count
Sharks/rays/skates		
Carcharhinidae[1]	Marine; Winter/spring	3
Carcharhinus altimus[1]	Marine; year round	7
Carcharhinus leucas[1]	Marine; year round	59
Urotrygon asterias[1]	Eastern Pacific; year round	2

Species	Distribution; Season in Panama	Count
Fish		
Albula neoguinaica[1]	Micronesia; Unknown	10
Anisotremus dovii[1]	Gulf of California to Peru; year round	1
Arius kessleri[1]	Pacific coast; year round	42
Arius lentiginosus[1]	Pacific coast; year round	2
Arius osculus[1]	Pacific coast; year round	4
Arius platypogon[1]	Pacific coast; year round	4
Arius seemanni[1]	Rivers & estuaries; year round	112
Bagre panamensis[1]	Pacific coast; year round	2
Bagre pinnimaculatus[1]	Pacific coast; year round	7
Bairdiella armata[1]	Atlantic and Pacific; year round	4
Bairdiella ensifera[1]	Pacific coast; year round	2
Bathygobius andrei[1]	Pacific coast; year round	2
Carangoides otrynter[1]	Pacific coast; year round	1
Caranx caninus[1]	Pacific coast; year round	11
Cathorops multiradiatus[1]	Pacific bays, rivers; year round	2
Cathorops tuyra[1]	Pacific draining rivers; year round	8
Centengraulis mysticetus[2]	Pacific bays; year round	2
Centropomus armatus[1]	Pacific coast; year round	21
Centropomus medius[1]	Pacific coast; year round	16
Centropomus nigrescens[1]	Pacific coast; year round	1
Centropomus robalito[1]	Pacific coast; year round	6
Centropomus viridis[1]	Pacific coast; year round	26
Chloroscombrus orqueta	Pacific mangroves; year round	2
Cynoscion albus[1]	Pacific coast; year round	17
Cynoscion squamipinnis[1]	Pacific coast and bays; year round	1
Cynoscion stolzmanni[2]	Pacific coast; year round	7
Diapterus peruvianus[2]	Pacific coast; year round	13
Dormitator latifrons[2]	Pacific coast; year round	425
Eleotris picta[2]	Pacific draining rivers and coast; year round	3
Elops affinis[2]	Pacific coast; year round	1
Epinephelus analogus[2]	Pacific coast reefs; year round	1
Eucinostomus currani[2]	Pacific coast; year round	1
Eugerres brevimanus[2]	Pacific coast and lagoons; year round	2
Eugerres lineatus[1]	Pacific coast; year round	8
Gerres cinereus[2]	Mangrove; year round	3
Gobioides peruanus[2]	Pacific coast; year round	11
Gobiomorus maculatus[2]	Pacific draining rivers; year round	4
Haemulon flaviguttatum[2]	Pacific coast; year round	1
Ilisha furthii[1]	Pacific coast; year round	6
Lobotes surinamensis[2]	Pacific and Atlantic coasts; year round	9
Lutjanus argentiventris[2]	Pacific coast; year round	3

Species	Distribution; Season in Panama	Count
Lutjanus colorado[2]	Pacific coast; year round	1
Lutjanus guttatus[2]	Pacific coast; year round	1
Lutjanus novemfasciatus[2]	Pacific coast; year round	2
Menticirrhus panamensis[2]	Pacific coast and bays; year round	1
Micropogonias altipinnis[2]	Pacific coast; year round	8
Mugil curema[2]	Pacific coast; year round	15
Oligoplites altus[2]	Pacific coast; year round	5
Ophioscion scierus[2]	Pacific coast; year round	2
Ophioscion typicus[1]	Pacific coast, shallow waters; year round	8
Ophioscion vermicularis[2]	Pacific coast; year round	1
Opisthonema libertate[2]	Pacific coast; year round	16
Orthopristis chalceus[2]	Pacific coast; year round	22
Paralonchurus dumerilii[2]	Pacific coast; year round	2
Polydactylus approximans[2]	Pacific coast; year round	2
Polydactylus opercularis[2]	Pacific coast; year round	35
Pomadasys (H.) elongatus[1]	Pacific coast; year round	1
Pomadasys (H.) leuciscus[2]	Pacific coast; year round	3
Pomadasys (H.) nitidus[2]	Pacific coast; year round	2
Pomadasys macracanthus[2]	Pacific coast; year round	32
Sciadeichthys dowii[1]	Pacific coast; year round	345
Selene peruviana[2]	Pacific coast; year round	3
Sphoeroides annulatus[2]	Pacific coast; year round	7
Stellifer oscitans[2]	Pacific coast; year round	3
Strongylura scapularis[2]	Pacific coast; year round	1
Frog		
Bufo marinus[3]	Native to Central and South America	26
Reptile		
Ameiva ameiva[4]	Native to Central and South America	3
Basiliscius basiliscus[4]	Native to Central and South America	1
Boa constrictor[4]	Native to Central and South America	7
Crocodylus acutus[4]	Native to Central and South America	1
Ctenosaura similis[4]	Native to Central and South America	32
Iguana iguana[4]	Native to Central and South America	30
Eretmochelys imbricata[4]	Nesting areas on Atlantic and Pacific coasts	2
Kinosternon scorpiodes[4]	Native to Central and South America	14
Birds		
Amazona ochrocephala[5]	Native to Central and South America	1
Calidris cantus[5]	Migratory bird; winters in South America	2
Calidris mauri[5]	Migratory bird; winters in South America	3
Catoptrophorus semipalmatus[5]	Migratory bird; winters on Atlantic coast of South America	8
Columbina talpacoti[5]	Native to Central and South America	1

Species	Distribution; Season in Panama	Count
Egretta alba[5]	Widespread distribution from North to South America	4
Eudocimus albus[5]	Distribution from North to South America	19
Geotrygon montana[5]	Breeds in Central and South America	4
Numenius phaeopus[5]	Winters in Central and South America	1
Tringa melanoleuca[5]	Winters in Central and South America	1
Zenaida asiatica[5]	Native to Central America	1
Mammal		51
Caluromys derbianus[6]	Native to Central and South America	1
Canis familiaris	Widespread distribution	2
Cuniculus paca[6]	Native to Central and South America	13
Dasyprocta punctata[6]	Native to Central and South America	1
Dasypus novemcinctus[6]	Native to Central and South America	13
Liomys adspersus[6]	Central Panamanian lowlands	2
Odicoileus virgineanus	Widespread distribution	1880
Sylvilagus brasiliensis[6]	Native to Central and South America	6
Tamandua mexicana[6]	Native to Central and South America	11
Tamandua tetradactyla[6]	Native to South America	6
Tayassu tajacu[6]	Native to Central and South America	3
Procyon lotor[6]	Native to Central America	408
Panthera onca[6]	Native to Central and South America	1
Potos flavus[6]	Native to Central and South America	13
Sciurus variegatoides[6]	Native to Central and South America	1

Numbers indicate citation source: [1]Pollok (2011); [2]Froese and Pauly (2011); [3]Hilgris (2001); [4]Malhotra and Thorpe (1999); [5]Alderton (2003); [6]Meyers *et al.* (2006)

The presence of certain organisms indicates various characteristics of the environment, particularly the variety of fish that represent marine and euryhaline environments. These euryhaline fish are especially important in the reinterpretation of Norr's 1991 data, which is considered further in the next section. In addition to considering seasonality, previous studies and their conclusions are considered in the interpretation of the faunal material. As other analyses of the faunal material have expressed, there does not appear to be a particular resource that dominates the archaeofaunal assemblage (see Martin *et al.* 2011). The preferential hunting patterns of deer and iguana observed at Cerro Mangote are more consistent with ceramic sites than Preceramic sites (see Cooke and Jimenez 2008a, Cooke *et al.* 2007, 2008, 2013). Also, the presence of *Cardisoma* crab in the later layers indicates occupation at least during the rainy season to exploit this resource, a concept considered in the framework of the previous notions of use at the site (Cooke 2005, Griggs 2005).

6.3 Cemetery organization

This first section summarizes the burial descriptions, burial orientation, and biological profiles in the Cerro Mangote cemetery. The following paragraphs provide an overview of the data included in Appendix 1, including summaries of the field burial descriptions, location and orientation, and the biological profiles for each individual[52]. The burial descriptions also include any information regarding who separated any commingled burials: the University of Texas (Texas), Lynette Norr (L. Norr) or myself (A. Huard). Additionally, individuals represented by commingled materials are noted in the burial descriptions of the 1955 and 1956-1957 excavations.

All three excavations record the presence of primary and secondary burial types. Primary burials consisted of tightly flexed and loosely flexed individuals. Secondary burials consisted of bundle burials (as described in Chapter 2), and disarticulated burials, which are typically a disorganized reburial of an individual. The excavation notes also situate the majority of the burials in terms of position within the overall grave and cardinal direction of the head.

[52] Some of the burials from the first two excavations received multiple labels, resulting in a discontinuity between the labels in the field (and notes) and laboratory analysis.

6.3.1 Burial summary

According to my analysis, the estimated minimum number of individuals at the Cerro Mangote sample is 110, approximately 20 more individuals than previously recorded (see McGimsey *et al.* 1987, Norr 1991). This increase is primarily due to the inclusive representation of all individuals in Burial 19, a commingled burial whose previous count of 3 has now been increased to 12 individuals based on dentition (for the juveniles) and os coxae (for the adults).

Burial type was assigned based on excavation notes and photographs of the burials. The excavation notes classified three burial types: primary burials (tightly flexed, loosely flexed, flexed), secondary burials (bundle, disarticulated) and unknown. Commingled individuals separated during analysis are not included in the assessment of burial types. First, a cursory examination of the photographs and locations revealed that all bundle burials were associated with primary burials, either within the same burial accession number or within the same pit. Relationships of variables were assessed using Pearson's Chi-Square, where significance is defined as $p<0.05$. Initial assessment of burials by type and age had no significance. Collapsing burial types to "Primary," "Secondary" or "Unknown" did show significant correlation ($p = 0.031$), as did excluding the "Unknown" burial type ($p = 0.041$) (Table 6.4). Burial type did not correlate significantly sex, with a p-value of 0.119 (Table 6.5).

Data related to burial types, orientation, and position were taken from the original excavation notes, correlated using Pearson's Chi-Square (Tables 6.6 – 6.8), with burial type and position, burial type and head orientation, and burial position and head orientation significantly correlated to each other. McGimsey *et al.* (1987) suggested that secondary burials had fewer skeletal elements present due to disarticulation or processing; however, burial type did not significantly correlate with the percentage of

Table 6.4: Burial type by age[53]								
Age	Primary	Secondary	Unknown	Total	Age	Primary	Secondary	Total
0-5	7	3	7	17	0-5	7	3	10
5-10	5	0	3	8	5-10	5	0	5
15-20	3	0	0	3	15-20	3	0	3
20-35	4	8	1	13	20-35	4	8	12
35-50	11	3	4	18	35-50	11	3	14
50+	0	0	1	1				
U	3	3	4	10	U	3	3	6
Total	33	17	20	n=70	Total	33	17	n=50

p = 0.031 p = 0.041

Table 6.5: Burial type by sex distribution (p = 0.119)							
	Tight flex	Loose flex	Flexed	Disarticulated	Bundle	Unknown	Total
F	4	0	0	1	1	1	7
F?	0	0	0	1	4	0	5
?	1	0	0	0	0	0	1
M?	5	1	0	1	0	1	8
M	5	2	1	1	4	5	18
U	10	3	0	0	4	14	31
Total	25	6	1	4	13	21	n=70

skeletal completeness. Skeletal completeness was categorized as 0 – 25%, 25 – 50%, 50 – 75%, and 75 – 100% using the skeletal inventories created for each individual. Effective sample size for Cerro Mangote ranges between 50 – 75 individuals, depending on the formula chosen for determining a significant sample size for categorical data (see Bartlett *et al.* 2001, Cockran 1977, Wunsch 1986). This suggests that burial type/position relationship is significant, but that the relationships between burial type, position, and head orientation may be a statistical artifact and not a true relationship.

[53] There were no individuals of age 10 – 15 with known burial information. Also, since the only burial aged 50+ with burial information was "Unknown," the individual was eliminated when only considering primary or secondary burial categories.

Table 6.6: Burial type and burial position at Cerro Mangote (p = 0.006)							
	Bundle	Disarticulated	Loose flex	Tight flex	Unknown	flexed	Total
Left	0	0	2	1	1	0	4
Prone	0	0	0	2	0	0	2
Right	0	0	1	6	0	0	7
Supine	7	0	2	12	1	0	22
Unknown	5	4	1	4	15	1	30
Total	13	4	6	25	21	1	n=65

Table 6.7: Burial position and head orientation at Cerro Mangote[54] (p = 0.05)										
	E	E?	N	NE	NW	S	SE	SW	W	Unknown	Total
Left	0	0	1	1	0	1	0	0	1	2	6
Prone	0	0	1	0	0	1	0	0	0	0	2
Right	2	0	4	0	0	1	0	0	0	0	7
Supine	0	0	14	0	1	1	1	1	5	0	23
Unknown	1	1	0	1	0	1	0	1	0	0	5
Total	3	1	20	2	1	5	1	2	6	2	n=43

Table 6.8: Burial type and head orientation at Cerro Mangote (p = 0.009)						
	Bundle	Disarticulated	Loose flex	Tight flex	Unknown	Total
E	0	1	0	2	0	3
E?	0	0	0	0	1	1
N	5	0	1	12	1	19
NE	1	0	0	0	1	2
NW	1	0	0	0	0	1
S	0	1	3	1	0	5
SE	1	0	0	0	0	1
SW	0	1	0	1	0	2
W	0	0	1	4	0	5
Unknown	0	0	0	1	0	1
Total	8	4	5	21	3	n=40

6.3.2 Taphonomy

As mentioned in Chapter 2, the taphonomic processes indentified at Cerro Mangote are extensive and complicate the biological profile analysis. The extensive

[54] If both the head orientation and burial position were recorded as "Unknown," the individual was removed from this correlation. Including these individuals resulted in a Pearson's Chi-Square significance value of 0.00.

fragmentation of the sample obscures pathologies, hampers potential element re-associations, and decreases the ability to reconstruct commingled individuals. The most common and extensive taphonomic condition present at Cerro Mangote is shell concretions that adhere to bone, with 20% of the burials affected (22/110). The combination of shell, soil, and bone form a type of coquina, or limestone sedimentary rock. These concretions cemented skeletal elements to each other (see Figure 6.5), cement non-human material to bone, and form adhesions on the surfaces of bone. While the concretion of skeletal elements to each other or other material makes

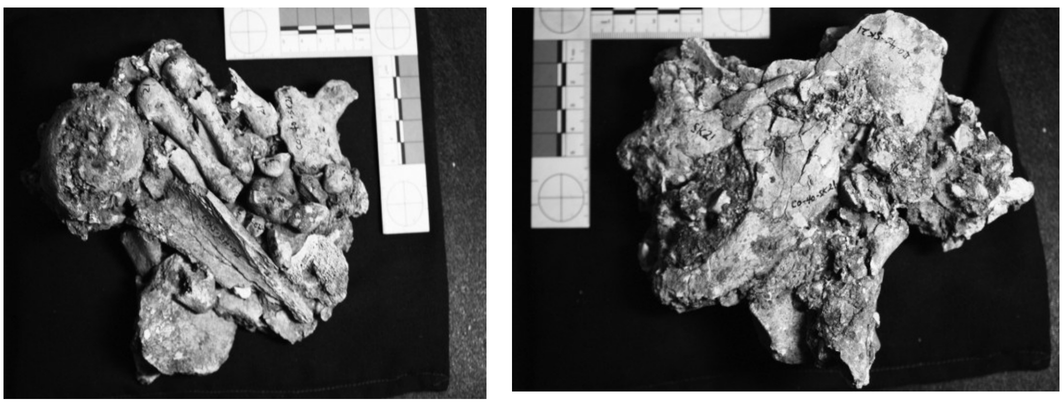


Figure 6.5: Example of bone adhered to other elements due to shell concretions. Left hand of CO-40-21 adhered to humeral head. Left mandible and cranium adhered to backside of concretion.

observation difficult, the adhesions on the surface of bone proved most problematic. As illustrated in Figure 6.6, the adhesions very closely resemble skeletal lesions. The irregular surface and porous nature of the adhesions look very similar to active periostitis. More than half of the secondary burials are eroded or bleached, whereas 10 out of 32 primary burials show erosion or bleaching (see Table 6.9).

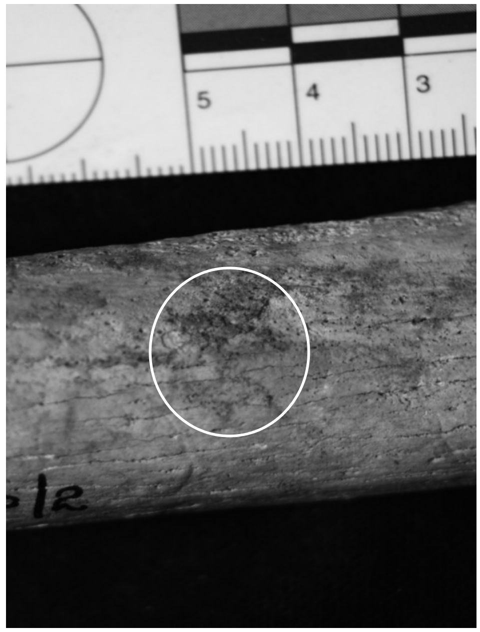


Figure 6.6: Example of shell adhesion (circled) next to an active periostitis lesion from CO-40-27 left femur.

Table 6.9: Burial type with erosion and/or bleaching at Cerro Mangote							
	Bundle	Disarticulated	Tightly flexed	Loosely flexed	Unknown	Lab	Total
Total	4	3	6	4	1	3	21

6.3.3 Biospatial analysis

Introduced in Chapter 2, in-group assessment of kinship analysis is based upon three groupings of burials, delineated by columns. Visual inspection of the site, and the location of the stacked stone and burials, suggest there may be a relationship between the columns and the individuals buried within the three groupings. Figure 6.7 shows the three column groups, with the number of individuals analyzed from each group. Adults and juveniles were considered together, as were males and females. To assess the relationship of individuals within these three groups, principal component 1 and principal

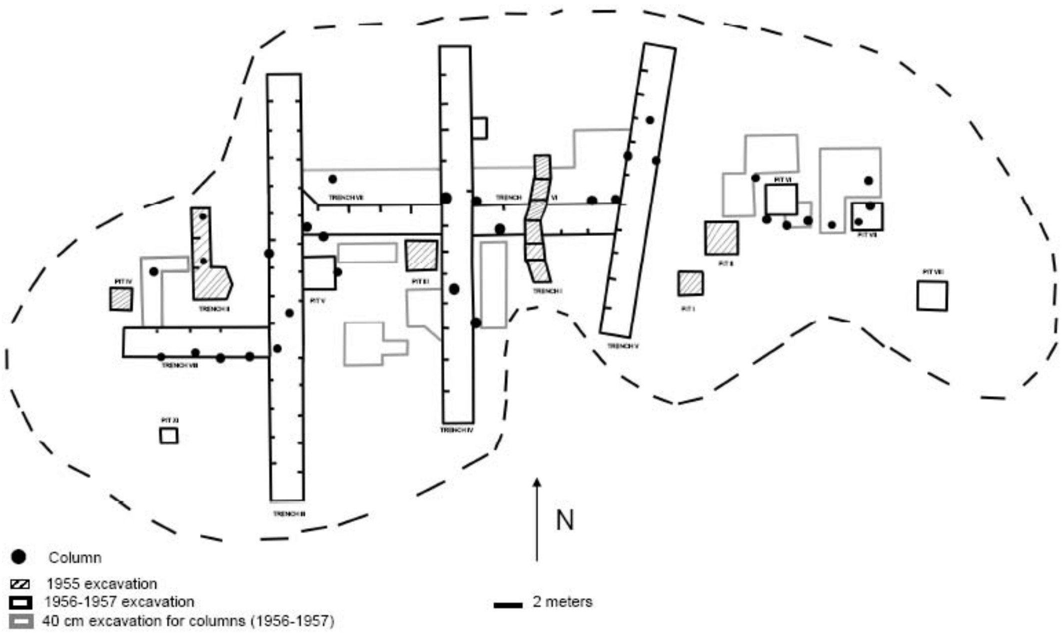


Figure 6.7: Column groupings at Cerro Mangote used for PCA

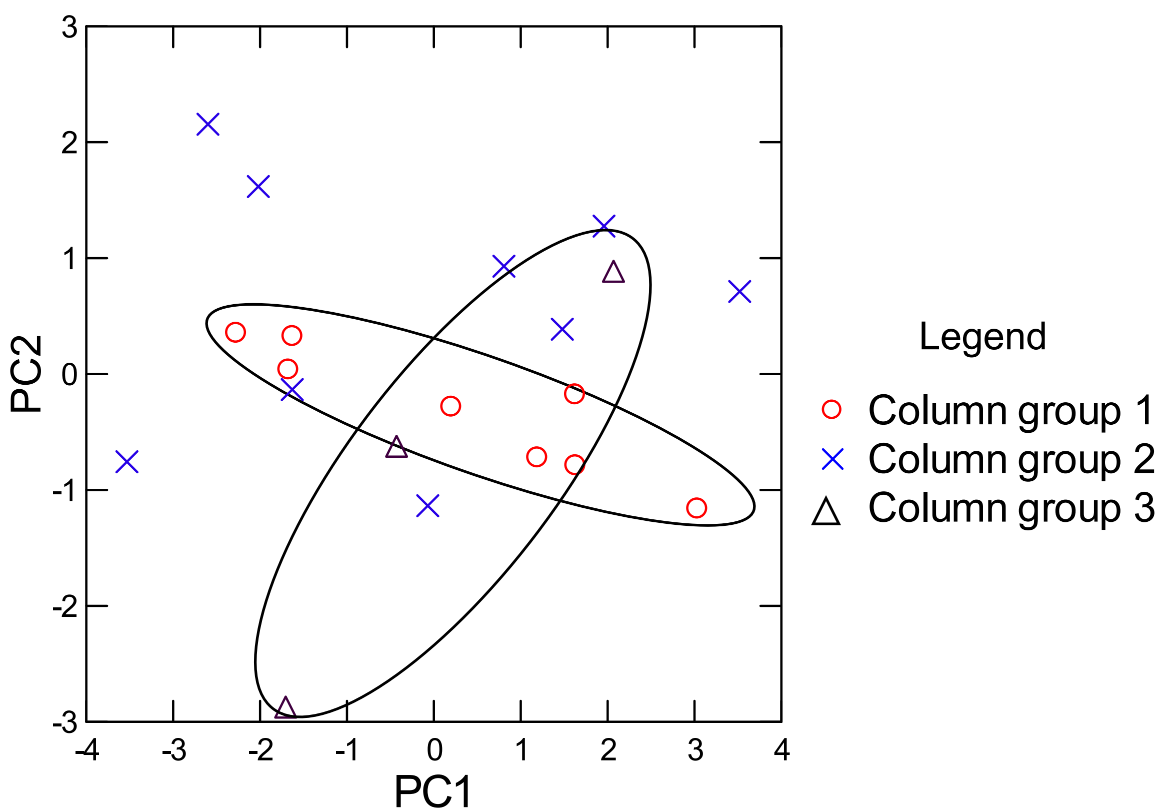


Figure 6.8: Principle components by burial

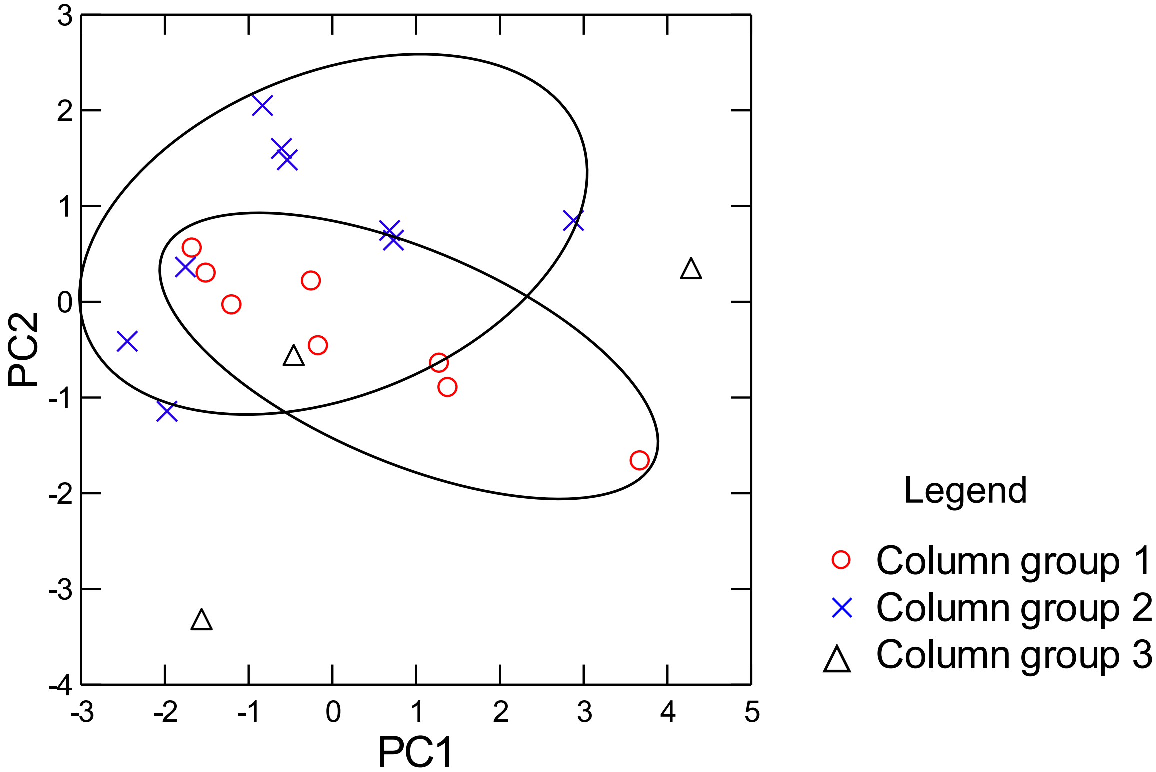


Figure 6.9: Principle components by burial (size

component 2 (PC1 and PC2) from the buccolingual measurements were plotted. PC1 describes overall tooth size, whereas PC2 describes the size difference between molars and premolars. PC1 explains approximately 55% of the variance, whereas PC2 explains approximately 20% of the variance (eigenvalues for PC1: 4.265, eigenvalues for PC2: 3.039). Figure 6.8 shows the specificity of the raw data and Figure 6.9 graphs the size-corrected data. The first and second column clusters grouped more cohesively than the third, but there was quite a bit of overlap in each, illustrated by the ovals delineating the boundaries of the first and second column groups. The findings suggest there is no relationship between the burial groups.

6.4 Subsistence patterning results

This section reports the findings of the analysis of the musculoskeletal stress markers, cross-sectional geometry, archaeofaunal interpretations, and the reinterpretation of the stable isotope data collected by Norr (1991). First, I present the results of musculoskeletal stress markers and synergist muscle groups at Cerro Mangote. The canonical scores of the discriminant function analysis are then compared to Rhode's (2006) model to determine subsistence patterning, suggesting a mixed to fishing based subsistence. Next, the cross-sectional geometric features of the humeri and femora are considered, first examining differences by sex. The overall shape of the cross-sections gives a broad view of types of forces the long bones were subjected to in life, with the medio-lateral plane indicating the most change. The archaeofaunal findings are considered, paying close attention to the findings of Grayson (1981) regarding the impact of the mechanisms of accumulation on the archaeofaunal sample. Finally, the original stable isotope data is compared to current findings in the field, particularly the impact of nitrogen fixation on carbon and nitrogen signatures, indicating the initial interpretations of a diet with a strong marine component.

6.4.1 Musculoskeletal stress marker results

Following Rhode (2006), the synergist muscle groups were analyzed using discriminant function analysis, grouped by sex. The discriminant function creates a sum of weighted values, which are calculated from predictor variables. The weights are scaled in order to maximize between group differences and minimize within group differences (Kachigan 1991, Barfield *et al.* 2006). Table 6.10 contains the canonical coefficients of the analysis created using the raw data set. Sex estimations were reduced to male or female, eliminating one individual of ambiguous sex, in order to match Rhode's (2006) original variables.

Table 6.10: Female and male canonical discriminant function coefficients				
	Huard results		Rhode results (2006)	
	Female	Male	Female	Male
SCPERD	0.08	0.04	no data (nd)	nd
FLXARM	-0.12	-0.14	0.38	-0.17
ADDARM	0.09	0.08	nd	-0.02
MDRARM	-0.02	-0.03	nd	-0.05
FRARMFX	0.08	0.11	nd	nd
FRARMEX	0.04	0.06	nd	nd
EXTARM	-0.08	-0.05	nd	0.34
PRNFARM	-0.01	-0.07	nd	nd
SUPFARM	0.11	0.13	nd	nd
FLXTHG	0.02	-0.01	-0.01	nd
ADDTHG	0.04	0.04	-0.64	nd
LTRTHG	-0.04	-0.03	0.18	nd
EXTLEG	-0.08	-0.05	0.09	0.00
PLTFXFT	0.14	0.11	0.09	-0.16
BTEXT	-0.01	0.06	nd	0.02
EAE	0.00	0.00	nd	1.12
TIBSQFCT	-0.02	-0.02	nd	-0.41
SEPAPRT	-0.16	-0.22	nd	nd
Constant	-0.18	-0.26	0.11	-0.28
Averages[55]	0.40	0.18		

Rhode created a range of possible values based on stacked histograms for male and female farmers and fishers, with the overlapping areas labeled as "unknown". Based on the scale, the male individuals' average canonical discriminant function coefficients are greater than -0.20, and therefore in the "fisher" category. The female individuals' average canonical discriminant function coefficients are between 0.25 and 0.60,

[55] The averages presented do not include the EAE scores, as all the scores were 0 for individuals at Cerro Mangote, resulting in a canonical coefficient of 0, which artificially lower the average. If the scores were included, the averages would be 0.37 for females and 0.17 for males.

therefore in the "unknown" category. Table 5.5 summarizes Rhode's original categories and values.

Table 5.5: Discriminant score subsistence scale (modified from Rhode 2006)				
Female				
Farmer	? Farmer	Unknown	? Fisher	Fisher
< - 0.10	- 0.10 to 0.25	0.25 to 0.60	0.60 to 0.95	> 0.95
Male				
Farmer	? Farmer	Unknown	? Fisher	Fisher
< -1.03	-1.03 to -0.75	-0.75 to -0.48	-0.48 to -0.20	> -0.20

Standardization for body size was not possible in this analysis. While an aggregate score for body size could be calculated, only three individuals had sufficient humeral measurements to calculate a humeral index. When the individual index was compared to the average, there was insufficient data to complete the standardization.

6.4.2 Cross sectional geometry results

To consider the internal changes to long bones, the cross sectional geometry of six femora and four humeri were considered. Males and females were compared (see Table 6.11 for the variables). The male femora and humeri were longer than the female femora and humeri, but student-t tests indicates the differences are not statistically significant ($p = 0.2$ and 0.1 respectively). At $p<0.05$, the differences were statistically insignificant with regard to length, so the femora and humeri are interpreted together (see Ruff *et al.* 1993) for most variables of shape to increase the statistical significance of the sample (see Table 6.12). The only variables where males showed significant variance were Ix/Iy for the humeri and Imax for the femora.

Table 6.11: Cross sectional geometry variables	
Variable	Definition
z	longitudinal axis of the diaphysis
y	anteroposterior axis
x	mediolateral axis
TA	total periosteal area
CA	cortical area
Ix	second moment of area about the x axis
Iy	second moment of area about the y axis
Imax	maximum second moment of area
Imin	minimum second moment of area
J	Torsional rigidity
Ix/Iy	ratios of second moments of area
Imax/Imin	ratios of second moments of area

Table 6.12: Cross sectional geometry summary values			
		Femora (n=6)	Humeri (n=4)
Max length	Mean	423.33	292.35
	SD	24.29	13.14
Length'	Mean	399.83	N/A
	SD	17.5	N/A
TA-std	Mean	796.57	1029.07
	SD	86.18	148.25
CA-std	Mean	627.73	768.14
	SD	57.89	88.15
Xbar	Mean	115.67	114.22
	SD	1.21	4.24
Ybar	Mean	107.37	122.40
	SD	3.93	9.15
Ix-std	Mean	287.26	388.68
	SD	52.75	91.48
Iy-std	Mean	252.53	359.13
	SD	51.01	103.31
Imax-std	Mean	314.61	421.20
	SD	72.74	110.97
Imin-std	Mean	234.14	326.61
	SD	44.06	76.51
J-std	Mean	548.75	712.87
	SD	2.78	24.29
Ix/Iy	Mean	1.15	1.11
	SD	0.18	0.16
Imax/Imin	Mean	1.34	1.28
	SD	0.07	0.05

The Ix/Iy ratio measures bending rigidity and is an index of shape (Ruff 1987). An Ix/Iy of 1.0 suggests a more rounded cross-section, where the shape has an equal distribution around the x and y axes. The aggregate Ix/Iy of Cerro Mangote is greater than 1.0, consistent with more anterior-posterior bending, elongating the cross-section anterior-posteriorly. The male humeri had significant separation from the female humeri ($p = 0.02$), which indicates that the males had more anterior-posterior bending than the females. One male and one female femora had Ix/Iy of slightly less than 1.0 (0.97 and 0.91 respectively), which suggests these two individuals had greater medio-lateral bending strength, with elongation in the same plane. Based on the published values of different hunter/gatherer groups, the values are similar to those published for mostly sedentary groups that form hunting/fishing parties for specific expeditions (see Knobbe 2010).

While the Imax variable did show significant separation ($p = 0.047$) of the male femora from the female femora, none of the combined variables indicating shape (J, Imax/Imin, Ix/Iy) were significant, nor were the measures of bending shape (Iy, Ix, Imin). Imax indicates males had more compensation for bending strength than females in the direction of greatest stress, but the direction is not significant. The compensation for bending strength suggests more habitual loading in males from more activity, but the sample size is quite low, which complicates the statistical interpretation.

6.4.3 Isotopic signatures revisited

Norr (1991) sampled isotopic data from 322 individuals from 23 sites in Panama, Costa Rica, and Belize. The sample included 48 individuals from Cerro Mangote, with 13 yielding successful results. Table 6.13 summarizes her original values for $\delta^{15}N$ and $\delta^{13}C$. These values were obtained using vacuum collection of gases from combustion- a popular method at the time- but it relied on large amounts of sample for a relatively low yield (Norr 1991: 42). Her interpretation of these values emphasized the C4 signature, suggesting maize consumption as part of the diet at Cerro Mangote (Norr 1995). When compared to other sites within her study, Cerro Mangote did have a C4 signature, but not as high as other later samples, where maize phytoliths are documented (see Dickau 2005, Piperno and Pearsall 1998). Figure 6.10 shows the relationship of Cerro Mangote values to the other samples from Parita Bay, illustrating that while there is overlap with some values, the majority of Cerro Mangote values are much lower than other sites.

Table 6.13: Cerro Mangote stable isotope from bone collagen (Norr 1991:144)

Provenience	δ15N	δ13C	C:N	%N/wt	%C/wt
Burial PH3ex1[56]	7.4	-14.4	3.4	1.6	4.7
Burial 31E	6.6	-14.1	3.4	3.4	9.9
Burial 31F	6.6	-14.6	3.5	3.4	10.1
Burial 68E[57]	7.6	-13.7	3.4	11.1	32.6
Burial 69i[58]	7.8	-12.9	3.4	7.7	22.2
Burial 69[59]	7.4	-12.8	3.4	9.9	29.1
Burial 15B	7.7	-13.7	3.4	3.1	8.9
Burial 27	7.7	-13.8	3.6	4.0	12.3
Burial 26	7.8	-13.8	3.4	3.5	10.2
Burial 20A	7.7	-13.5	3.3	9.3	26.6
Burial 22A	7.7	-14.2	3.2	3.8	10.4
Burial 32A		-12.5	3.1	1.7	4.6
Burial 23A	7.3	-13.7	3.4	12.0	34.7
Mean	7.4	-13.7	3.4	5.7	16.6
s.d.	0.4	0.6	0.1	3.6	10.4

[56] Burial PH3ex1 does not correspond to a burial assessed in this dissertation.

[57] Burial 68E corresponds to individual CO-40-68E/child6yo

[58] Burial 69i corresponds to individual CO-40-69/1yo

[59] Burial 69 corresponds to individual CO-40-69/adult

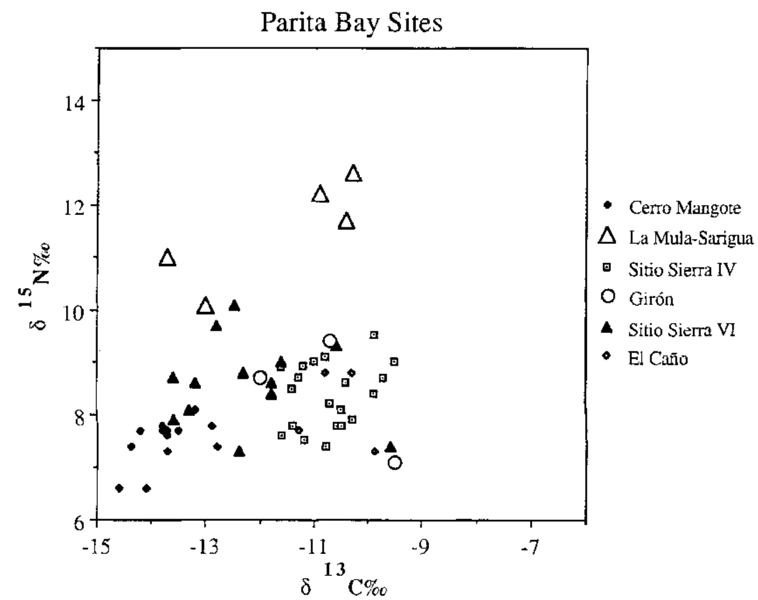


Figure 6.10: Carbon and nitrogen values from Cerro Mangote, La Mula-Sarigua, Sitio Sierra, Girón[60], and El Caño[61] (Norr 1991: 145)

At the time of publication, Norr's conclusions were reasonable, given her data. Indeed, her initial work (1991) alluded to the possible importance of marine sources in the diet of the Parita Bay region, with Figure 6.11 clearly situating the dietary components closer to terrestrial vertebrates and fish. Also, in her initial analysis, Norr (1991) emphasized the carbon isotope values, considering the nitrogen values more in terms of trophic levels. As discussed in Chapter 2, recent research (Keats 2002, VanderZanden and Rasmussen 2001) indicates that marine-based nitrogen causes carbon fixation, resulting in higher than expected carbon values (less negative) and lower nitrogen values. The isotopic signatures from Cerro Mangote have values consistent with those from a euryhaline environment, further supporting the concept that

[60] Girón is upstream from Cerro Mangote on the Santa Maria River, with pottery contemporary with Sitio Sierra. The site contained three burials (Norr 1991).

[61] El Caño is a large village site on the Grande River. Occupation began between 300BC – 500AD, through the sixteenth century and Spanish contact. Continuous looting and farming disturbed most of the site, but archaeological investigations suggest in the later occupation periods, earthen mounds were constructed for ceremonial rituals and burials (Norr 1991).

low nitrogen signatures are due to marine based nitrogen fixation. The presence of a euryhaline component is consistent with the archaeofaunal findings at the site.

By reconsidering the isotopic signatures, the argument of seasonal movement becomes suspect. While it does not eliminate the seasonal-occupation possibility, the need to explain a maize-based diet is lessened. Further, presence of maize at the site indicates that it was grown at the site, though not the foundation for the inhabitants' diets. There are no calculations to translate an isotopic signature to abundance within a diet, but the combination of a marine dominated faunal record and marine source represented in the isotopic signatures suggests constant settlement at Cerro Mangote to be near coastal resources.

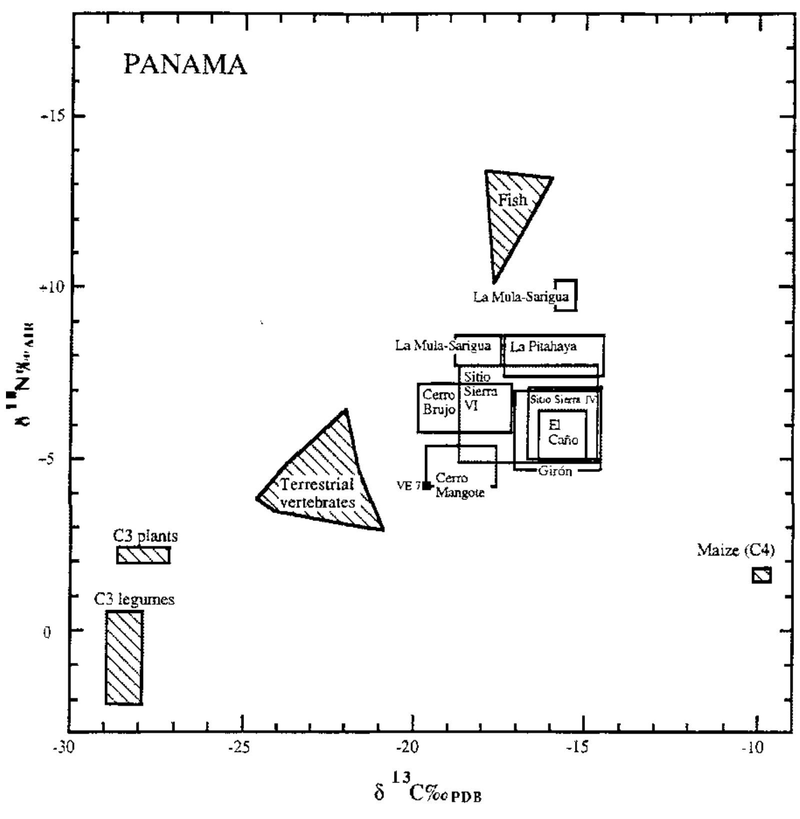


Figure 6.11: Norr's (1991:191) comparison of human and faunal carbon and nitrogen signatures

6.5 Health

The health at Cerro Mangote is assessed using multiple types of pathologies. First, summary dental pathologies are assessed and interpreted based on frequency and diet. Next, periostitis, a non-specific indicator of health, is considered. Frequencies and types of trauma, arthritis, and spinal defects are considered and compared to later skeletal samples. Finally, a single case of scurvy is discussed, as well as the criteria for determining the disease. It should be noted that at this point, there is no evidence for infectious disease, including treponemal diseases.

6.5.1 Dental pathologies

Norr (1991) reported nine linear enamel hypoplasias in the sample at Cerro Mangote[62]. When possible, Norr's recorded measurements for LEH were checked, revealing that many of the defects recorded as LEH were, in fact, other enamel defects, typically areas of hypocalcification, as illustrated in Figure 6.12 (see also Buikstra and Ubelaker 1994). My analysis assessed six LEH in four individuals, less than one percent of the sample (6/688). The details of the dental pathologies and frequencies are listed in Table 6.14. Only two caries involved multiple cusps, and only four individuals had calculus scores greater than one. The majority of teeth affected by caries, pitting and abscesses were molars, whereas calculus was found primarily on the anterior teeth (for specifics, see Appendix 5).

[62] Norr's (1991) analysis did not provide the total number of teeth assessed in her analysis. Since the sample has been transported and moved a number of times, it is more than likely she examined more than the 688 teeth available in this analysis. If using the sample size available for this analysis, the number of teeth with LEHs represents 1.3% of the sample.

Table 6.14: Dental pathologies at Cerro Mangote (n=688)		
Dental pathology	Number of teeth affected	Frequency
Antemortem tooth loss	124	0.180
Caries	10	0.015
Pitting	32	0.047
Abscesses	12	0.017
Calculus	185	0.269

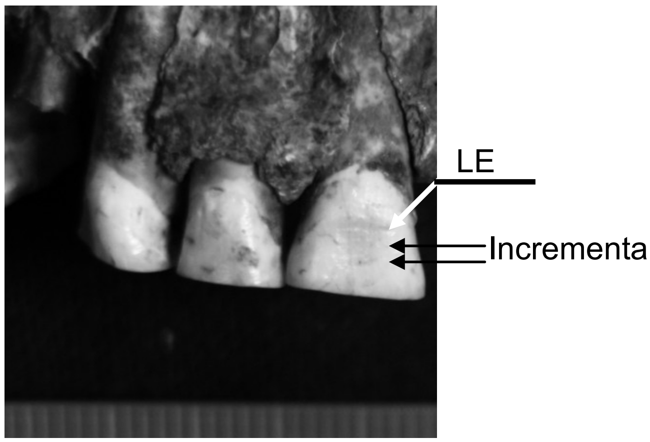


Figure 6.12: Example of a linear enamel hypoplasia and two incremental lines.

6.5.2 Periostitis

Periostitis is a reaction of the osteoblasts in response to irritation of the periosteum, the membrane that lines the outer cortex of bone. Periostitis is considered to be a non-specific indicator of health, meaning it is not diagnostic of a particular infection, and has many causative factors. Ortner (2003:207) discusses that the common occurrence of periostitis in archaeological samples and lack of clinical documentation suggests that the periosteal reaction is one portion of a specific disease process that can be identified and treated in the living, but not identified in an individual in an archaeological context. While there are a number of variations of expression (see Resnick and Niwayama 1995), the most common expression observed at Cerro Mangote includes layers of bone parallel to the surface and long, thin spicules of bone perpendicular to the underlying cortex (Resnick and Niwayama 1995:4435). Figures 6.13 and 6.14 highlight some of the variation by healing in the periostitis observed.

Ortner (2003:206) comments that "periostitis commonly stimulates the formation of woven bone, which later may become incorporated into the underlying cortex and remodeled into lamellar bone." Though the origins may be unknown, the remodeling of the periostitis lesions are indications of the healing within individuals. If lesions have both healing and active portions, it points to a chronic stressor(s) (see also Larsen 1997, Powell 1988). There are 34 individuals from the total sample at Cerro Mangote with periostitis (30.9%), represented by five active cases (14.7%), 21 healed or healing (61.8%), and 8 chronic cases (23.5%), with the femora and tibiae most commonly affected. Table 6.15 catalogs the distribution of the 34 individuals by age and sex.

Marx (2012) details the frequencies of periostitis and impact of frailty in the Cerro Mangote sample by assessing healing and healed lesions. Her indices compared individuals with lesions only, resulting in a nuanced understanding of survivorship:

> Index 1 looked at the relationship between individuals who had lesions with one area of healed activity and those who had only active or healing lesions, while Index 2 investigated the relationship between individuals with only healed lesions and those who had at least one area of active or healing activity. These groups can be considered to have different levels of frailty. The individuals with the lowest frailty have only healed lesions, followed by the individuals with a mixture of healed, healing, and/or active lesions, while individuals with no healed activity at all can be considered the most frail. (Marx 2012: 118)

By eliminating the compounding variables of individuals who do not display lesions (and therefore may be either unaffected by the disease or had died prior to lesion formation), Marx found significant differences in the survivorship of individuals based on age at death, with juveniles displaying the greatest frailty and those aged 15 – 35 years displaying the least frailty.

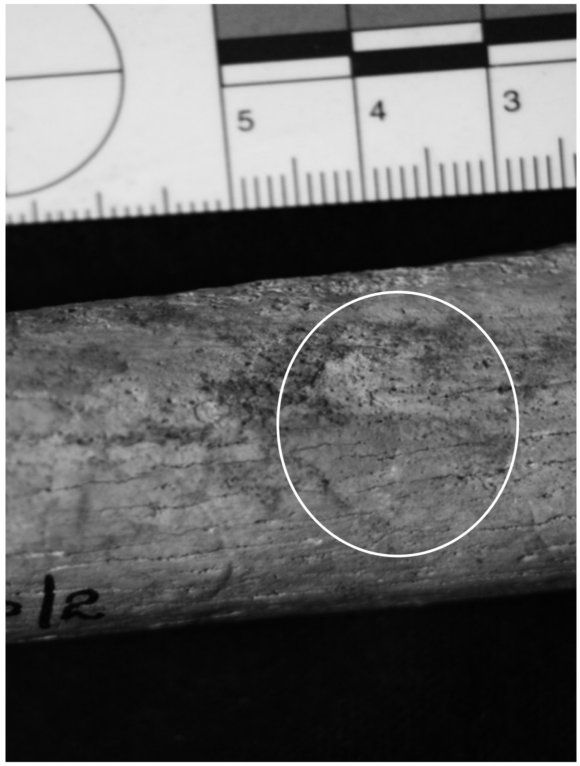


Figure 6.13: Example of an active, raised periostitis lesion from CO-40-27 left femur. Lesion circled.

Figure 6.14: Example of healed periostitis with vein etching from CO-40-6B left tibia.

Table 6.15: Periostitis distribution at Cerro Mangote[63]							
	M	M?	?	F?	F	U	Total
0-5	0	0	0	0	0	6	6
5-10	0	0	0	0	0	3	3
10-15	0	0	0	0	0	1	1
15-20	0	1	0	0	0	0	1
20-35	2	2	1	2	1	0	8
35-50	7	1	0	0	2	0	10
50+	0	0	0	0	2	0	2
U	0	0	0	1	0	2	3
Total	9	4	1	3	5	12	34

6.5.3 Trauma

The main type of trauma present at Cerro Mangote is healed fractures. Four of the five fractures present are healed fractures of the hands and feet, particularly the phalanges. Four individuals in the sample have a single antemortem fracture of the hands or feet (3.6%). The remaining fracture is of the right humerus of CO-40-4, the clearest example of an antemortem fracture with healing (see Figures 6.15 and 6.16). The humeral shaft appears to have been broken from a bending force, with the original shaft angled into the medullary cavity of the distal third of the shaft. The secondary callus shows remodeling of both the cortical bone and medullary cavity. The medial aspect of the callus shows compensatory remodeling, with added thickness of the new cortical bone added to the medial aspect (see Ortner 2003:128). Figure 6.17 illustrates a right metacarpal with remodeling from an antemortem break.

[63] The numbers recorded here are based on my observations.

6.5.4 Arthritis

All joints available were examined for indications of arthritis. The type observed in the Cerro Mangote sample was osteoarthritis. In general, the sample has minimal arthritis, with only 37% of adults (16/43) exhibiting osteological markers for arthritis. Table 6.16 shows the distribution of osteoarthritis by age and sex. Osteophytes are observed at the glenoid fossa, the patella, the elbow, the hands and feet. Osteoarthritis in these locations is commonly observed in archaeological samples (see Jurmain 1990, Ortner 2003). While the exact etiology of osteoarthritis is unknown, it is commonly attributed to long term activity and age. In addition to the appendicular skeleton, the vertebrae of the skeletal sample were examined. Ten vertebrae from nine individuals, particularly the cervical and lumbar, had osteophytes. Four individuals have both osteophyte formation and porosity of the cervical vertebrae (see Figure 6.18).

Table 6.16: Distribution of individuals with osteoarthritis at Cerro Mangote

	M	M?	?	F?	F
20-35	1	2	1		
35-50	5				1
50+	1			1	1

Figure 6.18: Examples of erosive arthritis of the centrum and articular facets of two cervical vertebrae. Left: CO-40-22D unsequenced cervical vertebra. Middle and right: CO-40-13 third cervical vertebrae, superior and inferior aspects.

6.5.5 Pathologies of the spine

Two types of congenital malformations observed at Cerro Mangote are L5 sacralization and S1 lumbarization. Research to date suggests that these two types of malformation are developmental disorders, stemming from an abnormal cranial shift (Masnicova and Benus 2003). L5 sacralization occurs when the fifth lumbar vertebra is incorporated into the sacrum and the lumbar spine loses a segment. While the morphology of the sacrum is normal, there is an extra sacral vertebrae (see Figure 6.19). Aufderheide and Rodriguez-Martin (1998) note that lumbarization of the S1 more commonly affects females than males, as illustrated by Figure 6.20, representing the female individual CO-40-3-1. However, if the first sacral segment resembles the last lumbar vertebra without a net loss in the number of vertebra, it is lumbarization of S1.

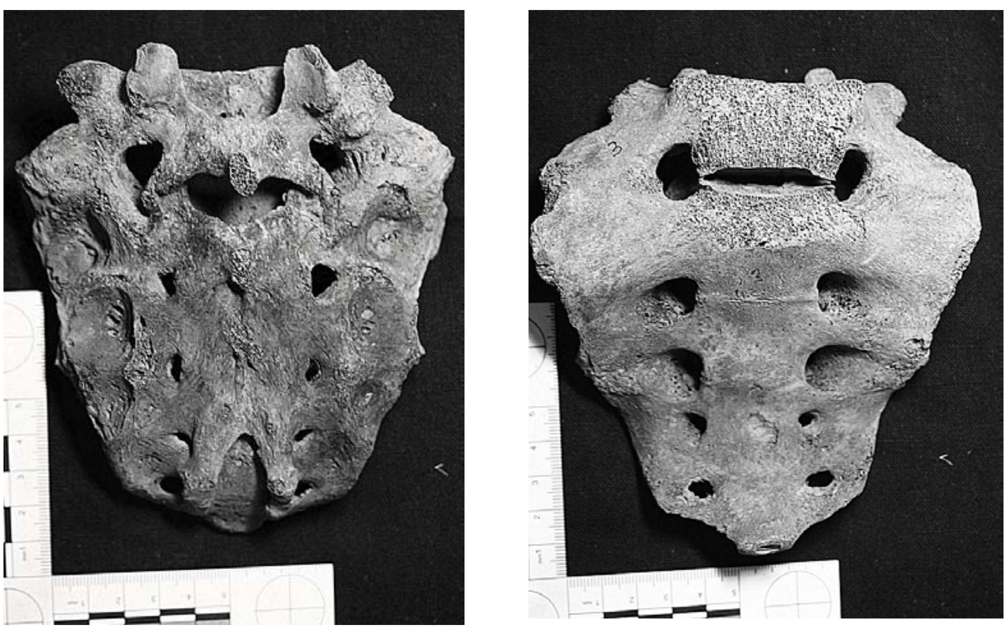


Figure 6.19: Anterior and posterior aspects of CO-40-3 sacrum, L5 sacralization

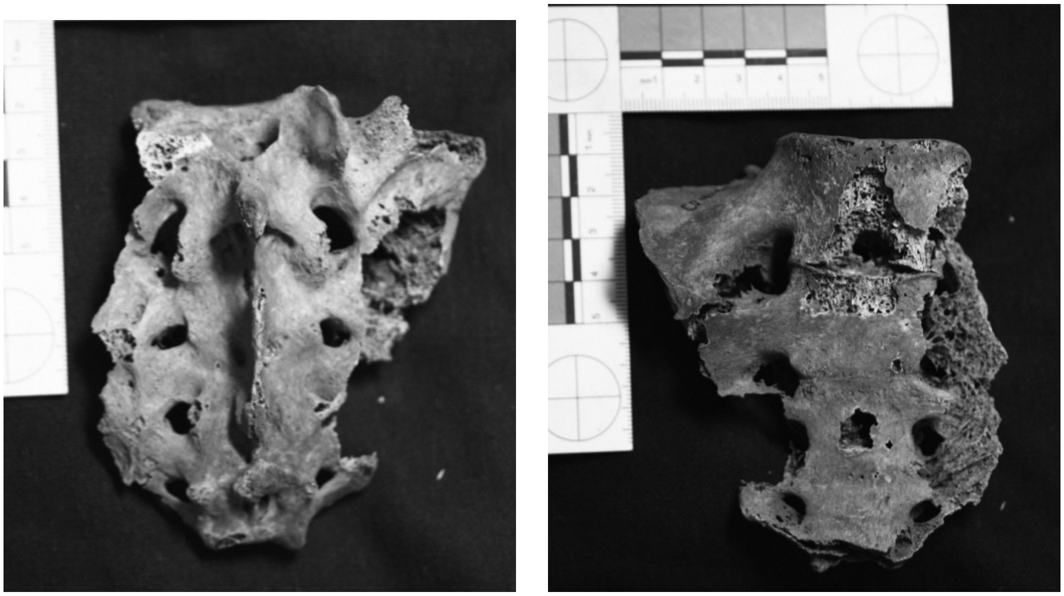
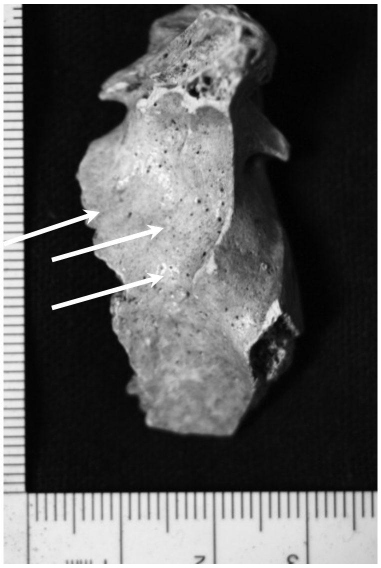


Figure 6.20: Anterior and posterior aspects of CO-40-3-1, lumbarization of S1

6.5.6 Scurvy

Individual CO-40-4 displays porosity consistent with scurvy, a vitamin C deficiency. While not typically identified in individuals from tropical regions, the patterning of porosity observed on the cranial fragments of CO-40-4 are consistent with the diagnostic criteria outlined in Ortner (2003, see also Ortner 1984). . The cranial lesions considered include porosity in the superior orbits, squamous portion of the temporal, maxilla, mandible, and greater wing of the sphenoid. Photographs of a fragment of the greater wing and a fragment of the right temporal are included in Figure 6.21.



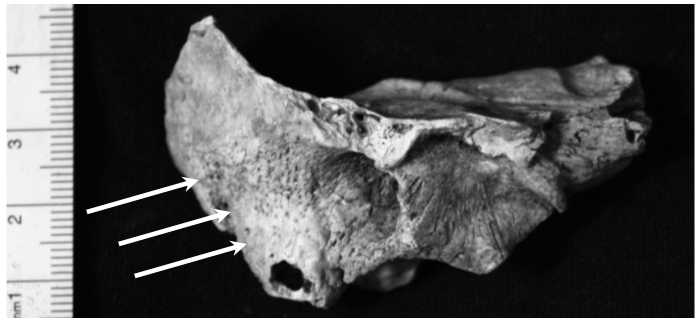


Figure 6.21: Greater wing of sphenoid (left) and right temporal of burial CO-40-4. Note diffuse porosity (arrows).

6.6 Summary

This chapter summarized the results of the mortuary, skeletal, and subsistence pattern analyses. The paleodemographic profile suggests a sample with high juvenile mortality rates and less than 1% growth. The majority of the archaeofaunal specimens identified at Cerro Mangote are native to most of Central and South America. The majority of the fish species recorded at Cerro Mangote are Pacific coastal fish, with the ability to survive in both marine and euryhaline environments. The majority of the terrestrial species have a wide range, with only the spiny Panamanian mouse limited to the western coast of Panama in the Parita Bay region.

Burial orientation and position is significantly correlated with age and sex, showing the living population had a ritual that resulted in different burial styles for adults and juveniles. Taphonomic processes complicated analysis, particularly lesion interpretation, illustrating the importance of understanding the original archaeological context of a skeletal collection. Additionally, the effects of the taphonomy and preservation at the site greatly impacts further analysis, including biodistance. The dental pathology rate is relatively low, suggesting good dental health, as well as a lower sugar content in the diet. Together with the dental data, the presence of chronic periostitis and healed fractures indicates lower frailty, or the sample had overall good health.

The musculoskeletal stress markers for males coincide with the range Rhode (2006) found for fisherpeople. The MSM for women lie in the range that cannot distinguish between farmers and fisherpeople. The cross-sectional geometry indicates both men and women at Cerro Mangote had more anterior-posterior bending strength, with similar increases seen in humeri and femora. This means the upper and lower limbs of both males and females had similar robusticity. Finally, the isotope patterns at Cerro Mangote indicate a diet containing both fish and terrestrial vertebrates. The next chapter will discuss these results within the archaeological context and in light of previous research.

CHAPTER 7: DISCUSSION

Table 7.1: Hypotheses		
	Hypothesis	Result
A	The faunal evidence will be consistent with year round exploitation of local resources.	Supported
B	Burial groupings tentatively defined at Cerro Mangote will have individuals more closely related to each other interred in the same area (within group similarity).	Rejected
C	Cerro Mangote will have similar robusticity of the upper limbs and lower limbs.	Supported
D	The individuals at Cerro Mangote will have low frequencies of dental defects, indicating low stress and overall good health of the sample.	Supported

This chapter summarizes the findings of the dissertation. Each of the hypotheses is revisited to assess whether it is supported or rejected by the evidence. Since sample size was problematic, no single approach would be sufficient to assess how the site was utilized by the living population at Cerro Mangote. Rather than rely on a single type of data, the strength of the interpretation of mortuary and subsistence patterning comes from layers of data. In this case, both food procurement and mortuary practices suggest that the site was most likely occupied year round (see Table 7.1). The hypotheses regarding occupation at Cerro Mangote are considered in relation to Hypotheses A, B, C. Then, the questions of health are addressed in relation to Hypothesis D.

7.1 Biological profile

Paleodemographic profile. The biological profile of the skeletal sample at Cerro Mangote is consistent with a relatively small group with low frailty. The juvenility index, hazard models, and Kaplan-Meier plot indicate an annual growth rate between 0.5% and 1%, with approximately 50% of individuals surviving past ten years. The majority of the individuals dying prior to ten years were between birth and one year, a trend consistently observed in prehistoric groups (see Livi-Bacci 2007, Bocquet-Appel 2008).

A growth rate of close to 1% would result in the population doubling within 20 to 30 years (Livi-Bacci 2007: 25-28). There was a seven-fold increase in sites between the Early to Late Preceramic, however, 1% is still probably a bit high. The error intervals in the Kaplan-Meier plot and the 2000 years the site was occupied suggest 1% seems unsustainable. More likely, the rate is closer to 0.5%, as suggested in previous studies of prehistoric hunter/gatherer populations (Carneiro and Hilse 1966, Cowgill 1975, Hassan 1981, Wilson 2010). Studies of demographic changes at similarly sized sites during the Neolithic point to much slower rate of population growth than initially assumed, incorporating the impact of the environment on the population, with Carneiro and Hilse (1966) arguing for a growth rate of 0.1% in the earliest portion of the Neolithic. It seems unlikely that, in the 4,000 years between the earliest Neolithic dates and the earliest carbon dates at Cerro Mangote, the population would have increased ten-fold, consistent with the 1% increase suggested by the Kaplan-Meier plot.

The Kaplan-Meier plot and hazard models also highlight some of the gaps in the data. The height of the steps illustrates the missing data, impacting the resolution of the survivorship estimates. Additionally, the Siler model shows little leveling – the hazard model for Cerro Mangote should become more level between approximately age 10 and age 30. This is most likely due to the small number of individuals in these age brackets.

Like other hunter/gatherer groups considered in this study, the infantile hazard has the greatest impact on the population shape. High infant mortality rates, though, are complicated by the sample size issues, as is determining the exact transition between the infantile hazard to the senescent hazard due to, again, the scarcity of individuals between 10 – 20 years. Though the hazard models do give an indication of the shape of the forces, it is currently impossible to verify these rates. When more information is gathered for other sites in Panama, the Cerro Mangote estimates can be further expanded to assess diachronic fertility changes in the region.

7.2 Archaeofaunal evidence

The archaeofaunal evidence does suggest local resource exploitation. However, the interpretations of the data are problematic. First, the assertion that the recorded species are consistent with local resources is based on modern understandings of species distribution and habitat. Though Grayson (1981) recognizes this flaw in most archaeofaunal studies, his argument raises a larger concern: mechanisms of accumulation. Though the accumulation of shells is termed a midden, the presence of shell does not necessarily mean that the organism it once housed was consumed by the group. Staller and Thompson (2002) suggest individuals at a Valdivia ceremonial site used maize for ritualized offerings, but not as a dietary component. Admittedly, Staller and Thompson’s (2002) phytolith collection methodology and interpretation has been questioned (see Piperno 2002); however, the theory of using a food resource for ceremonial, rather than dietary, purposes is still a possible alternate explanation for the presence of shell at the site (Rossen and Dillehay 2001).

The shell does, however, allow for re-evaluation of the previous theories of site use for Cerro Mangote. To date, seasonal-site based theories suggest that the site was utilized during the dry season for the collection of either salt or marine resources. However, the presence of *Cardisoma* crabs counters that supposition, as this species is predominately harvested during the wet season (Ranere n.d.). Furthermore, the recently identified starch residue (Piperno 2011a, 2011b) at Cerro Mangote demonstrates the presence of maize at the site, refuting Norr's initial assumption that the residents *had* to leave Cerro Mangote to grow maize. The rejection of the current seasonal site theories does not necessarily mean acceptance of their year-round counterparts, though they do seem to better match the current archaeofaunal evidence. The presence of the manatee rib on the Pacific side of Panama indicates that the residents had contact with groups on the Caribbean side. The preferential hunting of iguana and deer are consistent with year-round occupied ceramic period sites (Cooke *et al.* 2007). However, as with all archaeofaunal studies, questions of accumulation must be considered.

Since the majority of species are local to the area, there are numerous ways that these species could have been introduced to the site that are not related to the population that lived at Cerro Mangote. In addition to possible ceremonial explanations for the presence of certain animal remains at the site, Grayson (1981) emphasizes the importance of considering intrusive species (especially small organisms, like mice, lizards, or snakes) and scavengers (such as raccoons), which are normally found in the environment and may have died from natural causes. Since NISP only indicates a presence/absence of organisms, it illustrates the variety of possible species available to the individuals at Cerro Mangote as possible foodstuffs. The presence of these organisms does not confirm or negate the possibility that the site was occupied year-round. While the data within the archaeofaunal record are confounded by accumulation questions, the data collected for Hypothesis D may clarify some of the findings, which are expanded upon in the section below.

7.3 Cemetery organization

The location of a cemetery suggests ties of the living to a particular landscape for resources. The presence of a cemetery establishes ownership and lineage within an area through ancestry and maintains familial links to the landscape (Goldstein 1981). The rituals that result in the cemetery location and layout represent aspects of the culture and identity of the living (Goldstein 1995). Also, the secondary interments document further interaction between the living and the dead. While ancestor veneration may overstate the current evidence, the secondary burials imply a need to maintain connection with the individuals and their remains, implying the site was utilized regularly (Kujit 1996). First the results of the dental metric analysis are summarized, followed by the cemetery characteristics based on the biological profile and excavation notes.

Biodistance analysis. The three groups for the analysis are defined using the columns at Cerro Mangote, described by McGimsey (1956, McGimsey *et al.* 1987). Similar to Stojanowski *et al.* (2007), the first two components (PC1, PC2) signify tooth size (PC1) and tooth type (PC2). The eignvalues indicate PC1 and PC2 explain 52% of the variance when corrected for body size (PC1: 4.265, PC2: 3.039).The principal components analysis indicates no distinct patterns among the three groups. Groups one (n=8) and two (n=9) overlap considerably, with approximately 50% of the individuals from each group overlapping. Group three only contains three individuals, with a widespread distribution and no clear clustering. Additionally, preservation at the site and the fragmentary state of the skeletal remains created a number of missing data points, with some adjustments of the original approaches needed to analyze the data present. The techniques for calculating any missing data result in artificially homogenized data, making the achievement of a statistically significant result more difficult.

Since these column groupings are *a priori*, the potential error in the analysis is most likely the manner in which the burials were grouped. In other words, the results do not necessarily mean the individuals are not related, but, more likely, that the incorrect model was chosen. Further analysis of the biological affinities of the individuals should include a non-spatial model, eliminating the internal spatial distinctions. Stojanowski *et al.* (2007) arrived at the same conclusions in their study of individuals and relationships based on burial position within a church. After analysis, the researchers determined that burials within the church were not arranged based on familial relationships and proceeded with a non-spatial model for the site to determine relationships. However, a non-spatial model is not appropriate at this time for Cerro Mangote. Given the small sample size, the non-spatial model would have too many degrees of freedom to make an assessment (Stojanowski *et al.* 2007). To strengthen the analysis, more information is needed from contemporaneous regional sites or mitochondrial DNA profiles (see Appendix 7 for the results from the pilot study on the feasibility of mtDNA). Though the biodistance analysis did not add information to the current understanding of cemetery use, the mere presence of a cemetery suggests further assessment using other characteristics described during review of the mortuary information and comparative sites.

Cemetery characteristics. While Hypothesis A (cemetery organization based on familial relationships) was rejected, the analyses did bring other information to light. Although the stone columns did not represent intra-cemetery kinship boundaries, other statistics do give some indication as to how the cemetery was arranged and constructed. Most individuals were buried in the supine position, with the head to the north, in a tightly flexed primary burial. The characteristics within the burials are related statistically based on age, sex, burial type, burial position, and burial orientation. The correlation of these variables indicates the variables occurred together more often than random chance, suggesting those who interred the individuals in the cemetery followed guidelines for the burial of the dead, most likely dictated by rituals.

These burial rituals seem to be based around a rather complicated combination of factors, though age appears to play an important role. The only artifacts associated with burials were necklaces associated with juveniles. Most commonly, these necklaces are considered talismans at other sites (including La Paloma (Benfer 1990, Quilter 1989)), though the worked shell beads may represent a variety of magico-religious meanings. A linking characteristic between the burials at Cerro Mangote, La Paloma, and OSGE-80 are the presence of stones in the burials, perhaps as offerings, with some burials having dozens of associated stones.

Another common characteristic of juvenile burials is their proximity to other burials. Each juvenile burial was associated with at least one other individual, and typically more than one. However, the convoluted stratigraphy means it is impossible to determine if the juvenile was buried in the same grave as the associated individual(s) or simply in proximity to them. The ages and sexes of the associated individuals varied, but the consistency in spatial relationships suggests careful attention was paid to the placement of juveniles. Though groups of burials were much more frequently encountered at the site, the few single burials were always adults, such as CO-40-5 (see

Appendix 1). Quilter (1989) also references the placement of juveniles at La Paloma, attributing the importance of location to rituals. Cross-cultural studies of juvenile burials have suggested that juveniles are commonly buried within houses or structures because they may not have been considered full members of the group, for protection, and/or for comfort in the afterlife (see Parker Pearson 1999, Rega 2000). The placement of the juveniles within the Cerro Mangote cemetery suggests that they were considered full members of the group (Parker Pearson 1999). The special burial offerings and placement, though, suggest that, while members of the group, the living still saw juveniles as needing special treatment and protection after death.

The majority of the secondary burial types were of adults, split almost evenly between males and females. The secondary burials, particularly the bundle burials, were generally found in conjunction with primary burials, suggesting that the secondary treatments may have been used to re-inter individuals encountered when interring another individual. The close proximity of the two burial types does not negate Ranere's (n.d.) supposition that the secondary burials represent individuals who died away from the site and were transported back for a later burial. Moreover, there were no markings on the bones consistent with dismemberment or cannibalism, as concluded by other researchers.

Although the secondary burials show more taphonomic changes, the primary interments and secondary interments had similar percentages of completeness, despite the secondary burials having experienced more handling. One explanation for secondary burials is ancestor veneration, in which the living population ritually reburies certain individuals. The association of primary and secondary burials, though, suggests that the bundle burial practice is more likely the reburial of an encountered burial preparing for a primary interment. If bundle burials were created in response to burials encountered during the internment of another individual, it suggests that individuals occupied the site long term and used the cemetery regularly.

7.4 Subsistence patterning

The subsistence remains of Cerro Mangote have been extensively studied, but occupation time remains equivocal (see Table 7.2). This dissertation considers not only the previously published information regarding archaeofaunal and archaeobotanical evidence, but also combines the information with the biological profiles of the individuals excavated from the cemetery. In addition to the biological profile information, activity based skeletal markers were assessed through musculoskeletal stress markers and cross-sectional geometry. Finally, the health of the skeletal sample, activity markers, archaeofaunal, and archaeobotanical information, combined with the original stable isotope data published by Norr (1991), suggests a slightly different dietary picture than her later (1995) publication.

Table 7.2: Summary of theories of settlement type at Cerro Mangote

Occupation		Reasoning	Sources
Seasonal	Dry season	to collect salt	Griggs 2005
	Dry season	Marine resources, majority of time spent inland	Norr 1991, Norr 1995, Piperno and Pearsall 1998
Year-round		Evidence of plant exploitation, hunting, collecting shellfish, and shore-based fishing	Carvajal-Contreras and Hansell 2008, Cooke and Martin 2010, Cooke & Ranere 1992b, Piperno 2011a, Piperno 2011b
		Inland and coastal trade routes	Carvajal-Contreras *et al.* 2008, Cooke 2005, Cooke and Jimenez 2008a, 2008b; Cooke and Ranere 2003, Cooke and Sanchez 2004, Cooke *et al.* 2007, 2008, in press

Markers of occupational stress. Overall, both cross-sectional geometry and musculoskeletal stress markers indicate that the robusticity of the upper and lower limbs of the Cerro Mangote individuals were fairly similar. The cross-sectional geometry suggests a relatively round shape in both the humeri and femora for males and females, with an equally similar slight anterior-posterior loading. Knobbe (2010) compares cross-sectional geometry between other groups (Jomon, Aleut, Californian, and Georgian coastal gatherers) with documented activity patterns. The values she presents for the Aleut sample are similar to those seen at Cerro Mangote, suggesting a similar behavior pattern of local gathering punctuated by larger, organized hunting/fishing expeditions (Knobbe 2010, see also Nikita *et al.* 2011). However, the sample size for Cerro Mangote is currently too small for statistical comparison to the much larger Aleut sample.

The female MSM synergists groups classify as “unknown” a group characterized by similar robusticity of upper and lower limbs. The notable exceptions are the data for the male MSM synergist groups, which classify as fishers based on the values from Rhode’s (2006) model. Rhode suggests the fisher subsistence pattern should have more definition in the upper limbs than the lower.

Based on Rhode’s collection of potential motions that create the observed patterns (see Appendix 4), the cross-sectional geometry and MSM synergist patterns suggest activities consistent with gathering resources. Though Rhode considers throwing and pulling to be more strongly developed traits in fishers than other gathering activities, there is no correlation between exactly how much effort one uses and how strongly a synergist group develops. In other words, the residents of Cerro Mangote may have been engaged in fishing activities that were simply less strenuous than Rhode’s differentiation would imply. However, most MSM studies fail to clearly differentiate all possible types of activities leading to patterns of MSM, as shown by Weiss (2007) in her study on the complications of body size on MSM expression.

More problematic is that Rhode's study does not standardize for body size, making comparisons with other samples problematic. For example, the samples used in Rhode's study span approximately 8,000 years and range geographically from Peru and Chile. Changes in muscle marker size could be due to a longitudinal growth change and not to a particular activity. Without accounting for diachronic changes, distinguishing between secular changes in growth and development and activity-induced changes is problematic for comparison.

Additionally, the limited attribution of a particular activity to a particular muscle or synergist group has not been well supported through research to date. While the model does have some interesting potential, more information is needed to clarify and separate the overlapping synergist group use. Also, Weiss (2007) and Zumwalt (2006) caution that the confounding affects on body size on reconstruction of activities, given that body size, will impact activity patterns. Despite sample size issues at Cerro Mangote, the data from the cross-sectional geometry analysis are weighted more heavily than the MSM data. The impact of forces, changes due to loading, and cortical bone response are better documented than those of the MSM analysis proposed by Rhode. Furthermore, the data do not have the confounding problems of body size, as the values have been appropriately corrected for comparison to known activities. The overall rounded shape of both the humeri and femora shafts is a better indicator of similar habitual use than the non-standardized MSM.

Stable isotopes. The similar distribution of muscle loadings on the upper and lower body, combined with the isotopic analysis, are expected to indicate a mixed subsistence pattern. Though she reinterprets her data in a later publication (1995), Norr's original assessment and data (1991) support a minimal carbohydrate component in the Cerro Mangote diet. Also, later publications have refined the interpretations of the values based on further study of diet and stable isotopes (Keats 2002, VanderZanden and Rasmussen 2001). The reconsideration of the carbon and nitrogen isotopic signatures illustrate two concepts: first, Norr's original conclusions of a mixed diet are more likely, and second, the higher nitrogen values can be explained by nitrogen fixation common in euryhaline organisms. In sum, the values are more consistent with a diet containing both terrestrial vertebrates and marine vertebrates. As discussed above, the archaeofaunal specimens collected at the site are local to Panama, containing both terrestrial vertebrates and fish.

While the mechanisms of accumulation are unknown, the archaeofaunal record, combined with data from regional studies and this dissertation, point to a subsistence pattern with heavy reliance on local exploitation of terrestrial and marine organisms. First, the regional data suggests that as part of a coastal adaptation, most resources were collected locally, as is demonstrated in the overview of similar sites provided in Chapter 2. Next, the archaeofaunal materials collected at Cerro Mangote are consistent with locally found terrestrial and marine species. The MSM and cross-sectional geometry of skeletal materials from the cemetery are consistent with gathering activities, but not especially strongly developed in any particular plane of motion. Finally, the stable isotope analysis from the same skeletal materials is consistent with a diet based mainly on marine and terrestrial species. While each of these data alone is insufficient, together they point to a subsistence pattern highly dependent on locally collected marine and terrestrial vertebrate resources.

7.5 Health

The biological profiles at Cerro Mangote point to low stress and a low carbohydrate diet for the population. Dental health indicates that the individuals enjoyed relatively good health, with 688 permanent teeth assessed from the sample (n=110 individuals). This number represents 46% of the expected number of teeth, given the number of individuals with permanent teeth in the sample. Though not an ideal, random sample, the available dentition represents a statistically significant portion of the population (see van Emdun 2008). Since these teeth account for all available permanent teeth, the assessment for health is as accurate as possible with the current data. The frequencies of dental defects, periostitis, pathologies, and calculus are similar to the frequencies reported for OSGE-80, which are considered by Ubelaker (1995) to be relatively low values. Following the conclusions of Boldsen (2005, 2007), the low frequency of LEH in the sample is consistent with low stress during development, since growth and development were rarely interrupted. While this does not mean that the individuals experienced no stress, the stressors were not severe enough to disrupt growth.

The frequencies of periostitis also point to relatively low levels of stress at Cerro Mangote. Combining Ortner's (2003) ideas regarding the etiology of periostitis and the osteological paradox, all of the lesions are healed/healing and most likely indicate individuals who survived the initial stressor and had an immunological response, living with the stressed conditions long enough to begin the healing process and remodel the lesions into the original cortical bone (see Marx 2012). Also, the osteoarthritis, particularly of the spine, present in some individuals is consistent with a relatively healthy sample – the extensive remodeling of the spine suggests a response to a chronic stressor (Jurmain 1990).

For the most part, the pathologies present at Cerro Mangote are non-specific indicators of health. There is minimal cribra orbitalia and porotic hyporostosis present in the sample. Some individuals have well-remodeled expanded long bone shafts, potentially consistent with a treponemal disease, but the skeletal elements present are insufficient for a differential diagnosis. One unexpected disease identified at Cerro Mangote was scurvy. While it is unusual in tropical regions, Ortner (2003) reports incidences in later, precontact samples from Mexico and Peru.

While diet will be discussed in greater detail below, the dental defects also support the conclusion that the residents of Cerro Mangote had a low carbohydrate diet. The low frequencies of caries, antemortem tooth loss, and abscesses are consistent with a diet low in carbohydrates, which is supported by the presence of low levels of calculus (Ortner 1995).

7.6 Year-round or seasonal occupation?

The debate over whether Cerro Mangote was occupied year-round or seasonally began with the questions raised from the more recent interpretation of the carbon isotopic results as C4 signatures (Norr 1995). At the time, these interpretations stemmed from the need to explain the lack of maize at Cerro Mangote, despite its presence in the diet of the residents. However, the skeletal evidence and stable isotope values are consistent with a diet low in carbohydrates and high in marine resources. Norr's C4 values for Cerro Mangote suggest some maize as part of the diet, but also a marine and terrestrial vertebrate component. With the new findings of maize on the stone tools at the site, we no longer need to focus on explaining the origins of the maize. While this conclusion does not automatically imply year-round occupation at Cerro Mangote, it does change what the evidence and characteristics of the site best suggest.

Various characteristics of the site are more consistent with the year-round occupied ceramic sites than the seasonally occupied Preceramic sites of the Chiriquí highlands and Central Pacific Panama cultural regions. Though there are cultural distinctions between the two regions, there are similarities in site characteristics. The seasonally occupied sites tended to be rock shelters utilized for a particular terrestrial resource (Cooke 2005, Dickau 2005, 2010, Ranere 1979). The year-round occupied sites were open sites that were utilized for the collection of multiple resources, including plant, marine, and terrestrial species (Carvajal-Contreras *et al.* 2008, Cooke and Jimenez 2008a, 2008b, Piperno 2011a, 2011b). The AMS dates for Cerro Mangote place the site at the end of the Preceramic period in Panama, consistent with a site transitioning to the Ceramic period.

Unlike other Ceramic period sites, though, Cerro Mangote lacks features consistent with household occupation. There are no documented hearths, post holes, or other features of permanent dwellings. Poor preservation at the site may account for the lack of archaeological evidence, but this lack may also be explained by the methods and goals of previous excavations. The initial excavation was interested in determining the presence of the site; the second excavation was focused on recovering burials; the final excavation documented the extent of the Santa Maria River Basin and phytolith evidence. None of the excavations were designed to explore the extent of the site, which leaves much of the hill untested. It is possible that evidence of households is waiting to be uncovered in these unexcavated areas, with only approximately 50% of the site excavated.

7.7 Summary

The overall patterns of use at Cerro Mangote appear to be consistent with those of a year-round occupied site, most importantly the presence of a cemetery and the exploitation of a wide range of local resources. The pattern of exploitation of a variety of local resources is similar to sedentary sites from the ceramic period, rather than the seasonally used Preceramic sites. The burials present at the site indicate that the population experienced a low risk of death after infancy, and the relationship of primary and secondary burials suggest regular and long-term occupation.

Despite the small size of the sample, this dissertation has the advantage of building on previous research. Research conducted by McGimsey on the sample at Cerro Mangote highlighted questions of site use and the biological profile of the sample, creating the initial questions of this dissertation research. Furthermore, the strength of this analysis rests on the regional research conducted by Cooke, Ranere and others. Our understanding of the broad patterns and nuances of the regional archaeofaunal and archaeobotanical research has greatly increased since the sample was first excavated in 1955, resulting in a better understanding of how resources were used in the area in this current study, a concept further explored in the final chapter.

CHAPTER 8: CONCLUSIONS

As a late Preceramic period open site with burials, research at Cerro Mangote offers the chance to addresses archaeological questions with new and reinterpreted evidence. Cerro Mangote illustrates a variety of patterns in burial arrangement, cultivation, hunting, and gathering. Rather than examine the data separately, this dissertation explores multiple data lines at a single site, Cerro Mangote, to examine how the living experimented within their landscape.

The population demographic profile is considered within the known, regional archaeological data, paying attention to replacement rate and the proposed number of inhabitants based on the size of the site. Next, the commonly held dichotomy of site use and subsistence patterning are reconsidered on the basis of current data from Cerro Mangote. The oversimplification of the model masks local variation, such as by classifying groups as hunter-gatherer, when, in fact, agriculture is also present. Finally, the impact of the new biological profile from Cerro Mangote on research within Panama is considered. Cerro Mangote may have been an early center for trade and development of mortuary rituals seen in later Ceramic sites in Parita Bay. Further, if Cerro Mangote was occupied year-round, the site provides insight into the connections between Parita Bay and Central and South America through specialized mortuary rituals.

The purpose of this study was to create an in-depth understanding of a particular site. Regional and diachronic studies are extremely important to understand the local impact and importance of a particular site, but they can gloss over local variation, masking details necessary to understand variation specific to Cerro Mangote. The site characteristics at Cerro Mangote indicate a transition by the living into the more complex rituals and site use that defines the later Ceramic period sites. If simply included as a Preceramic site, the combination of unique mortuary treatments and resource management are neglected. That said, including more sites and individuals will open new opportunities to use different methodologies and comparison of population growth rates. Also, the dental measurements from Cerro Mangote can be combined with any future measurements to examine regional and diachronic patterns of biological affinity, adaptation, and migration.

Population models indicate a relatively stable growth rate, typically associated with smaller, hunter-gatherer groups. Previous research (Cooke 2005, McGimsey *et al.* 1987) has suggested no more than 30 individuals occupied Cerro Mangote based on site size, an estimate that resembles other populations with a replacement rate of approximately 0.5% per year. Further, the biological profile of the sample is consistent with a low stress sample. Based on dental and osteological analysis, the individuals at Cerro Mangote had relatively low rates of disease, with the rate of chronicity indicating that most survived the initial disease, living with it for enough time to develop an osteological response before death. To maintain a low level of stress, a high quality diet is critical. The low rates of caries, abscesses, and calculus are consistent with a diet low in carbohydrates. Combined with the faunal and stable isotope data, this information indicates that the diet most likely consisted of local marine resources collected near the site.

The data from Cerro Mangote also offer an alternative to the standard dichotomy of occupation types. Traditionally, early groups are seen as fairly simple in their technology, moving as necessary to exploit a particular resource type or area. In contrast, later groups are seen as sedentary, agrarian based, and much more sophisticated in their technology. Cerro Mangote suggests a greater degree of variation in settlement types than either hunter/gatherer-migratory or agrarian-sedentary. Site use is much more consistent with a sedentary site than a seasonal one. The patterns of resource exploitation suggest a hunter/gatherer model with some agriculture, but there was no reliance on a particular resource or specialized subsistence patterning. Indeed, research on marine harvesting techniques suggests that there was no need for technology more complicated than simple nets to gather the abundant resources. This disjunction between technological complexity and resource exploitation is typical of Central and South American sites.

In addition to diet/site use, the increase in sedentism is commonly correlated with an increased frequency of infectious diseases and other health problems. Much of North American bioarchaeological research has tried to tease out the impact of sedentism and/or agriculture on the overall health of various groups. The evidence from Cerro Mangote indicates that the debate is much more complicated than previous work would suggest. Though Cerro Mangote has many characteristics of sedentary site use, the occupying group was rather small. Most infectious diseases thrive only in much larger groups. Additionally, the diet was clearly not specialized, instead relying on the many resources found in Parita Bay. Regular access to a variety of resources may have helped the residents of Cerro Mangote maintain sufficient nutrition to resist a higher level of pathogens and environmental hazards.

The cemetery at Cerro Mangote indicates a much more multifaceted use of space than the overly-simplistic binary typology. The mere presence of a cemetery indicates that the people of Cerro Mangote thought about space differently than the residents of contemporaneous sites. As one of the first cemeteries in the Parita Bay region, Cerro Mangote indicates that groups were engaging in complex rituals prior to the transition to the Ceramic period signaled by the introduction of pottery.

Furthermore, the stone columns, burials, and attendant mortuary rituals suggest that the Cerro Mangote cemetery was much more than an infrequently-inhabited processing site. Though the columns still remain enigmas, the number of columns and their wide scattering suggest that they held some importance in the culture. The primary and secondary burials show some inconclusive patterning in how individuals were buried, but also show a great deal of variety. Since the cemetery was utilized for over 2000 years, the variety may be due changes in burial ritual over time. Also, the presence of similar bundle burials at Cerro Juan Diaz and OSGE-80 indicates a connection between these regions, at least through at least rituals.

The few burial goods provide an interesting counterpoint to later cemeteries: at Cerro Mangote, shell beads were mostly associated with juvenile burials, while later cemeteries, such as Cerro Juan Diaz, imply greater social stratification, with burial goods more commonly associated with adults and status difference (see Cooke 2005, Cooke and Ranere 1992c). The inclusion of burial goods with a few juveniles suggests that the shell beads may have had a magico-religious meaning for the residents, perhaps acting as talismans for the very young, as seen at La Paloma.

To better situate Preceramic burial rituals, an enhanced understanding of Preceramic and Ceramic cemeteries and burials is needed. Currently, additional cemeteries from the Parita Bay region are being curated, each of which could expand our understanding the mortuary behaviors in the region. How these groups' notions of space varied and changed could further explain the processes recorded at Cerro Mangote. Furthermore, the individuals buried at these other sites can deepen our understanding of local patterns of migration and biological affinity between sites, a goal to which the current research can not yet contribute. But, the findings in this research also offer a reminder to be wary of overly reductive typologies. This dissertation applies a series of methodologies that can throw light on the continuum of variation present in Central and South American archaeological sites. The strength of the research is within the multiple methods used to examine remains from a single site, to explore more thoroughly the significance of complex sites with varied inventories and diverse uses in the past.

The next step in this research is to utilize multiple methods at nearby sites. While still under study, the cemeteries at Cerro Juan Diaz and Sitio Sierra will provide additional sites with cemeteries and subsistence activities. Also, these two sites illustrate patterns of mortuary behavior similar to Cerro Mangote, potentially revealing development and variation in rituals. Furthermore, these two sites are geographically proximate to Cerro Mangote, but represent different temporal periods. Each may provide answers regarding familial relationships through time. The site at Cerro Mangote provides a touchstone not only in methodological application, but also for questions regarding population movements and site utilization within the Central American land bridge area.

APPENDIX 1: CERRO MANGOTE RADIOCARBON DATES

The radiocarbon dates at Cerro Mangote were originally listed in Table 2.2 (reproduced below). In addition to the dates from the three excavations, two new dates are added from this analysis from dental samples representing two additional burials. The radiocarbon dates from the three excavations seem to fall into two groups, with the shell and charcoal dates dating to the Late Preceramic and the skeletal material dating to the Ceramic periods. This section will briefly discuss radiocarbon and AMS dating, the inherent problems in utilizing skeletons in radiometric dating, and why the above division may not necessarily mean all the burials are intrusive.

Table 2.2: Radiocarbon dated samples at Cerro Mangote

Context	Method	Material	BP	Deviation	Collected
Stratum C, 130-145 cm, just above red clay zone	radiometric	charcoal	6810	110	1955
PH 1, 189-190 cmbd, red	radiometric	*Protothaca*	6710	170	1979
PH 1, Bk. 1, 193-215 cm bd, red zone	radiometric	charcoal	6670	215	1979
PH 1, 180-190 cm bd, red zone	radiometric	*Crassostrea,* outside shell	6370	180	1979

Table 2.2: Radiocarbon dated samples at Cerro Mangote					
Context	**Method**	**Material**	**BP**	**Deviation**	**Collected**
PH-1, 209-219 cm bd, red zone	radiometric	*Crassostrea,* inside shell	5820	130	1979
PH 1, 180-190 cm bd, red zone	radiometric	*Crassostrea,* inside shell	5520	120	1979
PH 1a, 145-155 cm bd	radiometric	*Crassostrea*	5055	150	
PH 1, 180-190 cm bd, red zone	radiometric	charcoal	3555	100	1979
Cat. No. 68E	AMS	Human fibula	2630	60	
Cat. No. 69	AMS	Human femur	2320	50	
Burial 31E, ass. With shell monkey pendant	AMS	Intercostal bone, human	2260	50	1988
Burial 26	AMS	Intercostal bone, human	1850	45	1987
Burial 69	AMS	Tibia-fibula, human	2220	45	1987
Burial 23A	AMS	Intercostal bone, human	1970	60	1987
Burial 20A	AMS	Intercostal bone, human	2015	50	1987
CO-40-32	AMS	Dentine	2983	66	2011
CO-40-22A	AMS	Dentine	4360	530	2011

Briefly, radiocarbon dating relies on the decay of radioactive ^{14}C, which is present in all living things. All living things achieve an equilibrium concentration of ^{14}C, and when they die, their ^{14}C nuclei decay with a half-life of 5,730 years. The radiocarbon dates submitted by Anthony Ranere after 1987 and the additional radiocarbon dates added from this analysis utilize Accelerator Mass Spectrometry (AMS). Accelerator Mass Spectrometry is a more sensitive technique, as opposed to the radiographic techniques used for the initial radiocarbon dates, since the amount of ^{14}C in the sample is measured directly by accelerating sample atoms as ions to high energies using a particle accelerator, and using nuclear particle detection techniques (Taylor 2001).

Directly dating human bone would be convenient, but research has highlighted the radiometric dating of bone is fraught with problems. Since bone is a connective tissue, it is composed of an organic protein (collagen) and inorganic mineral (hydroxyapatite), both of which contain carbon. For the seven AMS dates submitted between 1979 and 1987, the techniques could have included whole bone analysis or a separation of the organic or inorganic component of bone. Both these initial techniques were relatively unsuccessful in consistent dating because of different fractions obtained during bone pretreatment, including the impact of humics.

Humic acid, common carbon containing compounds in soil, can not only degrade the sample, but also swap elemental compositions through diagenic processes, introducing exogenous carbon (Hassan *et al.* 1977). The quantities and composition of surviving organic materials in a specimen are dependent on their burial environment, where the degradation rate is influenced by the composition, pH, hydrology, oxygenation, temperature, and changes brought about by soil flora and fauna (Hedges and van Klinken 1992). More recent analyses have focused on amino acids with more consistent results (for examples, see Ajie et al. 1990, Law and Hedges 1989, Stafford et al. 1982, 1987, 1988).

The possibility of contamination from humic acid and exogenous carbon is quite likely in the Cerro Mangote skeletal sample. First, fragmented materials are more susceptible to diagenesis. The skeletal samples submitted for dating between 1979-1987 are mostly rib bones, which have quite thin cortical bone and therefore are more easily fragmented or impacted by diagenesis. Second, though bone appears to be more impacted, Rink and Schwarcz (1995) demonstrated that enamel and dentine were also susceptible, potentially impacting the skeletal samples submitted in 2011.

Finally, dietary studies are important regarding the radiocarbon dating of skeletal samples in two ways: 1) the components of diet can impact the calibration of samples and 2) the C/N ratios commonly considered in diet studies also indicate potential diagenesis. The impact of diet calibrations, first introduced in the late 1980s, show that the types and amounts of carbon and nitrogen ingested impacts the structures of the organic and inorganic components of bone (see Fitzpatrick 2002, Keegan and DeNiro 1988, McGovern-Wilson and Quinn 1996, Stuiver *et al.* 1998, Weisler 2000).

Norr (1991) included C/N ratios in her diet assessment. Ambrose (1990) indicates that these ratios can measure possible diagenesis. Ratios between 2.8 – 3.5 are less impacted by diagenesis, and samples over 4 are considered to have a high proportion of exogenous carbon (see also DeNiro 1985, Hedges *et al.* 1995, Hedges and van Klinken 1992). The mean C/N proportion for Cerro Mangote is 3.4, which is on the high side of acceptable ratios (see Table 6.13). Some samples do fall outside this range, suggesting again that exogenous carbon may be a factor.

The introduction of exogenous carbon is likely in the Cerro Mangote skeletal samples, which would make the radiocarbon dates appear younger than they truly are. The two dental enamel samples submitted in 2011 do overlap with the archaeological carbon samples; however, the sample for CO-40-22A has an enormous range. The majority of the skeletal samples submitted between 1979 and 1987 do cluster together, which indicates a systematic error, most likely from exogenous carbon. The exception to this is the sample submitted for burial 31E. This burial has been questioned from the start as to whether it is a part of the Preceramic site due to the presence of a monkey pendent, characteristic of much later groups in Panama. Since diagenesis isn't a linear process, though, this knowledge cannot be used to determine the potential impact of diagenesis on the rest of the samples. Based on the likely impact of diagenesis, I do not believe the dates are definitive. While there may be more intrusive burials, I believe the majority are coeval with the archaeological dates in the Preceramic. To determine the accuracy of these dates, more analysis must be done on the impact of diagenesis on the Cerro Mangote sample.

APPENDIX 2: BURIAL DESCRIPTIONS

For each burial, the original notes from the excavation are directly transcribed or summarized. Any changes to the accession numbers between excavation and analysis are noted in the descriptions. Additionally, any commingled individuals are listed in the description. For each individual with an accession number, the excavation, location, burial type, age, sex, and completeness is summarized in a table. For burial location, the trench number and pit are listed first, followed by the depth. The 1955 and 1956 – 1957 labeled the trenches in Roman numerals, and the pits in Arabic numerals (e.g. I-4 refers to Trench I, Pit 4). Burial type includes the primary burial types (flexed, loosely flexed or tightly flexed), the secondary burial types (bundle or disarticulated), or if the burial was separated, created, and numbered in analysis (Lab). Completeness follows Buikstra and Ubelaker's (1994) categories regarding the completeness of the individual (less than 25%, 25 – 50%, 50 – 75%, or 75 – 100%) to illustrate how much of the individual is present for analysis. Any further details regarding the burial or biological profile are included below the summary table. Figures 1 – 9 show the locations of the burials on the excavation map and include photographs or sketches when available.

Burial 1

McGimsey recorded 6 skeletons in his excavation notes, numbered 1-6. At Texas, the individuals were relabeled (with corresponding original number in parentheses): 1A (1), 1AB, 1AB1, 1B (2), 1C (3), 1D (4), 1E (5), 1F (6) according to McGimsey. However there are no remains labeled 1C or 1F. The commingled remains for the burial include elements representing one fetus (32 – 40 weeks), one 1-year-old juvenile, one unaged juvenile, and one 35 – 50 year-old adult female.

CO-40-1

Excavation	1955	Location	I-4; 40 – 55 cm
Sex	Female	Type	Lab
Age	50+	% Complete	50% - 75%

The majority of the present long bones have diffuse periostitis, represented by small patches of porosity (most of the lesions appear to be lost to postmortem damage). All of the skeletal elements associated with this burial are fragile and yellowed. The majority of the long bones have cortical bone erosion, giving the bones an artificial undulating morphology.

CO-40-1A

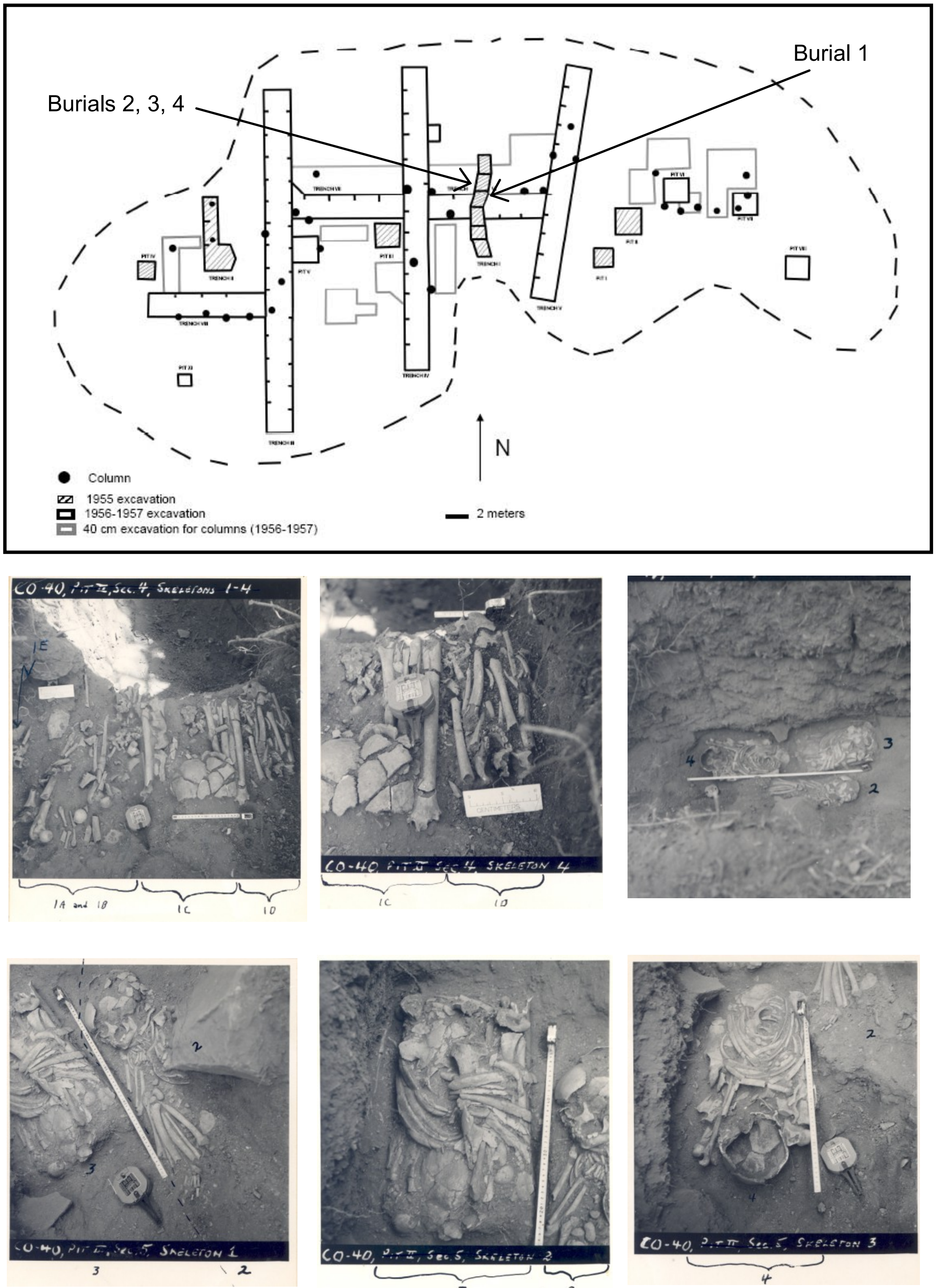
Excavation	1955	Location	I-4; 40 – 55 cm
Sex	Ambiguous	Type	Bundle
Age	20 – 35	% Complete	50% - 75%

The individual was buried as a bundle burial, supine, with the head facing north. Lipping on the left and right humeri proximal epiphysis indicates arthritis of the shoulder. Chronic periostitis on portions of femurs, indicated by lesions with areas that are healing and active. Also, portions of the fibulae indicate bone expansion with healed lesions.

CO-40-1AB

Excavation	1955	Location	I-4; 40 – 55 cm
Sex	Probable male	Type	Tightly flexed
Age	20 – 35	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, with the head facing left. There is healed porosity of cranium on parietals, occipital, and mandible. There is plastic deformation of parietals at midline, without changes to internal table morphology. Lipping of the left shoulder at glenoid fossa, lipping of vertebral facets, and carpals is consistent with arthritis. There is focal bone loss of acetabulum. The os coxae have some postmortem damage from a trowel, as well as rodent gnawing.



Burials 1, 2, 3, and 4 locations and excavation photographs. Used with permission.

CO-40-1B

Excavation	1955	Location	I-4; 40 – 55 cm
Sex	Probable female	Type	Bundle
Age	Unknown	% Complete	Less than 25%

The individual was buried as a bundle burial, supine, with the head facing north. There is healed porosity of occipital and parietals, as well as healed cribra orbitalia in left orbit.

CO-40-1D

Excavation	1955	Location	I-4; 40 – 55 cm
Sex	Unknown	Type	Bundle
Age	0 – 5	% Complete	50% - 75%

The individual was buried as a bundle burial, supine, with the head facing north. The dentition is consistent with a 3-4 year old juvenile, +/- 1 year. There is active and healed cribra orbitalia of right orbit. Periostitis on the left and right ulnae, radii, tibiae, one rib fragment and fibula fragments. There are concretions on most elements.

CO-40-1E

Excavation	1955	Location	I-4; 40 – 55 cm
Sex	Male	Type	Bundle
Age	35 – 50	% Complete	75% - 100%

The individual was buried as a bundle burial, supine, with the head facing north. There is diffuse cranial porosity, with some healing present on parietal fragments. There is slight lipping of right glenoid fossa, lumbar centra, and right calcaneus, indicating arthritis. The left radius has lesions consistent with periostitis with areas of active and healing bone. Left ulna eroded, with cracks and discoloration to bone. Rodent gnawing to left humerus, right femur lateral condyle, left tibial crest. There are concretions on right radius.

Burial 2

The excavation notes mention how closely CO-40-2 is to CO-40-3 and CO-40-4. The individual appears to be buried around a large rock, placed near the vertebral column.

CO-40-2

Excavation	1955	Location	I-5; 130 cm
Sex	Unknown	Type	Tightly flexed
Age	0 – 5	% Complete	75% - 100%

The individual was buried as a tightly flexed burial, on the right side, with the head facing south. The dentition is consistent with a juvenile between 3 – 4 years, +/- 1 year. There is diffuse, fine-grained pinprick porosity of superior left clavicle, right ilium. There is shaft expansion with sclerotic bone on left and right ulnae and left femur, as well as sclerotic bone only on right radius and right femur. There are lesions consistent with periostitis on the distal tibia and fibulae.

Burial 3

Burial 3 originally was recorded as a single male burial, but later inventory analysis indicated a commingled female, separated into another burial by A. Huard. The darker coloration suggests CO-40-3-1 was in contact with soil with a high organic content, therefore possibly buried below CO-40-3.

CO-40-3

Excavation	1955	Location	I-5; 130 cm
Sex	Male	Type	Bundle burial
Age	35 – 50	% Complete	75% - 100%

The individual was buried as a bundle burial, supine, with the head facing north. There is active pinprick and larger porosity on occipital, healing pinprick and porosity on parietals. There is possible lipping of right glenoid fossa, and erosion of medial aspect, consistent with possible arthritis. There is arthritis of cervical vertebrae, and some lipping of costal groove of rib body fragments. There is L5 sacralization, with L5 completely fused to S1 on left side, but incomplete fusion on the posterior right aspect. There is incomplete fusion of S4-S5 of posterior neural arch. The external cranial vault is eroded and bleached. The present humerii, radius, and femora have erosion of cortical bone with concretions.

CO-40-3-1

Excavation	1955	Location	I-5; 130 cm
Sex	Female	Type	Lab
Age	50+	% Complete	50% - 75%

Some bones – including the mandible, scapula, left ilium, ribs – are light and fragile, suggesting osteoporosis, but taphonomy cannot be ruled out. Morphological changes to T11 and T12 suggests antemortem trauma to the right side of the spinal column. There is some postmortem damage to the area, but the morphology of S1 is consistent with lumbarization of S1. Lipping and eburnation of radial notch of right ulna, as well as lipping of the patellar surface of the left femur are consistent with arthritis. There are lytic-like lesions on some vertebral centra, but edges of ‘lesions’ are consistent with postmortem damage. There is rodent gnawing on right ulna, left and right femora, and right tibia.

<u>Burial 4</u>

McGimsey originally labeled Burial 4 as CO-40 Pit II-5 skeleton 3 (relabeled in Texas). The commingled adult elements associated with CO-40-4 may belong to either CO-40-3 or CO-40-3-1, but the cortical erosion and bone adhesions make manual articulation of the present skeletal elements impossible.

CO-40-4

Excavation	1955	Location	I-5; 130 cm
Sex	Female	Type	Bundle burial
Age	20 – 35	% Complete	75% - 100%

The individual was buried as a bundle burial, supine, with the head facing north. The left and right orbits have small patches of cribra orbitalia, with the midline aspect of the lesions with more active, pinprick porosity. The left and right parietals, left and right temporals, left and right sphenoid, left and right palatines, and occipital have diffuse pinprick porosity, with most concentrated porosity near saggital suture, bilaterally, and most healed near frontal. There is no healing of porosity on sphenoid. The right humerus has antemortem break with healing and remodeling of the secondary callus. The left ulna has both erosion of the cortical bone and warping of the shaft. Concretions on the retroauricular surface impact ability to assess the age range.

Burial 5

The sketches of CO-40-5 suggest the individual was buried supine, but the later tabulations of data do not include the burial position. There is a commingled distal ulna epiphysis, consistent with a child less than 15-years-old.

CO-40-5

Excavation	1955	Location	II-1; 145 cm
Sex	Probable male	Type	Disarticulated
Age	20 – 35	% Complete	75% - 100%

The individual was buried as a disarticulated secondary burial, with the head facing south. The present parietal fragments have diffuse pinprick porosity. Active, sclerotic lesions are present on the left ulna and fibulas, with shaft expansion on the tibiae. Evidence of arthritis is present on the right patella, and hand phalanges. Cranial fragments have erosion at the edges. The left and right clavicles, left scapula, right patella, vertebrae, left and right arm bones, and left and right leg bones are eroded with concretions. The mandible was crushed postmortem, with concretions. Some rodent gnawing was observed, particularly on the tibias. The right humerus, ulna and tibia have more postmortem damage than left elements, including cracking and warping.

Burial 6

The sketches from the excavation notes indicate the original burials recorded (6A, 6B, 6C) were arranged in a line from north to south. Burial 6D was created by A. Huard from commingled dentition. The burial contains commingled skeletal elements representing an unaged juvenile and an unaged adult.

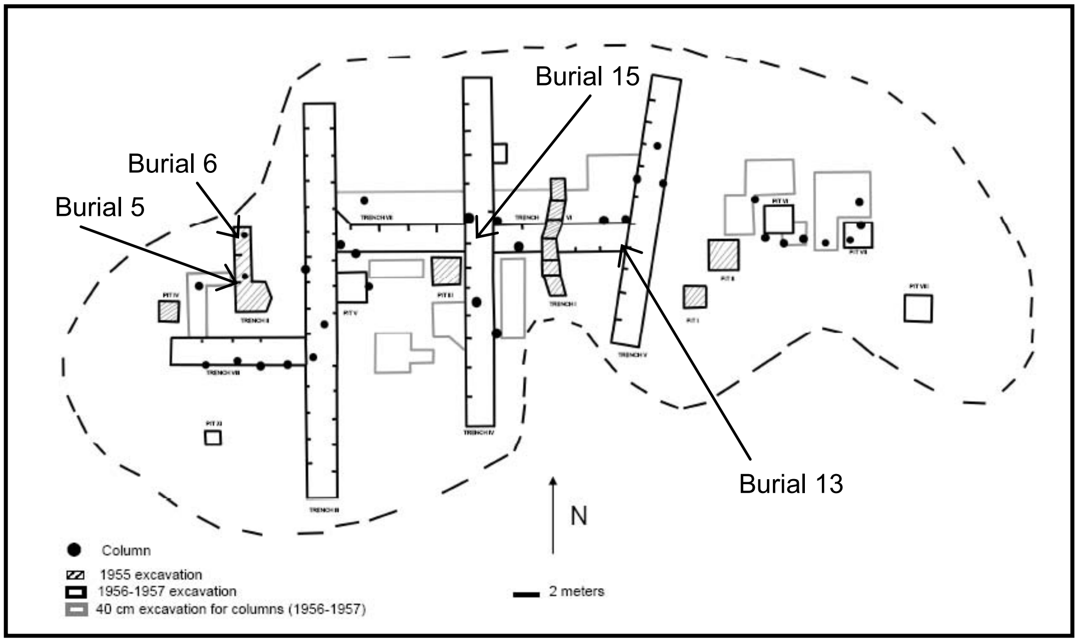
CO-40-6A

Excavation	1955	Location	II-3; 75 – 90 cm
Sex	Female	Type	Tightly flexed
Age	15 – 20	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, supine, with the head facing west. The unsided radius proximal epiphysis is fused and iliac crest is unfused, which is consistent with an age between 13 – 18 years. Occipital and parietal fragments have pinprick and healing porosity.

CO-40-6B

Excavation	1955	Location	II-3; 75 – 90 cm
Sex	Male	Type	Tightly flexed
Age	35 – 50	% Complete	Less than 25%



Burial 5

Burial 13

Burial 15

Burials 6A, 6B, 6C

Burials 5, 6, 13, and 15 locations and excavation photographs. Used with permission.

The individual was buried as a tightly flexed burial, supine, with the head facing west. The frontal has a small area of healed trauma – a small circular depression with inbending and porosity. There is diffuse pinprick porosity on the occipital and parietals, with higher concentrations near the sutures. Both the left and right femora have well remodeled shaft expansion. The internal cranial table is eroded with concretions.

CO-40-6C

Excavation	1955	Location	II-3; 75 – 90 cm
Sex	Unknown	Type	Tightly flexed
Age	5 – 10	% Complete	Less than 25%

The individual was buried as a tightly flexed burial, supine, with the head facing west. The dentition is consistent with an 8 year old, +/- 2 years. The left femur and left and right tibiae have well remodeled shaft expansion, with the left tibia most expanded with vein etching laterally. There is erosion of the cortical bone of the humerus fragments, rib fragments, and left and right femora.

CO-40-6D

Excavation	1955	Location	II-3; 75 – 90 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

The burial was created from commingled dentition from CO-40-6C. The dentition is consistent with a 1 year old, +/- 4 months.

<u>Burial 13</u>

The burial was on top of sterile red soil, with a stone on top of the cranium. The notes comment on the weight of the stone probably crushing the cranium, as well as the red stain (most likely ochre) on the bottom of the stone:

> The head is turned just slightly to the left and is resting on sterile soil somewhat higher than the rest, the body is on a pillow so that the face is at about a 30 degree angle with the plane of the spine. The spinal column is straight. The left arm is against the left side and the forearm is doubled back exactly over the upper arm with the hand at the shoulder and under the chin. The right arm is along the right side, but the forearm is doubled back and folded slightly over the chest so that the head too is under the chin. The legs are doubled back over the body in the fetal position. The right knee [rests] directly over the spine and the right foreleg is parallel to and just to the left of the spine. The right foot is turned so that the toes are to the right and are directly beyond the pelvis. The left knee [rests] directly on top of the left forearm. The left tibia is directly on top of the femur and again the toes are turned to the right just beyond the pelvis. The arms lay under the legs. (McGimsey n.d. 6)

CO-40-13

Excavation	1956 – 1957	Location	V-4, VI-1; 70 – 105 cm
Sex	Male	Type	Loosely flexed
Age	35 – 50	% Complete	75 – 100% complete

The individual was buried as a loosely flexed burial, supine, with the head facing south. There is antemortem dentition loss, with an abscess under left maxillary canine. Diffuse, healing porosity is present on the left and right parietals and occipital. Lipping is present on the left glenoid fossa, right radius, right ulna, an acetabulum fragment, left and right hand and feet phalanges, consistent with arthritis. There is erosive arthritis of the cervical vertebrae. The entire skeleton shows indications of erosion of the cortical bone, longitudinal cracks, and concretions, with some bones crushed from burial pressure and the resulting fragments concreted together.

Burial 15

The original burial descriptions indicate 15B was only represented by a cranium and 15C had more elements present at time of excavation. 15E was created by L. Norr during her analysis based on coloration of the bones. She hypothesized that 15E (created from skeletal elements from both burials 15 and 23) was originally located in the wall between the two burials. McGimsey (n.d.) writes:

> Most of the line were *[sic]* without discernable order. A good part of A was taken out when the pick just encountered them but they seemed to be at the level indicated but whether the body was articulated or not could not be determined exactly though I would guess not. There was little of B except the skull under the bones labeled D which came from the 85 – 100 in level. Labels both should be B or skeleton A may belong to skull B. skeleton C was somewhat less disturbed and seemed to follow the pattern [observed] last year in the 6 skeleton in the East Trench [renamed Trench I] with the long bones evenly divided, north – south at either side of the skull which was to the north. Part of what seemed to be yet another skeleton observed in the wall. Could there be the ends or a continuous series of skeletons [spanning] from here to the East Trench? (12)

CO-40-15A

Excavation	1956 – 1957	Location	IV 7-8; 60 – 100 cm
Sex	Probable female	Type	Bundle
Age	20 – 35	% Complete	50% - 75%

The individual was buried as a bundle burial, supine, with the head facing south. There is diffuse, pinprick porosity on the parietals. The healed, woven bone lesion on the left humerus is consistent with healed periostitis. There is erosion of the outer table of the left and right parietals, occipital, and left frontal. The left frontal table also has rodent gnawing present.

CO-40-15B

Excavation	1956 – 1957	Location	IV 7-8; 60 – 100 cm
Sex	Male	Type	Unknown
Age	35 – 50	% Complete	50% - 75%

There are no notes on how this individual was buried, though the burial is noted in the original excavation notes. The mandibular dentition was lost antemortem with active resorption at time of death. The ulna, left and right femora, and left and right tibiae have shaft expansion with both active and healed periostitis lesions.

CO-40-15C

Excavation	1956 – 1957	Location	IV 7-8; 60 – 100 cm
Sex	Male	Type	Bundle
Age	Adult	% Complete	Less than 25%

The individual was buried as a bundle burial, supine, with the head facing north. The right maxillary premolars are resorbing.

CO-40-15D

Excavation	1956 – 1957	Location	IV 7-8; 60 – 100 cm
Sex	Male	Type	Unknown
Age	Unknown	% Complete	Less than 25%

There are no notes on how this individual was buried, though the burial is noted in the original excavation notes. There is diffuse pinprick porosity on frontal and left and right parietals.

CO-40-15E

Excavation	1956 – 1957	Location	IV 7-8; 60 – 100 cm
Sex	Female	Type	Lab
Age	35 - 50	% Complete	50% - 75%

There is a small periostitis lesion of healed woven bone on right clavicle, with healed shaft expansion of the right ulna and tibia. Some skeletal elements have varying levels of cortical bone erosion.

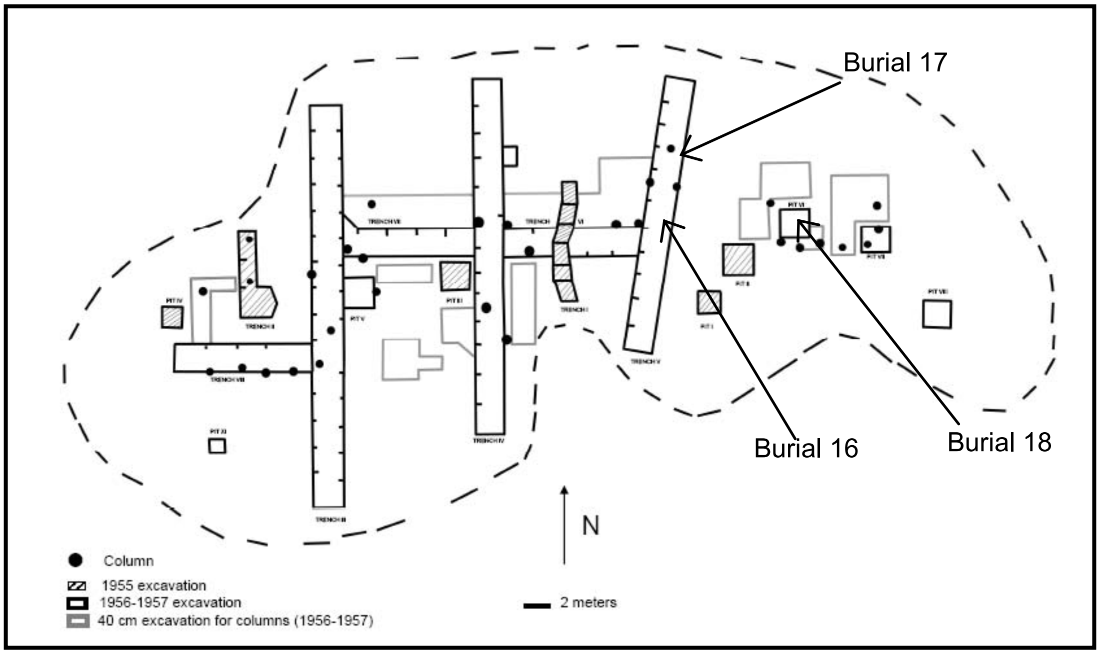
Burial 16

CO-40-16E was created from commingled long bones and skeletal elements by A. Huard. McGimsey (n.d.) writes:

> Appears to be at least three, and probably four, small children ranging in age from 5 years to shortly after birth. A – a skull and perhaps some of the long bones under C. B: a just born baby. C – red staining and oldest skeleton. Appears to be above A & B. D head spread around same level or above C. (13)

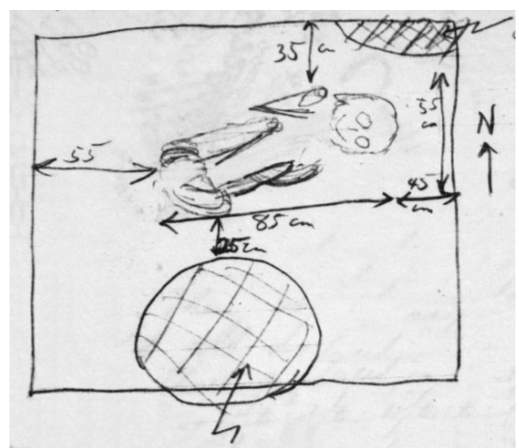
CO-40-16A

Excavation	1956 – 1957	Location	V-5; 50 – 75 cm
Sex	Unknown	Type	Unknown
Age	0 – 5	% Complete	50% - 75%



Burial

Burial 17



Burial 18

Burials 16, 17, and 18 locations and excavation photographs. Used with permission.

There are no notes on how this individual was buried, though the burial is noted in the original excavation notes. The left and right ulnae have raised sclerotic lesions with faint pinprick porosity. The fibula fragment has shell concretions present. The age is consistent with an individual between birth and 1.5 years.

CO-40-16B

Excavation	1956 – 1957	Location	V-5; 50 – 75 cm
Sex	Unknown	Type	Unknown
Age	Fetal	% Complete	75% - 100%

There are no notes on how this individual was buried, though the burial is noted in the original excavation notes. The left ilium, left and right femora, left and right tibiae have taphanomic erosion of the cortical bone. There are some shell concretions on the long bones.

CO-40-16C

Excavation	1956 – 1957	Location	V-5; 50 – 75 cm
Sex	Unknown	Type	Loosely flexed
Age	5 – 10	% Complete	75% - 100%

The individual was buried as a loosely flexed burial, on the left side. The dentition is consistent with a 6 year old juvenile, +/- 24 months. Cribia orbitalia is present in both left and right orbits, with large pores and bone formation. Most of the cranial fragments do not have porosity, but a portion of the left parietal near the lambdoid suture and a temporal fragment both have large, active pores, with two parietal fragments with healed porosity. The right ulna has a small lesion with unincorporated margins and pinprick porosity. The left and right tibiae have some shaft expansion, with diffuse pinprick porosity. The right fibula has a healed lesion. Many of the rib fragments have shell concretions adhered to the cortical bone, resembling pathology. The long bone shafts have erosion of the cortical bone and longitudinal cracking. There may be more pathological lesions present, but the concretions and taphonomic damage make diagnosis questionable at best.

CO-40-16D

Excavation	1956 – 1957	Location	V-5; 50 – 75 cm
Sex	Unknown	Type	Unknown
Age	0 – 5	% Complete	75% - 100%

There are no notes on how this individual was buried, though the burial is noted in the original excavation notes. The dentition is consistent with a 1 year old, +/- 4 months. There is diffuse porosity on the midline frontal bone. Some postmortem damage is present on the left tibia from trowel marks.

CO-40-16E

Excavation	1956 – 1957	Location	V-5; 50 – 75 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

The dentition is consistent with a juvenile between 9 months, +/- 3 months. Left and right fibulae have active periostitis lesions, with diffuse pinprick porosity and little incorporation of lesion margins.

Burial 17

There is a stone column in close proximity to the burial (approximately 25 cm south). The burial notes illustrate the orientation in the grave, and also comment on the badly crushed nature of the skeletal elements: "Badly crushed and found with the pick, so even more disturbed." (McGimsey n.d. 16)

CO-40-17

Excavation	1956 – 1957	Location	V-9; 60 – 80
Sex	Male	Type	Tightly flexed
Age	35 – 50	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, supine, with the head facing west. There is faint pinprick porosity on parietal fragments, the majority is healing, particularly at the midline.

Burial 18

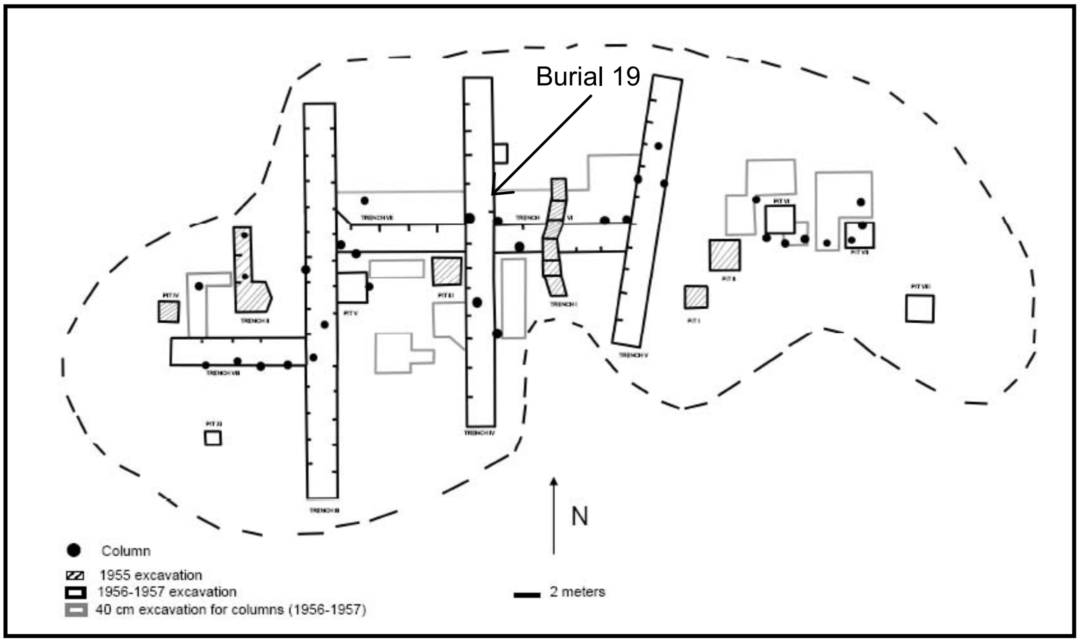
The commingled elements are consistent with an additional unaged adult. McGimsey (n.d.) states:

> "At least two bodies are represented. One is well articulated and lying on its back in the fetal position. The other bones are more scattered the portions are articulated. Perhaps these scattered bones represent more than one individual. They are represented on the material as being skeleton "A". Note: these bones also vandalized so that all bone in above sketch was gathered and placed in a single group of bags, [but only somewhat resolved in the field]." (17-18)

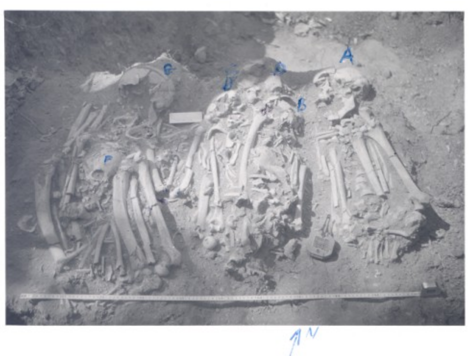
CO-40-18A

Excavation	1956 – 1957	Location	Pit 6; 50 – 70 cm
Sex	Male	Type	Disarticulated
Age	20 – 35	% Complete	75% - 100%

The individual was buried as a secondary disarticulated burial, with the head facing southwest. The parietal and occipital fragments (without taphonomic damage) have concentrated pinprick and coalesced porosity. The mandibular dentition is almost completely resorbed. The cervical vertebrae have erosive arthritis, with lipping of the glenoid fossa, costal groove, left and right ulnar coracoid, and lumbar vertebrae centra, indicating arthritis. The left and right humeri, left and right tibiae, and right fibula have patches of well incorporated lesions, with undulating bone on the shaft. The majority of cranial fragments have both the external and internal tables eroded.



Burial 19 prior to vandalism



Burial 19A and 19B

Burial 19C and 19D

Burial 19C, D, F, and G

Burial 19 locations and excavation photographs. The letters on the photographs are the original letters assigned by McGimsey. Used with permission.

CO-40-18B

Excavation	1956 – 1957	Location	Pit 6; 50 – 70 cm
Sex	Female	Type	Tightly flexed
Age	35 – 50	% Complete	75% - 100%

The individual was buried as a tightly flexed burial, supine, with the head facing southwest. The left and right temporals, occipital, and left and right parietals have pinprick, active porosity. The majority of dentition is resorbing. The left clavicle, left radius, left and right femora have shaft expression with a well incorporated, undulating morphology. Indications of arthritis are found on C2, costal groove lipping, calcaneus and talus.

Burial 19

Burial 19 represents a series of individuals that were uncovered during excavations and vandalized before they were removed from Trench IV. The descriptions that follow are McGimsey's initial descriptions, based on his numbering system. Upon arrival at Texas, the individuals were labeled 19A, 19B, and 19G. Further consideration by A. Huard indicated 19G represented at least 11 individuals, with 10 relabeled and one commingled (one additional 2-year old, 3 months juvenile). Since the original elements were all labeled "19G", the lab created burials were labeled using alternative letters, which do not correspond to McGimsey's (n.d.) original field notes:

> Bodies all in fetal position and except for "E" all of the heads to the north.
> A: On back, arms at side and folded directly back on themselves so that ulna and radius overlay the humerus. Left hand in area between left knee and mandible and overlaying the left shoulder. Right hand was placed under the face and wrapped around it so that some of the fingers were found in the orbits. The right leg was folded on itself with the fibula and tibia over the femur and placed over the center of the line between the body of the right arm so that the knee was just below the point of the chin. The left femur was similarly placed but the fibula and tibia are slightly to the side of the line midway between the femur and the vertical. In both cases the heel was right at the femoral head and the feet were turned inward and crossed so that they were just below the pelvis. The head was lying on its right side but on a level with and centered with the rest of the body.
>
> Note: at this point it was necessary to stop for the day. During the night vandals made mincemeat of the skeletons so the remainder of these descriptions are based on memory and observations of the lower or bottom portions of the skeletons, which, to a certain extent had not been disturbed.
>
> B, C, D – a group. "B": a child's skeleton (probably 2 years or less on size and teeth) lying face down on the left (east) side; the adult skeleton "D" with its head about on the left shoulder of "D". It was in the fetal position with its arms doubled in the center under the body and its legs doubled up along its sides. "C": an adolescent or young adult in a position similar to "B" but on the other side of "D" again with the head about on the shoulder of "D". The [pieces] of thin shell was facing

directly up and the mandible was slightly misplaced. There was apparently a necklace of shell beads around this skeleton's neck. "C" was more overlapping "D" than was B extending well of the right (west) side of the body of "D". Many of the beads were found in sequence with the more concave sides of all the beads faced in the same direction. "D": a young adult in the fetal position on its back. When examining this skeleton yesterday (before disturbance) I was under the impression that it was on its back, but one of the legs (undisturbed) on closer inspection seemed to suggest that the [burial was] on its stomach." Later notes reiterate that the burial was on its back (based on photographic evidence).

"H": this is the description of a 1 +/- year old child's skeleton apparently found underneath "D". No more than the mandible. The right arm and some ribs were found and perhaps this individual will prove to be apart [*sic*] of "B" which had been somewhat misplaced since the mandible was on the west side of the vertebral column of "D".

"E", "F", "G": another group buried lying just to the west of BCD

"G": the main body of this group much as "D" apparently was of the proceeding group. In the fetal position on its back, but the legs were lying somewhat to the right side (east) that is the left knee was over or just to the right side of the vertebral column and the right leg or knee was well beyond the body. Over the pelvis but under the left leg was the skeleton of a child ("F"). One hand I believe was in the general area of "F" of the stomach while the other was nearer the chin. The vertebral column of this skeleton was cleared and photographed. Note the fused 2nd and 3rd thoracic verts.

"F": a young child of 1 – 2 years lying in the fetal position on its back, with its head just north of the pelvis of G and its pelvis in the same area as G. it had a necklace of shell beads around its neck (these were observed to coincide with the cervical vertebrae). These beads differed slightly from those of C in that the beads were not as concave on one surface and some were considerably longer than their diameter.

"E": was badly disturbed during the initial discovery and its condition was badly [damaged] by last night's vandalism. Apparently the head was in the vicinity of the right shoulder of G while the body was laid over G in an east-west direction with the legs placed as though the long bones were parallel to those of G just over G's right shoulder that is with the hip by G's ear and the knees more toward G's elbow. (19-23)

CO-40-19A

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Female	Type	Tightly flexed
Age	20 – 35	% Complete	25 – 50%

The individual was buried as a tightly flexed burial, on the right side, with the head facing north. The occipital has diffuse porosity. One rib fragment has a healed fracture and diffuse pinprick porosity. The left humerus and left radius have shaft expansion with elongated porosity, well incorporated margins, and an undulating morphology.

CO-40-19B

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Tightly flexed
Age	5 – 10	% Complete	25 – 50%

The individual was buried as a tightly flexed burial, prone, with the head facing south. The dentition is consistent with a juvenile between 5 – 9 years. The left orbit has pinprick and larger porosity, consistent with active cribra orbitalia. The fibula shaft fragments have periostitis lesions, with woven bone morphology and pinprick porosity. The right radius and ulna have taphanomic erosion of the cortical bone.

CO-40-19E

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Lab
Age	10 – 15	% Complete	25 – 50%

The left and right tibiae have large lesions on the shafts, with elongated and pinprick porosity, with some reconstruction on the mesial aspect (margins are remodeled). The dentition is consistent with an 11 year old, +/- 30 months.

CO-40-19F

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

The dentition is consistent with a juvenile between 3 – 5 years.

CO-40-19H

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

The dentition and fusion are consistent with a juvenile between 2.5 – 3 years.

CO-40-19I

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Lab
Age	5 – 10	% Complete	Less than 25%

The left and right orbits have large pores consistent with cribra orbitalia. The age is based on an unfused ilium crest, consistent with an individual between 9 – 10 years old.

CO-40-19J

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

The individual is consistent with an age of 9 months – 1 year due to dentition development and cranial element development (specifically, the pars lateralis and pars petrosas).

CO-40-19K

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

The individual is consistent with an age of birth due to the dens fusing on C2 and the fusion of C1 right neural arch.

CO-40-19L

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

Dm1, dm2 crowns are mineralized. The developmental stages of the crowns of the molars are consistent with a fetus 11 weeks in utero.

CO-40-19M

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Probable female	Type	Lab
Age	20 – 35	% Complete	50% – 75%

The auricular surface and pelvic characteristics are consistent with a 30-34 year old female.

CO-40-19P

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Male	Type	Lab
Age	20 – 35	% Complete	50% – 75%

The auricular surface and pelvic characteristics are consistent with a 25-34 year old male.

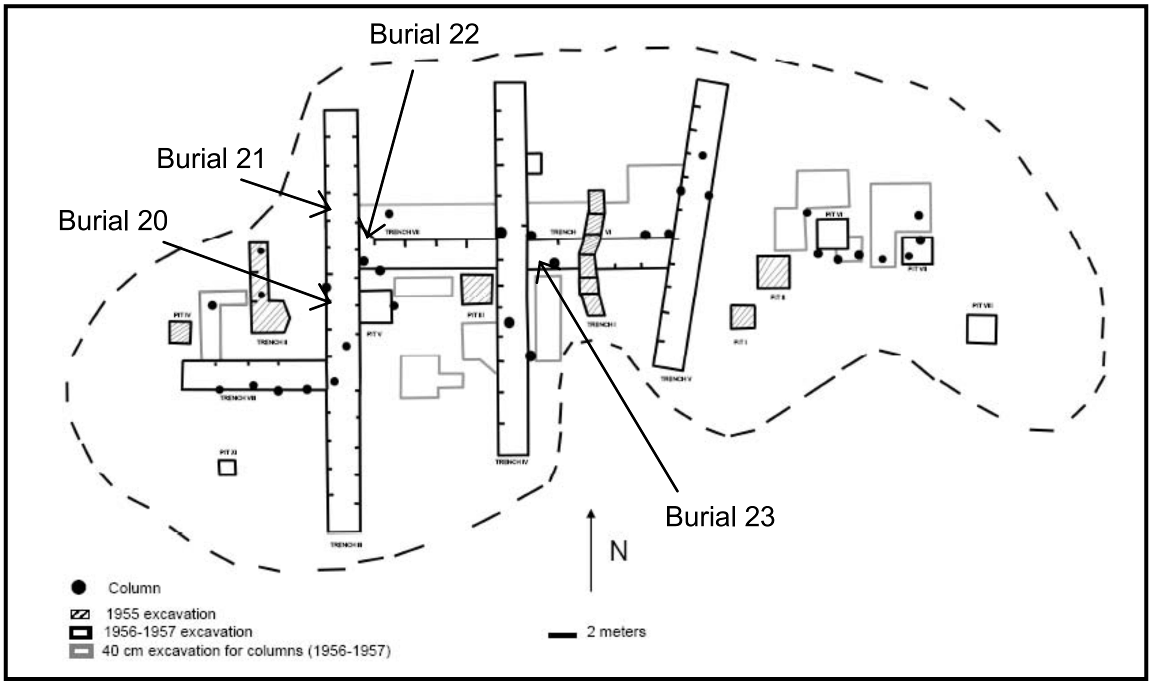
CO-40-19R

Excavation	1956 – 1957	Location	IV-9; 110 – 140 cm
Sex	Male	Type	Lab
Age	35 – 50	% Complete	Less than 25%

The pubic symphysis and pelvic characteristics are consistent with a 40-49 year old male.

<u>Burial 20</u>

When excavated in the field, McGimsey noted that the burial consisted of at least one individual, with the possibility of a commingled individual. During initial analysis in Texas, the burial was separated into three individuals (20A, B, and C). However, none of the skeletal elements were repeated, indicated another individual, or labeled separately,

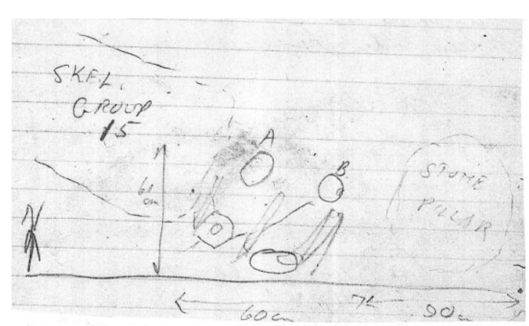


Burial 20

Burial 21

Burial 22

Burial 23



Burials 20, 21, 22, 23 locations and excavation photographs. Used with permission.

resulting in the most recent analysis reassembling the three individuals into one (20A). McGimsey (n.d.) writes:

> The long bones of the left leg ran almost due east-west but the body which from the position of and distance between the limbs may have had meat on it at the time of burial apparently not fully articulated. The left leg and foot yes, but the right femur runs northeast – southwest under the left leg and patella at northeast end but the right tibia runs northwest – southeast…; the left leg knee area at the southeast end. No trace of right foot. The right pelvis entirely overlay the center portion of the left leg. The skull facing parallel was just east of the left knee. Just beyond the skull (east or northeast) were scattered portions of a pelvis, ribs, toes and a few vertebrae. These may not belong to skeleton 20, because at least some were beyond the area of brown soil. (25)

CO-40-20A

Excavation	1956 – 1957	Location	III-8; 130 – 150 cm
Sex	Probable female	Type	Disarticulated
Age	20 – 35	% Complete	75% - 100%

The individual was buried as a secondary disarticulated burial, with the head facing east. Diffuse and healed porosity is located on the frontal, left and right parietals, left and right temporals, and occipital with the most concentrated porosity near the sutures. There is healed cribra orbitalia in the left and right orbits. The left and right ulna, right radius, and right femur have healed periostitis with elongated porosity, undulating morphology, and well incorporated margins. The first right metacarpal has a healed break.

Burial 21

McGimsey (n.d.) writes:

> The body is lying on its left side in a loosely flexed position. The distal end of the right humerus and arms, and the adjacent ribs are stained red. A rock is lying directly on top of the area of the skull. (26)

CO-40-21

Excavation	1956 – 1957	Location	III-11; 100 – 125 cm
Sex	Probable male	Type	Loosely flexed
Age	15 – 20	% Complete	50% - 75%

The individual was buried as a loosely flexed burial, on the left side, with the head facing north. There is probable healed cribra orbitalia in the right orbit. There is probable incomplete sacralization of L5. The majority of the spinous processes of the vertebrae are blunted, suggesting ossification of the ligament. The left ulna and left and right femora have probable periostitis, with elongated porosity, undulating morphology, and well incorporated margins. The entire skeleton was crushed from the pressure of burial, and then cemented together from shell concretions, making definitive diagnosis difficult.

Burial 22

22B has an adult and juvenile commingled together, but the adult appears to be the original burial. There are similar taphonomic patterns of the adult and 22E (gray and weathered), but repeated skeletal elements indicate two individuals. Individuals 22D and 22E were created by Texas from commingled material. McGimsey (n.d.) writes:

> A: in a flexed position, with the backbone [slightly] curved as if the body were crunched together to fit it into the hole. What apparently is the head is placed just beyond (north) the feet but otherwise the body is articulated. The neck vertebrae almost lie under the left clavicle. The left scapula has shifted down so that it overlies the left elbow. The hands were right under where the chin would have been had the head been in place.
>
> B: appears to be a bundle burial with the head to the east and pelvis to the west just under and to the east of the skull of A. the bones are in very bad condition. The long bones do not appear to be divided but rather just spread in layer east – west between the skull and the pelvis. Skull B^2 was under the long bones. Just below the teeth of skull "A" were 3 shell pendants. They were about at the east end of the long bones of skeleton B at the level of the zygomatic arch of skull C.
>
> C: a young child facing E the femurs were running east – west alongside the south side of the skull at about the level of the zygomatic arch. Some of the bone of this skeleton I think got [damaged] like those of B. the entire area of B seems to have been hard on bone for some reason. The bones of B look terrible but a few bones which extend outside the main area also look much better on the end [away from] the main area. A was definitely placed in the hole last but the order or placement of B and C could not be determined nor could the position of C. the feet of A were right in the face of C. (31-32)

CO-40-22A

Excavation	1956 – 1957	Location	VII-5; 70 cm
Sex	Male	Type	Tightly flexed
Age	35 – 50	% Complete	75% - 100%

The individual was buried as a tightly flexed burial, on the right side, with the head facing north. The left and right tibiae, left fibula, right fourth metatarsal, and an ilium fragment have woven bone with well remodeled margins and diffuse porosity. The left and right glenoid fossas, left ulnar coracoid process, left and right tali, and C2 have lipping, suggesting arthritis of the shoulders. The left and right frontals and parietals have erosion of the cortical bone and some diploe as well as longitudinal cracks with warping. Age of individual is based on present and erupted third molars and the dental attrition.

CO-40-22B adult

Excavation	1956 – 1957	Location	VII-5; 70 cm
Sex	Probable female	Type	Bundle
Age	Unknown	% Complete	Less than 25%

The individual was buried as a bundle burial, supine, with the head facing northwest. The left radius, left ulna, right ulna, right femur, unsided tibia and unsided fibula have pinprick porosity with sclerotic bone formation. The unsided tibia and unsided fibula have considerable shaft expansion, masking the morphological characteristics. The right ulna has a taphonomic pressure lesion throughout the periostitis lesion.

CO-40-22B juvenile

Excavation	1956 – 1957	Location	VII-5; 70 cm
Sex	Unknown	Type	Lab
Age	5 – 10	% Complete	Less than 25%

The dentition is consistent with a juvenile between 5 – 9 years.

CO-40-22C

Excavation	1956 – 1957	Location	VII-5; 70 cm
Sex	Unknown	Type	Tightly flexed
Age	0 – 5	% Complete	Less than 25%

The individual was buried as a tightly flexed burial, on the left side. The left and right tympanic plate stage is consistent with approximately 11 months old, the unfused jugular is consistent with an individual 1 – 3 years. Active porosity with large pores is located on the parietals, along with a raised bone lesion.

CO-40-22D

Excavation	1956 – 1957	Location	VII-5; 70 cm
Sex	Male	Type	Lab
Age	50+	% Complete	Less than 25%

There is antemortem loss and remodeling of the majority of the dentition with pinprick porosity and a probable periostitis lesion. The lumbar vertebrae have ring osteophytes, suggesting arthritis. The cervical vertebrae present have erosive arthritis. The cranium is heavily damaged by taphonomic processes; it appears that some cranial bones were crushed in burial, and then eroded. There is some rodent gnawing at right supraorbital margins. The mandible has longitudinal weathering cracks.

CO-40-22E

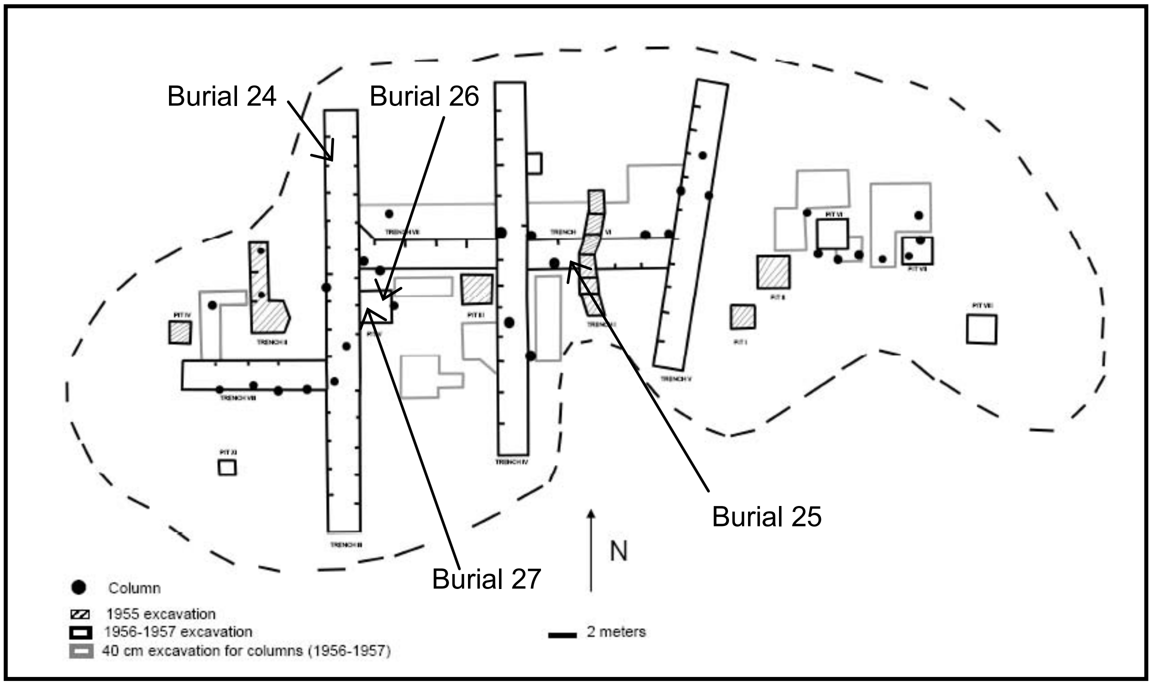
Excavation	1956 – 1957	Location	VII-5; 70 cm
Sex	Probable male	Type	Lab
Age	35 – 50	% Complete	Less than 25%

The burial is highly fragmented, eroded, with longitudinal cracks and warping. The taphonomy is similar to A, but there are overlapping elements.

Burial 23

MNI for burial is 3 adults, based on the left femora present. One femur is associated with CO-40-23B, but other two are unassociated. Commingled long bones have some lesions associated with periostitis. McGimsey (n.d.) writes:

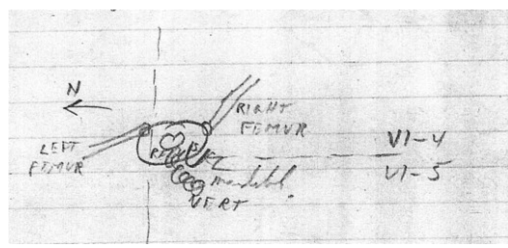
> A: Badly disturbed even before we found it; part of a skull was near pelvis and very little of it found. Many bones are missing. As far as could be determined it was a bundle burial with head to northeast.



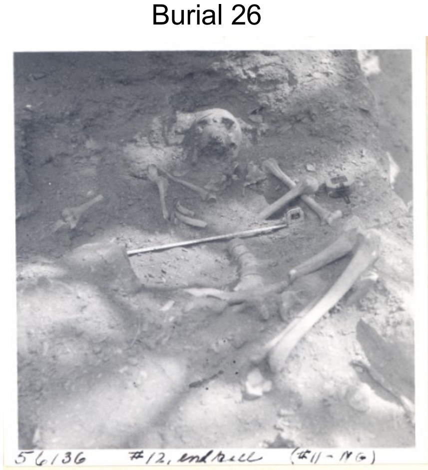
Burial 24

No Sketch/
photograph

Burial 25



Burial 26



Burial 27

Burials 24, 25, 26, 27 locations and excavation photographs. Used with permission.

> B: was partially below "A" and the bones were stained a sort of brown (doesn't appear to be ochre stains) so the bones could be sorted from A fairly well. This also slightly disturbed and not all bones found but appears to have been a flexed burial lying on its left side, head to the north with knees under chin. (33)

CO-40-23A

Excavation	1956 – 1957	Location	VI-5; 60 – 95 cm
Sex	Probable female	Type	Bundle
Age	20 – 35	% Complete	50% – 75%

The individual was buried as a bundle burial, with the head facing northeast. There is diffuse pinprick porosity of the parietals. There is some postmortem damage to the cranium and left tibia from trowel marks. The coloration of the left and right parietals is distinct, with the left side appearing much darker than the right. Some elements are eroded and/or have shell concretions, notably the right auricular surface. The right femur and right tibia have some rodent damage.

CO-40-23B

Excavation	1956 – 1957	Location	VI-5; 60 – 95 cm
Sex	Unknown	Type	Loosely flexed
Age	Unknown	% Complete	Less than 25%

The individual was buried as a loosely flexed burial, on the left side, with the head facing northeast. The right patella is eroded and bleached. The left femur has postmortem damage from excavation and longitudinal cracks. The left and right femora and right tibia have rodent damage.

<u>Burial 24</u>

There is only one note on how this individual was buried, indicating the head may have faced east *in situ*.

CO-40-24

Excavation	1956 – 1957	Location	III-13; 40 cm
Sex	Male	Type	Unknown
Age	Adult	% Complete	Less than 25%

The left and right parietals have porotic hyperostosis, represented by pinprick and larger porosity, with diploe expansion.

<u>Burial 25</u>

MNI for burial is 3, two adults based on right femora and one juvenile (25-1). Juvenile separated by A. Huard. McGimsey (n.d.) states:

> In northwest corner of VI-4, extending into pit 5. Bone were between 40 – 70cm and apparently the body was placed in the grave in a sitting position facing east with his legs crossed. Not all of the body was there and the skull is missing. (35)

CO-40-25

Excavation	1956 – 1957	Location	VI-4-5; 40 – 70cm
Sex	Female	Type	Disarticulated
Age	20 – 35	% Complete	Less than 25%

The individual was buried as a secondary disarticulated burial. There is a mandibular abscess between the right first premolar and first molar. One proximal toe phalanx was broken and healed. The left and right humeri and right ulna have rodent damage.

CO-40-25-1

Excavation	1956 – 1957	Location	VI-4-5; 40 – 70cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	Less than 25%

Based on mixed dentition, the juvenile is approximately 4 – 5 years.

<u>Burial 26</u>

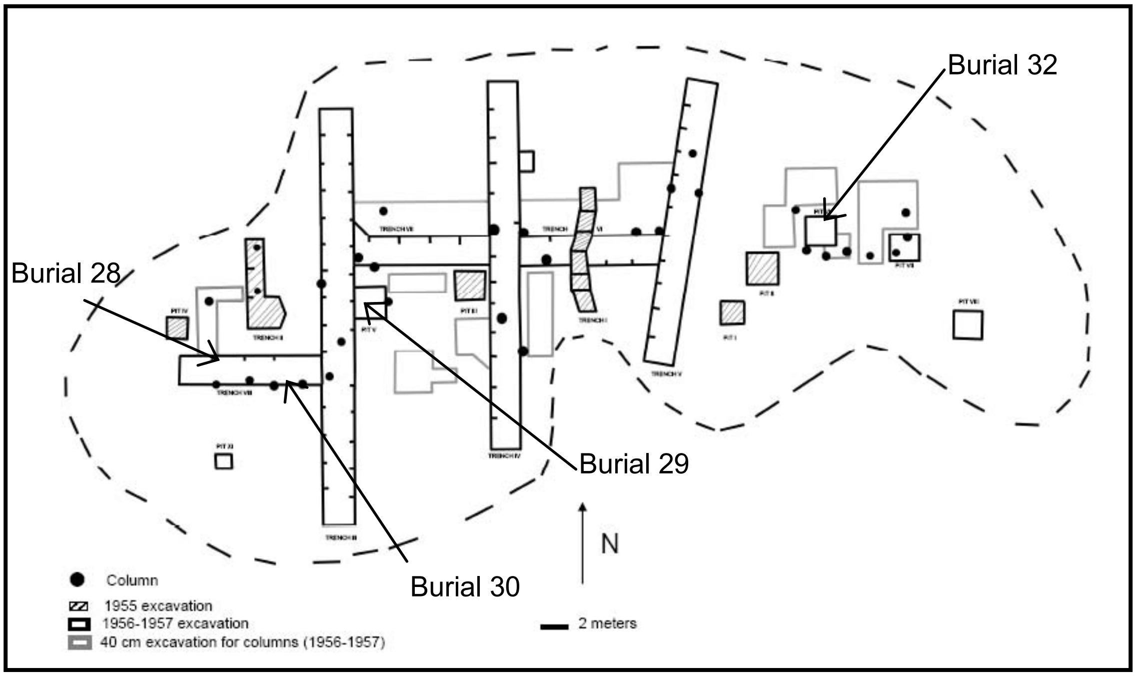
McGimsey (n.d.) states:

> The body is on its back – head to the south. Vertebral column nearly straight. The legs are partially flexed so that the knees were both to the left of the body and the femurs were at right angles to the vertebral column, the feet just below the pelvis. The lower left arm was missing but the left humerus was almost parallel to the body. The proximal half of the right humerus overlays the left humerus. The right elbow is out at about a 50 degree angle to the body. Lumbar vertebrae in place, most others missing or scattered. (14)

CO-40-26

Excavation	1956 – 1957	Location	Pit 5; 95 cm
Sex	Male	Type	Loosely flexed
Age	35 – 50	% Complete	75% - 100%

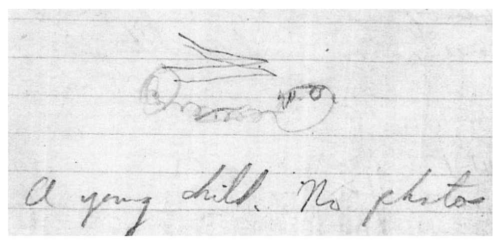
The individual was buried as a loosely flexed burial, on the left side, with the head facing south. The left and right posterior parietals have localized bone formation from inflammation. The area is raised, with pinprick and coalescing porosity. The internal table of the middle left parietal has an area of the bone formation. The dentition has calculus at and below the CEJ, indicating periodontal disease. The left glenoid fossa, left and right acetabulum, all present rib heads, articular facets, costal grooves, and tarsals have lipping, indicating arthritis. The lumbar vertebrae have lipping on articular processes, as well as erosive arthritis of L3 and L4. There is possible dislocation of the left auricular surface. The superior articular surface and neural arch of S1 more closely resemble a lumbar vertebra, consistent with probable lumbarization of the sacrum (with postmortem damage to L5 and the remaining sacrum). The skeleton is highly fragmented, with erosion of cortical bone, longitudinal cracks, warping, and bleaching. There is rodent gnawing present on the left tibia.



Burial 28

No Sketch/
photograph

Burial 29



Burial 30

No Sketch/
photograph

Burial 32

Burials 24, 25, 26, 27 locations and excavation photographs. Used with permission.

Burial 27

McGimsey (n.d.) states:

> The feet of #27 are about 60 cm directly below those of #26. The body is in stratum D, and at a greater depth than the bottom of the nearly column (but not under the column). The body is on its back, flexed with head to the east. Left knee at left side, right knee just left of vertebral column. Right arm over chest cavity with hands alongside of the respective sides of the head. Present length of vertebral column approximately 65 cm. bone not in good condition. The stone overlaid was lying below the chin in position marked “x” on sketch. (43)

CO-40-27

Excavation	1956 – 1957	Location	Pit 5; 155 cm
Sex	Probable male	Type	Tightly flexed
Age	35 – 50	% Complete	75% - 100%

The individual was buried as a tightly flexed burial, supine, with the head facing west. The frontal bone has active, concentrated porosity on the left supraorbital margin. The remaining portion of the frontal bone, left temporal, left clavicle, and left acetabulum have diffuse porosity. There is periodontal disease present, with a possible abscess under the first right mandibular molar. The right clavicle, left femur, left and right tibiae, and left and right fibulae have periostitis and shaft expansion, with both active margins and more incorporated bone matrix. There are shell concretions near some of the lesions on the long bones, making diagnosis difficult in some cases. The frontal bone and right tibia are very eroded. The right clavicle has some bleaching present.

Burial 28

There are elements consistent with an unaged juvenile present. This burial is a male and female, commingled. The original notes have the male as the main burial. The commingled female is consistent with age 50+. McGimsey (n.d.) states:

> Found in the northeast corner of Trench IX-4f at a depth of 110 – 135 cm, just above red sterile clay in stratum D. appears to be at least two bodies in no discernable order. One adult, the other quite young. Bones in very poor shape and no attempt made to recover them all. (44)

CO-40-28

Excavation	1956 – 1957	Location	VIII-4; 110 – 135 cm
Sex	Male	Type	Unknown
Age	35 – 50	% Complete	Less than 25%

There are no notes on how this individual was buried, though the burial is noted in the original excavation notes. The right glenoid fossa has erosive arthritis, as well as slight erosion and porosity in the left and right acetabulum. The left humerus anterior distal epiphysis has bone spicules and lipping, with corresponding arthritis on the left ulna. Age is based on the extent of arthritis.

Burial 29

29A has adult phalanx commingled with it. McGimsey (n.d.) states:

In Trench VIII-1 at a depth of 110 cm and about 10 – 15 cm deeper than #26. Flexed on right side with head to the north. A young child. No photo. (44)

CO-40-29A

Excavation	1956 – 1957	Location	Pit 5; 110 cm
Sex	Unknown	Type	Tightly flexed
Age	5 – 10	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, on the right side, with the head facing north. The left and right orbits have active cribra orbitalia. The dentition is consistent with a 7 year old, +/- 2 years.

CO-40-29B

Excavation	1956 – 1957	Location	Pit 5; 110 cm
Sex	Unknown	Type	Lab
Age	0 – 5	% Complete	25% – 50%

The vertebra neural arches are fused at the spinous process, with some neural arches fusing to the centra; this is consistent with an individual between 2 – 3 years.

Burial 30

McGimsey (n.d.) states:

> In trench IX-2, stratum C, the skull was located in the center of the north edge of the pit, the body apparently ran north from the skull. Only the skull excavated [because] it was such poor condition that did not warrant digging another pit to the north to clear it. The skull was upright and looking northeast. The long bones observed also ran northeast – southwest. Around the skull and inside the skull was a powdery yellow ochre like substance. (45)

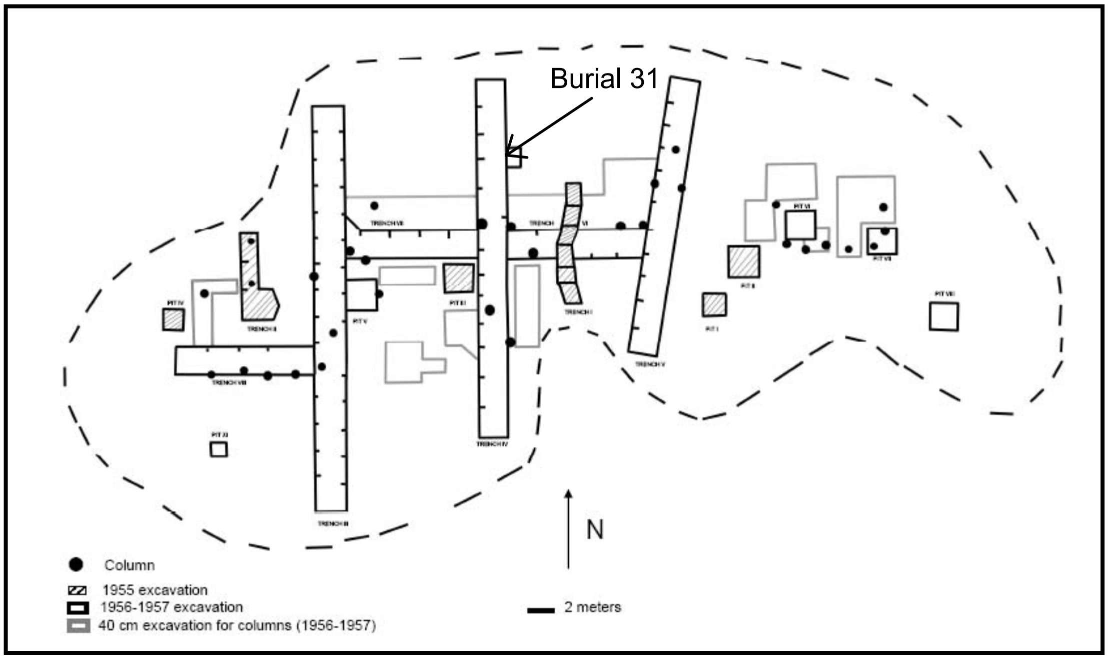
CO-40-30

Excavation	1956 – 1957	Location	VIII-2; 60 cm
Sex	Probable male	Type	Tightly flexed
Age	35 – 50	% Complete	Less than 25%

The individual was buried as a tightly flexed burial. The burial is represented by a cranium only, which is highly fragmented and eroded. The majority of the sutures show significant closure, but the internal, surface has bone and shell concretions adhered to the surface. The age is estimated based on the dentition present and cranial suture closure.

Burial 31

Burial 31 commingled consists of elements representing a probable female adult, over age 17, and one child, 5 – 10. 31-1C, a burial created in Texas, has a small petrus



Burial 31A - H

Burial 31A - F

Burial 31

Burial 31A, B, C

Burial 31 locations and excavation photographs. Used with permission.

portion commingled with the burial, consistent with a juvenile around birth, and an adult. B' labeled as B1 on bones, but B' in the excavation notes. McGimsey (n.d.) states:

> A: is a tightly flexed hands by chin. Right foot folded up along leg, but left twisted back [to] leg and pelvis.
>
> B': is that of a newborn child (less than 6 months on tooth eruption or rather lack of it). Flexed across the stomach of A on top of all the bones all about the elbow level. The big bracelet, 2 medium ones were near its feet (it's lower in relation to A's body than in sketch). The pearl (!) one was near its head (by the pelvis of A) and one small well finished one was found between the right tibias and _ of A.
>
> B: was lying in a tightly flexed position against the legs and left arm of A. a slightly older child.
>
> C: is in a flexed position on its stomach, hands under chin and feet turned up under legs. Length of vertebral column from sacrum to foramen magnum – 49cm.
>
> D: appears to have been flexed on its right side close up against the right side of C.
>
> D': a very young baby (even younger than D I believe) was flexed and underneath C with its head below the right shoulder of C and its body extends, about half of the depth of C all between C's vertebral column D might be found below D' in the general area of its neck was a red curly tailed monkey pendent well within the tradition of the Coclé curly tailed monkey is perhaps a little less well done. This implies either (1) this tradition is quite old, (2) these burials are intrusive or (3) the side is Coclé in date. On the basis of the present evidence I think the first is most likely. The total evidence still makes it seem unlikely that the site as a whole is contemporary with Coclé (as it happened this group of shell with baby and a half out of a pit that there was a good opportunity to study the strata along the shelving in cross section after the pendant was found the strata immediately surrounding the skeleton and which portion of the skeleton still extend[s] as well as that overlaying the 3+ skeletons at the same level…which are probably contemporary. In no instance could any signs of intrusive be observed. At no points did A or B seem to extend down to the skeleton (though in the region of the hands "A" comes quite close and there were some oyster shells around the heads. They could have been buried during the deposition of C or in part since B is very thin here perhaps even during early A time.
>
> The five skeletons E, F, G, H, or I were such a compounded mess (though I believe all were fully articulated) that I have little hope that I have properly sorted out though I tried. E, F, G, H, and I were stacked right on top of one another with H or G on the bottom.
>
> H in a tightly flexed position slightly on the left side though head was upright and facing south-southeast.
>
> G is tightly flexed on back as was F.

I was tightly flexed probably on its back with its head to the south-southeast just beyond pelvis of F, G, and H, parallel to I, [head not recovered] though the mandible was down by belt area was recovered – a young child. I was on top of F, G, and H; F was on top of G and H and E was on its right side snuggled up right against F and G. (47 – 50)

CO-40-31A

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Probable male	Type	Tightly flexed
Age	20 – 35	% Complete	75% - 100%

The individual was buried as a tightly flexed burial, supine, with the head facing north. The left and right parietals have pinprick porosity, with more active porosity on the right parietal. The occipital has larger, diffuse porosity present with little to no healing. The right fibula has a well healed periostitis lesion. The iliac crest is consistent with an age of 17 – 22 years. S1 is unfused to S2, consistent with an age of less than 27 years. There are postmortem pressure lesions present in the left and right acetabula.

CO-40-31B

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Unknown	Type	Tightly flexed
Age	0 – 5	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, supine, with the head facing north. The acetabulum is completely open, but the rib heads and tuberosities are fused, consistent with an age of 4 years, +/- 1 year.

CO-40-31B1

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Unknown	Type	Tightly flexed
Age	0 – 5	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, on the right side, with the head facing east. The tympanic plate is consistent with stage C. The dentition is consistent with a child between 7 months in utero and birth, +/- 2 months.

CO-40-31C

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Male	Type	Tightly flexed
Age	35 – 50	% Complete	75% - 100%

The individual was buried as a tightly flexed burial, prone, with the head facing north. The frontal and right parietal have diffuse, healing pinprick porosity. There is slight lipping at the costal grooves, carpals, metacarpals, and tarsals. There is healed periostitis of the left and right radii, right ulna, left and right femora, left and right tibia, and the left and right fibulae. The right tibia has longitudinal weathering cracks.

CO-40-31-1C

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Probable male	Type	Lab
Age	20 – 35	% Complete	50% - 75%

The parietals and occipital have some cranial modification, with the flattening of the posterior parietals and superior occipital (superior to the external occipital protuberance), creating a shape similar to lambdoid head shaping (Buikstra and Ubelaker: 162) and faint pinprick porosity associated with the flattened areas. The right glenoid fossa has lipping and localized porosity associated with the lipping.

CO-40-31D

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Unknown	Type	Tightly flexed
Age	0 – 5	% Complete	Less than 25%

The individual was buried as a tightly flexed burial, supine, with the head facing north. The dentition is consistent with a child between 2 – 3 years, +/- 8 months.

CO-40-31D'

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Unknown	Type	Tightly flexed
Age	0 – 5	% Complete	Less than 25%

The individual was buried as a tightly flexed burial, supine, with the head facing north. The external auditory meatus is in stage A, which is consistent with age birth – 5 months. The humerus shaft has a well healed circumferential periostitis lesion near the midshaft.

CO-40-31E

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Probable male	Type	Tightly flexed
Age	15 – 20	% Complete	75% - 100%

The individual was buried as a tightly flexed burial, on the right side, with the head facing north. The fusion of the glenoid fossa and unfused iliac crest are consistent with an individual between 17 – 19 years. The left and right frontal and left and right parietals have diffuse pinprick porosity. It appears to extend to the left and right occipitals, but the cortical bone is eroded. The left femur head is concreted into the acetabulum. The left femur shaft has longitudinal weathering cracks.

CO-40-31F

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Female	Type	Tightly flexed
Age	35 – 50	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, supine, with the head facing north. The frontal bone has diffuse, pinprick porosity with healing at bregma. The left and right tibiae and right fibula have healed periostitis, with well healed margins and undulating cortical bone morphology.

CO-40-31G

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Ambiguous	Type	Tightly flexed
Age	Adult	% Complete	50% - 75%

The individual was buried as a tightly flexed burial, supine, with the head facing north. The left and right orbits have diffuse porosity, but do not appear to be cribra orbitalia because of lack of bone formation. There is diffuse, healing porosity near lambda on the left parietal. The right radius and left and right femora have a healed periostitis lesion with undulating morphology and well incorporated margins.

CO-40-31H

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Unknown	Type	Tightly flexed
Age	5 – 10	% Complete	Less than 25%

The individual was buried as a tightly flexed burial, supine, with the head facing north. The dentition in this burial is commingled, representing a three-year-old and an eight-year-old (approximately). The eight-year-old child appears to be the main burial (based on excavation notes) with the three-year-old possibly representing commingled material from CO-40-31D.

CO-40-31I

Excavation	1956 – 1957	Location	IV-11-11A; 100 cm
Sex	Unknown	Type	Flexed
Age	Adult	% Complete	Less than 25%

The individual was buried as a flexed burial. The left scapula glenoid fossa secondary epiphyses are fused to the scapular body, consistent with an age of puberty or greater.

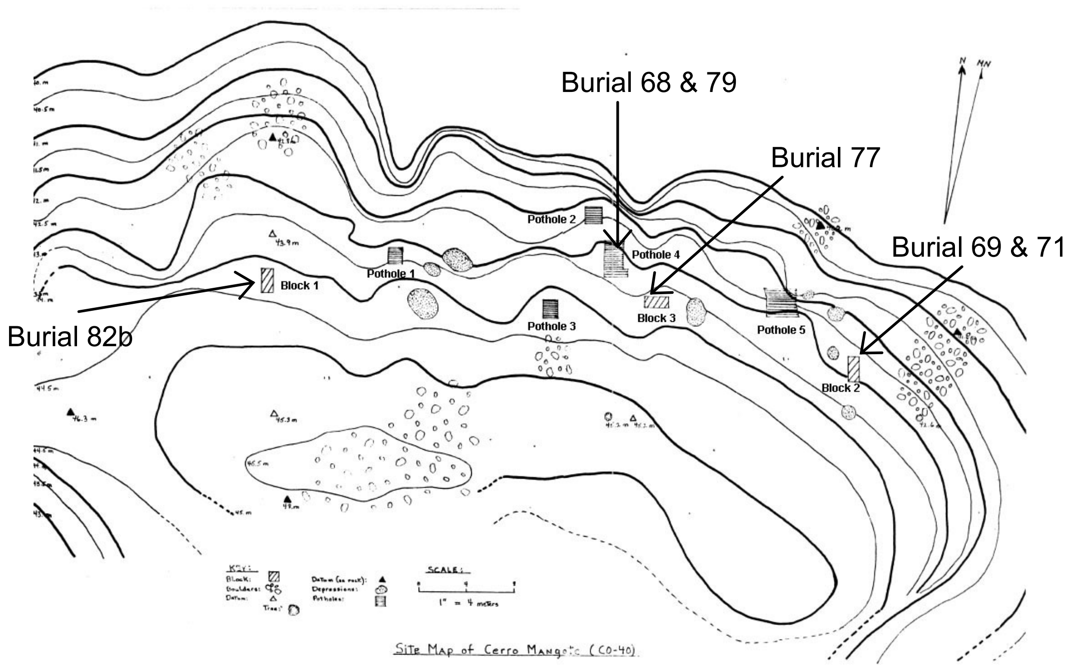
<u>Burial 32</u>

"Found just below group 18A in stratum B." (McGimsey n.d. 48)

CO-40-32A

Excavation	1956 – 1957	Location	Pit 6; 65 – 80 cm
Sex	Male	Type	Tightly flexed
Age	20 – 35	% Complete	75% - 100%

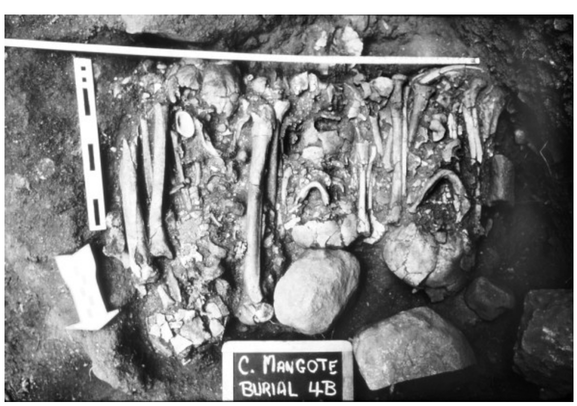
The individual was buried as a tightly flexed burial, on the right side, with the head facing east. There is pinprick and larger porosity on the left and right parietals, with a higher concentration on the left parietal. Three middle thoracic vertebrae have schmoral's nodes, consistent with a compression of the intervertebral disks, most likely from a fall. Vein etching on the right femur suggests there was previous shaft expansion that was remodeled. There are longitudinal cracks on the left and right femora.



Burial 69

Burial 77

Burial 68



Burials 68, 69, and 77 locations and excavation photographs. Used with permission.

CO-40-32B

Excavation	1956 – 1957	Location	Pit 6; 65 – 80 cm
Sex	Unknown	Type	Loosely flexed
Age	0 – 5	% Complete	50% - 75%

The individual was buried as a loosely flexed burial, on the right side, with the head facing west. The dentition is consistent with a juvenile 6 – 9 month old. The left and right tibiae have small periostitis lesions with unincorporated bone matrix and pinprick porosity.

CO-40-68C/Infant

Excavation	1979	Location	Pothole 4; 40 – 90 bd
Sex	Unknown	Type	Unknown
Age	0 – 5	% Complete	25 – 50%

This individual was commingled with at least two other juveniles, as well as 68E and 68W individuals. The dentition is consistent with a 6 month old – 1 year old child. The fibula shaft has concretions.

CO-40-68C/3yo

Excavation	1979	Location	Pothole 4; 40 – 90 bd
Sex	Unknown	Type	Unknown
Age	0 – 5	% Complete	50% - 75%

This individual was commingled with at least two other juveniles, as well as 68E and 68W individuals. The fusion timing and dentition are consistent with a 3 to 4 year old child, +/- 1 year. There is some cortical bone erosion, particularly of the long bones. Some of the long bone shafts are unidentified due to the concretions present.

CO-40-68C/7yo

Excavation	1979	Location	Pothole 4; 40 – 90 bd
Sex	Unknown	Type	Unknown
Age	5 – 10	% Complete	Less than 25%

This individual was commingled with at least two other juveniles, as well as 68E and 68W individuals. The dentition is consistent with a 7 year old child, +/- 24 months.

CO-40-68E/fetal (commingled)

Excavation	1979	Location	Pothole 4B; 80 – 90 bd
Sex	Unknown	Type	Unknown
Age	8 months in utero	% Complete	Less than 25%

This individual was commingled with at least two other individuals, as well as 68C and 68W individuals. The fusion pattern of the sphenoid is consistent with an 8 months in utero fetus.

CO-40-68E/child6yo

Excavation	1979	Location	Pothole 4B; 80 – 90 bd
Sex	Unknown	Type	Unknown
Age	5 – 10	% Complete	25% - 50%

The records also list this individual as 79 b. 68E. This individual was commingled with at least two others, as well as 68C and 68W individuals. The dentition is consistent with a 6 year old child +/- 24 months. The left and right humeri, femora fragments, and right tibia have well healed periostitis lesions. There are concretions on the highly fragmented remains.

CO-40-68E/adult

Excavation	1979	Location	Pothole 4B; 80 – 90 bd
Sex	Probable female	Type	Unknown
Age	50+	% Complete	75% - 100%

This individual was commingled with at least two other juveniles, as well as 68C and 68W individuals. There is evidence of periostitis on rib shaft fragments, well remodeled shaft expansion of the right femur, and left and right tibiae. There is arthritis present, with lipping at the elbow, wrist, vertebrae, hands, and feet. The burial is highly fragmented, longitudinal cracks, with shell and bone concretions.

CO-40-68W/infant

Excavation	1979	Location	Block 4B; 40 – 90 bd
Sex	Unknown	Type	Unknown
Age	0 – 5	% Complete	Less than 25%

This individual was commingled with at least an adult and a juvenile, as well as 68E and 68C individuals. The dentition is consistent with a 6 month to 1 year old child, +/- 24 months.

CO-40-68W/child9yo

Excavation	1979	Location	Block 4B; 40 – 90 bd
Sex	Unknown	Type	Unknown
Age	5 – 10	% Complete	Less than 25%

This individual was commingled with at least an adult and a juvenile, as well as 68E and 68C individuals. The cranium is facing northeast. The burial notes describe the "individual [was] part of packaged burial unit" with at least two other individuals (most likely the juvenile and adult). The dentition is consistent with a 9 year old child, +/- 24 months. There are shell concretions and fragmenting.

CO-40-68W/adult

Excavation	1979	Location	Block 4B; 40 – 90 bd
Sex	Probable male	Type	Unknown
Age	20-35	% Complete	Less than 25%

This individual was commingled with at least two juveniles, as well as 68E and 68C individuals. The burial is represented only by a fragmented cranium, with open sutures. Some of the fragments are concreted together with bone adhesions.

Burial 69

The burial was described in detail in excavation notes, with the researchers noting 2 juveniles and one adult (most likely CO-40-69/1yo, CO-40-69/4yo, and CO-40-69/adult).

Burials dug into red clay (bundle burials). Skeletons removed and photographed in 4 phases. The two children have been called child (NE) and child (NW). Adult facing south…the northwest child skull was resting on bedrock so there was little or no soil under it. The adult skull was resting against bedrock also

CO-40-69/neonate

Excavation	1979	Location	Block 2A; 102 – 111bd
Sex	Unknown	Type	Lab
Age	38 – 40 weeks	% Complete	25% - 50%

This individual was commingled with at least an adult and two juveniles. The measurement of the mandible is consistent with a neonate between 38 – 40 weeks.

CO-40-69/1yo

Excavation	1979	Location	Block 2A; 102 – 111bd
Sex	Unknown	Type	Bundle
Age	0 – 5	% Complete	25% - 50%

This individual was commingled with at least an adult and two juveniles. The dentition and fusion are consistent with a juvenile between 1 – 1.5 years. The alveolar bone has been crushed postmortem and concreted together with bone adhesions.

CO-40-69/4yo

Excavation	1979	Location	Block 2A; 102 – 111bd
Sex	Unknown	Type	Bundle
Age	0 – 5	% Complete	25% - 50%

This individual was commingled with at least an adult and two juveniles. The dentition is consistent with a juvenile between 4 – 6 years old. There is active periostitis on the left femur, with pinprick porosity and sclerotic bone.

CO-40-69/adult

Excavation	1979	Location	Block 2A; 102 – 111bd
Sex	Male	Type	Bundle
Age	20 – 35	% Complete	Less than 25%

This individual was commingled with at least three juveniles. The burial is represented by a mandible with dentition. According to excavation notes, the skull faced south in the burial. The presence of third molars is consistent with an age after 20 years. Additionally, the excavation notes mention the presence of an unfused femur head and unfused iliac crest, suggesting the burial is between 20-22 years.

CO-40-71

Excavation	1979	Location	Block 2A; 30 – 40 bd
Sex	Unknown	Type	Unknown
Age	Unknown	% Complete	Less than 25%

The original excavation notes indicate individual 71 was near the CO-40-69 individuals. The majority of the bags available for analysis were labeled “screened” or floatation, indicating the individual was probably highly fragmented in situ.

Burial 77

Initially marked 68, the individual was re-catalogued as #77.

> 1 individual flexed facing SE (see photograph for position). This was not removed in stages as most of what was showing was the complete bone available in 3A. Bone relatively brittle and fractured upon any impact hence broken in removal.

CO-40-77

Excavation	1979	Location	Block 3A; 15 – 30bd
Sex	Male	Type	Flexed
Age	35 – 50	% Complete	75% - 100%

There is well healed periostitis on the left femur. The majority of the skeletal elements have postmortem compression fractures present with shell concretions.

CO-40-79b.69

Excavation	1979	Location	Block 2A; 102 – 111bd
Sex	Male	Type	Unknown
Age	35 – 50	% Complete	75% - 100%

There are well incorporated periostitis lesions on the tibiae.

CO-40-79

Excavation	1979	Location	Pothole 4
Sex	Probable male	Type	Unknown
Age	35 – 50	% Complete	50 – 75%

The burial is fragmented with rodent gnawing, particularly on the os coxae. The mental eminence of the mandible is obscured by shell adhesions.

CO-40-82b

Excavation	1979	Location	Pothole 1A, 145 – 155cm
Sex	Unknown	Type	Unknown
Age	< 16	% Complete	Less than 25%

There is a well healed periostitis on a fibula shaft fragment. The burial is commingled with a few elements from a 1 year – 18 month old child.

APPENDIX 3: NISP FOR TAXA IDENTIFIED AT CERRO MANGOTE

Species	Common Name	Count
Sharks/rays/skates		
Carcharhinidae	Requiem sharks	3
Carcharhinus altimus	Reef shark	7
Carcharhinus leucas	Reef shark	59
Dasyatis	Stingray	2
Elasmobranchs	Sharks, rays, skates	14
Urotrygon asterias	Stingray	2
Fish		
Albula neoguinaica	Sharpjaw bonefish	10
Anisotremus	Grunt	1
Anisotremus dovii	Spotted head sargo	1
Arius	Catfish	48
Arius kessleri	Marine catfish	42
Arius lentiginosus	Freckled sea catfish	2
Arius osculus	Marine catfish	4
Arius platypogon	Marine catfish	4
Arius seemanni	Shark catfish	112
Bagre panamensis	Chilhuil sea catfish	2
Bagre pinnimaculatus	Red sea catfish	7
Bairdiella	American silver perch	1
Bairdiella armata	Armed croaker	4
Bairdiella ensifera	Swordspine croaker	2
Bathygobius andrei	Estuarine frillfin	2
Batrachoides	Toadfish	63
Carangidae	Marine fish family	4
Carangoides otrynter	Threadfin jack	1
Caranx caninus	Pacific crevalle jack	11
Cathorops	Catfish	79
Cathorops hypophthalums	Gloomy sea catfish	4
Cathorops multiradiatus	Box sea catfish	2
Cathorops tuyra	Besudo sea catfish	8
Centengraulis mysticetus	Pacific anchovy	2
Centropomus	Marine fish	55
Centropomus armatus	Armed snook	21
Centropomus medius	Blackfin snook	16
Centropomus nigrescens	Black snook	1
Centropomus robalito	Yellow-fin snook	6
Centropomus viridis	White snook	26
Chloroscombrus orqueta	Pacific bumper	2

Species	Common Name	Count
Clupeiformes	Ray finned fish order	1
Cynoscion	Drum fish	3
Cynoscion albus	Whitefin weakfish	17
Cynoscion squamipinnis	Weakfish	1
Cynoscion stolzmanni	Stolzmann's weakfish	7
Diapterus peruvianus	Peruvian mojarra	13
Dormitator latifrons	Pacific fat sleeper	425
Eleotris picta	Spotted sleeper	3
Elops affinis	Pacific tenpounder	1
Epinephelus analogus	Spotted grouper	1
Eucinostomus currani	Pacific flagfin mojarra	1
Eugerres	Mojarra	8
Eugerres brevimanus	Short fin mojarra	2
Eugerres lineatus	Streaked mojarra	8
Gerres cinereus	Yellow fin mojarra	3
Gobiidae/Eleotrididae	Gobies	1
Gobioides peruanus	Peruvian eelgoby	11
Gobiomorus maculatus	Pacific sleeper	4
Haemulidae	Grunt	5
Haemulon flaviguttatum	Yellow spotted grunt	1
Ilisha furthii	Pacific ilisha	6
Lobotes surinamensis	Atlantic tripletail	9
Lutjanus argentiventris	Yellow snapper	3
Lutjanus colorado	Colorado snapper	1
Lutjanus guttatus	Spotted rose snapper	1
Lutjanus novemfasciatus	Pacific dog snapper	2
Menticirrhus panamensis	Panamanian king fish	1
Micropogonias altipinnis	Tallfin croaker	8
Mugil curema	White mullet	15
Oligoplites altus	Longjaw leatherjacket	5
Ophioscion scierus	Point-Tuza croaker	2
Ophioscion typicus	Point-nosed croaker	8
Ophioscion vermicularis	Vermiculated croaker	1
Opisthonema libertate	Pacific thread herring	16
Opisthopterus	Longfin herring	1
Orthopristis chalceus	Brassy grunt	22
Paralonchurus dumerilii	Suco croaker	2
Polydactylus approximans	Blue bobo	2
Polydactylus opercularis	Yellow bobo	35
Pomadasys		3
Pomadasys (H.) elongatus	Elongate grunt	1
Pomadasys (H.) leuciscus	White grunt	3

Species	Common Name	Count
Pomadasys (H.) nitidus	Shining grunt	2
Pomadasys macracanthus	Longspine grunt	32
Pristis	Sawfish	1
Rhamdia	Catfish	1
Sciadeichthys dowii	Brown sea catfish	345
Selene peruviana	Peruvian moonfish	3
Sphoeroides annulatus	Bullseye puffer	7
Stellifer oscitans	Yawning stardom	3
Strongylura scapularis	Shoulderspot needlefish	1
Frog		
Anuran	Frog family	2
Bufo marinus	Cane toad	26
Reptile		
Ameiva ameiva	Giant Ameiva	3
Basiliscius basiliscus	Common basilisk	1
Boa constrictor	Boa constrictor	7
Crocodylus acutus	American crocodile	1
Ctenosaura similis	Black spiny-tailed iguana	32
Chrysemys scripta	Slider turtle	4
Iguana iguana	Common iguana	30
Iguanidae	Iguana	61
Eretmochelys imbricata	Hawkbill sea turtle	2
Kinosternon	Mud turtles	23
Kinosternon scorpiodes	Scorpion mud turtle	14
Lizard		27
Turtle		2
Snake		4
Trachemys scripta	Pond slider	19
Birds		
Amazona ochrocephala	Yellow crowned Amazon	1
Calidris cantus	Red Knot	2
Calidris mauri	Western sandpiper	3
	Osprey	1
Calidus		2
Catoptrophorus semipalmatus	Willet	8
Columbidae	Paloma	4
Columbina talpacoti	Ruddy ground dove	1
Egretta alba	Great egret	4
Eudocimus albus	American white ibis	19
Geotrygon montana	Ruddy Quail dove	4
Numenius phaeopus	Whimbrel	1
Passeriformes	Perching birds	4

Species	Common Name	Count
Tringa melanoleuca	Greater yellowlegs	1
Zenaida asiatica	White-winged dove	1
Mammal		51
Artiodactyl	Even toed ungulate	1
Caluromys derbianus	Central American woolly opossum	1
Canis familiaris	Domestic dog	2
Cuniculus paca	Lowland paca	13
Dasyprocta punctata	Agouti	1
Dasypus novemcinctus	Nine-banded armadillo	13
Liomys adspersus	Panamanian spiny pocket mouse	2
Odicoileus virgineanus	White tailed deer	1880
Sylvilagus	Cotton tailed rabbit	6
Sylvilagus brasiliensis	Tapeti (mammal)	6
Tamandua mexicana	Northern Tamandua (mammal)	11
Tamandua tetradactyla	Southern Tamandua	6
Tayassu tajacu	Collared peccary	3
Procyon lotor	Raccoon	408
Panthera onca	Jaguar	1
Potos flavus	Kinkajou (mammal)	13
Rodentia	Rodent order	5
Sciurus variegatoides	Variegated squirrel	1
	NISP total	4425

(McGimsey 1956, McGimsey et al. 1987, McGimsey n.d., Ranere n.d. (2), Cooke 1992, Cooke and Taipa 1994, Cooke *et al.* 1996, Cooke and Ranere 1999, Cooke *et al.* in press)

APPENDIX 4: MUSCULOSKELETAL STRESS MARKER RECORDING FORM

Muscle Marker Coding Form

Site: _______________ Sex: _______________ Recorder: _______________

Tomb #: ____________ Age: ______________ Date: __________________

HABITUAL USE
Robusticity Markers [RM] (ridges, crests)
Stress Lesions [SL] (furrows, grooves)
0 = absence of expression (normal/smooth)
1 = robusticity grade 1 [RM1] (faint/trace)
2 = robusticity grade 2 [RM2] (moderate)
3 = robusticity grade 3 [RM3] (strong)
4 = stress lesion grade 1 [SL1] (faint/trace)
5 = stress lesion grade 2 [SL2] (moderate)
6 = stress lesion grade 3 [SL3] (strong)

ABRUPT TRAUMA
Ossification Exostoses [OS] (bony growths)
0 = absence of expression
1 = ossif. exo. grade 1 [OS1] (faint/trace)
2 = ossif. exo. grade 2 [OS2] (moderate)
3 = ossif. exo. grade 3 [OS3} (strong)

Note:
999 = score if location is missing or obscured
Write additional information with notes

Cranium	**Lt. | Rt.**
Ext. Auditory Exostoses	____|____

Clavicle	**Lt. | Rt.**
Deltoid (sup. ant. med.)	____|____
Costoclavicular lig. (inf. med.)	____|____
Subclavius (inf. mid-shaft)	____|____
Trapezoid ligament (inf. lat.)	____|____
Conoid ligament (inf. lat.)	____|____

Scapula	**Lt. | Rt.**
Trapezius (sup. spine)	____|____

Humerus	**Lt. | Rt.**
Supraspinatus (ant. grtr. tub.)	____|____
Infraspinatus (med. grtr. tub.)	____|____
Teres minor (post. grtr. tub.)	____|____
Subscapularis (ant. lesr. tub.)	____|____
Teres major (med. itg.)	____|____
Latissimus dorsi (mid. itg.)	____|____
Pectoralis major (lat. itg.)	____|____
Deltoids (lat. mid-shaft tub.)	____|____
Coracobrachialis (post. midshaft)	____|____
C. Extensors (lat. condyl.)	____|____
C. Flexors (med. condyl.)	____|____
Septal Aperture (inf. olec foss)	____|____
Deltoid Tub. Wdth (lat. midshaft)	____|____

Radius	**Lt. | Rt.**
Supinator (sup. prox. rad.)	____|____
Biceps brachii (med. rad. tub.)	____|____
Pronator teres (lat. mid-shaft)	____|____
Bicipital Tub. Wdth (prox. med.)	____|____

Ulna	**Lt. | Rt.**
Triceps brachii (post. semlun.)	____|____
Brachialis (ant. sub. semlun.)	____|____
Supinator (sup. crest lat.)	____|____

Hands	**Lt. | Rt.**
Prox. Phalange (m&l plmr grwt)	____|____
Med. Phalange (m&l plmr grwt)	____|____

Pelvis	**Lt. | Rt.**
Rectus femoris (ant. iliac crst)	____|____
External obliques (iliac crest)	____|____
Obturator externus (obt.foram.)	____|____
Adductor magus (ischial tub.)	____|____

Femur (Femora)	**Lt. | Rt.**
Gluteus medias (gtr. troch.)	____|____
Obturator externus (troch. fossa)	____|____
Gluteus maximus (sup. lin. aspera)	____|____
Psoas major, Iliacus (lsr. troch.)	____|____
Gastrocenmius MH (dist. post.)	____|____

Tibia	**Lt. | Rt.**
Tib. Tub. (AntSupTb)	____|____
Soleus (soleal ln. prox. post.)	____|____
Squatting Facet (ant. distal cond.)	____|____

Calcaneus	**Lt. | Rt.**
Achilles Tendon-Gast/Sole (post.)	____|____
Heel Spur -Flex. digit. (inf. mid.)	____|____

Feet	**Lt. | Rt.**
Ext. halluc. brev. (prx. sup. grwth)	____|____

APPENDIX 5: MUSCLES SYNERGISTS

Muscle Marker Synergists and Miscellaneous Variables (based on Rhode 2006:214-216)

Bone(s)	Motion	Synergists	Abbreviation
Upper Body			
Scapula	Depression, Elevation, & Retraction	Trapezius (middle)	SCPERD
Humerus, Radius	Arm Flexors	Anterior deltoid, Biceps brachii, Coracobrachialis	FLXARM
Humerus, Ulna	Arm Extensors	Latissimus dorsi, Posterior deltoid, Teres major, Triceps (long head)	EXTARM
Humerus, Ulna	Arm Adductors	Anterior & Posterior deltoid, Coracobrachialis, Latissimus dorsi, Pectoralis major, Teres major, Triceps (long head)	ADDARM
Humerus	Medial Arm Rotator	Anterior deltoid, Latissimus dorsi, Pectoralis major, Subscapularis, Teres major	MDRARM
Humerus, Radius	Forearm Flexors	Biceps brachii, Brachialis, Common flexors, Pronator teres	FRARMFX
Humerus, Ulna	Forearm Extensors	Common extensors, Septal aperture, Triceps	FRARMEX
Radius	Forearm Pronators	Pronator teres	PRNFARM
Radius, Ulna	Forearm Supinators	Biceps brachii, Supinator & Supinator Crest	SUPFARM
Lower Body			
Pelvis, Femur	Thigh Flexors	Adductor magnus, Psoas, Gluteus medius (anterior), Rectus femoris	FLXTHG
Pelvis, Femur	Thigh Adductors	Adductor magnus, Iliacus / Psoas, Gluteus maximus (lower)	ADDTHG
Femur	Lateral Thigh Rotator	Gluteus maximus (upper), Gluteus medius (posterior), Obturator externus	LTRTHG
Femur, Tibia	Leg Extensors	Gluteus maximus, Gastrocnemius, Quadriceps femoris, Rectus femoris, Soleus	EXTLEG
Femur, Tibia, Calcaneus	Plantar Foot Flexors	Gastrocnemius, Soleus, Achilles Tendon	PLTFXFT
Hallux	Big Toe Extensors	Extensor hallucis brevis	BTEXT
Miscellaneous and Non - metric variables			
Cranium	External Auditory Exostoses	Bony growths in external auditory meatus (slight, moderate, severe)	EAE
Humerus	Septal Aperture	Absence or Presence (slight, moderate, severe)	SEPAPRT
Tibia	Squatting Facets	Distal, Anterior Border, (presence or absence)	TIBSQFCT

Synergist Groups Expected to be Influenced by Fishing and Farming Activities (after Rhode 2006:215-216)		
Fishers		
Common Activity	Probable Synergist Groups	Expected Development
Throwing – Spears, Harpoons, Fishing Lines with Hook and Weights, Nets	FLXARM, EXTARM, MDRARM, FRARMFX, FRARMEX	Strong
Pulling – Harpoons, Fishing Lines with Hooks and Weights, Nets	SCPERD, FLXARM, ADDARM, FRARMFX, PRNFARM	Strong
Swimming and Diving (crawl and moderate to strong variants)	EAE, SCPERD, FLXARM, EXTARM, ADDARM, MDRARM, FLXTHG, ADDTHG, EXTLEG	Low to Moderate
Walking/Carrying (often heavy burdens) Short Distances	FLXARM, MDRARM, ADDARM, FLXTHG, EXTLEG, PLTFXFT	Low to Moderate
General Gathering, Squatting, Pulling, Cutting, Carrying	ADDARM, MDRARM, FRARMFX, FRARMEX, PRNFARM, FLXTHG, ADDTHG, BTEXT	Low to Moderate
Walking/Carrying short distances (medium – heavy weights)	FLXARM, MDRARM, ADDARM, FLXTHG, EXTLEG. PLTFXFT	Low to Moderate
Grinding (using one or both arms) using mano and metates or batanes	FLXARM, EXTARM, ADDARM, FRARMFX, FRARMEX, TIBSQFCT	Moderate to Strong
Farmers		
Common Activity	Probable Synergist Groups	Expected Development
Fieldwork (using one or two handed tools) over long period of time while in a bent over position.	ADDARM, FLXARM, EXTARM, FRARMEX, FLXTHG, EXTLEG, PLTFXFT	Moderate to Strong
Walking/Carrying (heavy burdens) Long Distances	FLXARM, MDRARM, ADDARM, FLXTHG, EXTLEG, PLTFXFT	Moderate to Strong
General Gathering, Squatting, Pulling, Cutting, Carrying	ADDARM, MDRARM, FRARMFX, FRARMEX, PRNFARM, FLXTHG, ADDTHG, BTEXT	Low to Moderate
Grinding (using one or both arms) mano and metates or batanes	FLXARM, EXTARM, ADDARM, FRARMFX, FRARMEX, TIBSQFCT	Moderate to Strong

APPENDIX 6: SKELETAL DATA FOR CERRO MANGOTE

Accession Number	Sex	Age	L Ex Aud Exotoses	L Deltoid	L Costo-clavicular	L Sub-clavius	L Trapezoid	L Conoid	L Trapezius
CO-40-1	F	50+			0				
CO-40-1A	?	20-35							
CO-40-1AB	M?	20-35			1	1	1	1	
CO-40-1B	F?	U	0						
CO-40-1E	M	35-50	0						
CO-40-3	M	35-50	0						
CO-40-3-1	F	50+							
CO-40-4	F	20-35	0						0
CO-40-5	M?	20-35	0				1	1	
CO-40-6A	F	15-20	0						
CO-40-6B	M	35-50	0						
CO-40-13	M	35-50					1	2	
CO-40-15A	F?	20-35							
CO-40-15B	M	35-50							
CO-40-15C	M	ADULT	0						
CO-40-15E	F	35-50							
CO-40-17	M	35-50	0						
CO-40-18A	M	20-35	0						1
CO-40-18B	F	35-50	0				2		1
CO-40-19A	F	20-35							
CO-40-19P	M	20-35	0			1	2	2	
CO-40-19M	F	20-35					1	1	
CO-40-19R	M?	35-50							
CO-40-20A	F?	20-35	0	2	4	1	1	1	
CO-40-21	M?	15-20							
CO-40-22A	M	35-50		1	0	0	1		2
CO-40-22D	M	50+	0						
CO-40-23A	F?	20-35							
CO-40-23B	U	U							
CO-40-25	F	20-35					1	2	
CO-40-26	M	35-50				3	1	1	0
CO-40-27	M?	35-50		1	3	0	1	2	0
CO-40-28	M	35-50							
CO-40-28-1	F	50+							
CO-40-31-1C	M?	20-35	0						
CO-40-31A	M?	20-35	0	1		2	1		
CO-40-31C	M	35-50	0			1	1.5	2	1.5
CO-40-31E	M?	15-20	0			1	1	1	1
CO-40-31G	?	ADULT	0		3.5	0	1		
CO-40-32	M	20-35	0			1	1	0	
CO-40-68E/adult	F	50+				1	2	2	2
CO-40-77	M	35-50				1	2	2	
CO-40-79b69	M	35-50		3	1	2	3	3	

Accession Number	L Supra-spinatus	L Infra-spinatus	L Teres minor	L Sub-scapularis	L Teres Major	L Latissius Dorsi	L Pectoralis major	L Deltoids	L Coraco-brachialis
CO-40-1									
CO-40-1A					1	1			
CO-40-1AB									
CO-40-1B									
CO-40-1E			1	1	1	1	1	1	0
CO-40-3									
CO-40-3-1									
CO-40-4	0	0	0	0	0	0	1	1	0
CO-40-5					0	0	1	1.5	0
CO-40-6A									
CO-40-6B									
CO-40-13							1	2	
CO-40-15A						1	1	1	
CO-40-15B									
CO-40-15C									
CO-40-15E									
CO-40-17									
CO-40-18A					2		1	2	2
CO-40-18B					0	0	1	2	1
CO-40-19A							0	0	0
CO-40-19P	1	1	1	0	0	0	1	1	0
CO-40-19M	0	0			1	0			
CO-40-19R									
CO-40-20A									
CO-40-21						0	0	1	0
CO-40-22A				2				1.5	1
CO-40-22D									
CO-40-23A							1	1	
CO-40-23B									
CO-40-25	1	1	1				1	1	0
CO-40-26	0	0	0	0	0	0	1	1	0
CO-40-27									
CO-40-28									
CO-40-28-1					1	1	1	1	0
CO-40-31-1C									
CO-40-31A					0	0	1	2	2
CO-40-31C	1	1	1	1					
CO-40-31E					4	0	2	2	0
CO-40-31G						1	1.5	2	2
CO-40-32	1	1	1		1	2	2	2	0
CO-40-68E/adult									0
CO-40-77							3		
CO-40-79b69									

Left and Right Muscoskeletal Stress Markers

Accession Number	L C Extensors	L C Flexors	L Septal Aperature	L Deltoid Tuberosity Width	L Supinator R	L Biceps brachii	L Pronator teres	L Bicipital Tub Width
CO-40-1						1		1
CO-40-1A				1				
CO-40-1AB								
CO-40-1B								
CO-40-1E	1	0	0	1	1	2	1	1
CO-40-3								
CO-40-3-1								
CO-40-4	0	0		0	0	1	0	0
CO-40-5	0.5	0	0	1			1	
CO-40-6A						1		1
CO-40-6B								
CO-40-13	1	1	0	2				
CO-40-15A	1	1		1				
CO-40-15B								
CO-40-15C								
CO-40-15E								
CO-40-17								
CO-40-18A	1	1	0	2				
CO-40-18B			0				1	
CO-40-19A	0	0		0			0	
CO-40-19P	0	1		1		3		2
CO-40-19M		0					1	
CO-40-19R								
CO-40-20A								
CO-40-21	1	0		1		2	0	1
CO-40-22A	1.5	1	0	1	0.5	2	1	1
CO-40-22D								
CO-40-23A	0	0	0	1	0	0	0	0
CO-40-23B								
CO-40-25								
CO-40-26	1	1		1	1	2		1
CO-40-27							1	
CO-40-28								
CO-40-28-1		0	0	1				
CO-40-31-1C	0	0						
CO-40-31A		2	0	1			1	
CO-40-31C					1		1	
CO-40-31E	0	0		1		1.5	1	1
CO-40-31G	0	1	1	1	1	4	4.5	1
CO-40-32	1	1	2	2	0	4		2
CO-40-68E/adult	0	0	2			3	1.5	1
CO-40-77				2				
CO-40-79b69					1		0	

Accession Number	L Triceps brachii	L Brachialis	L Supinator U	L Prox Phalange	L Middle Phalange	L Rectus femoris	L External obliques
CO-40-1							
CO-40-1A	0	1					
CO-40-1AB							
CO-40-1B							
CO-40-1E						0	1
CO-40-3							
CO-40-3-1							
CO-40-4	0	2	0				
CO-40-5		1	0.5	2	1		
CO-40-6A				1			
CO-40-6B							
CO-40-13		1		0	0	2	
CO-40-15A	0	1	1				
CO-40-15B							
CO-40-15C							
CO-40-15E							
CO-40-17			1	1	1		
CO-40-18A	1	2.5	0				
CO-40-18B		1	2			3	1
CO-40-19A			0	1	0		
CO-40-19P							
CO-40-19M							
CO-40-19R		0	0				
CO-40-20A		1	1	1	0		1
CO-40-21	0	2	1				
CO-40-22A	0	1	0	1	1		
CO-40-22D						1	
CO-40-23A	0	0	0	0	0	0	0
CO-40-23B							
CO-40-25		0	1				
CO-40-26	1	1				1	1
CO-40-27				2			1
CO-40-28							
CO-40-28-1			2				
CO-40-31-1C			1				
CO-40-31A	1	1	1	0	0	1	
CO-40-31C	0			1	0.5		
CO-40-31E		1	1				
CO-40-31G			1.5	1			
CO-40-32	0	1	2	1	1		
CO-40-68E/adult							
CO-40-77	0	1	1		1		
CO-40-79b69		1	1				

Accession Number	L Obturator-externus P	L Adductor magus	L Gluteus medias	L Obturator externus F	L Gluteus maximus	L Psoas major iliacus	L Gastro-cenmius	L Tibial tuberosity
CO-40-1								
CO-40-1A								
CO-40-1AB								
CO-40-1B								
CO-40-1E			0	0	1.5		0	1.5
CO-40-3						0		
CO-40-3-1								1
CO-40-4		1			1		1	0
CO-40-5		0			1.5		1	
CO-40-6A				2				
CO-40-6B					3			
CO-40-13		1	1					
CO-40-15A					1			
CO-40-15B					2			0
CO-40-15C								
CO-40-15E					2			
CO-40-17					2.5			
CO-40-18A					2			
CO-40-18B		1			1			
CO-40-19A			0	0	1	0	1	
CO-40-19P								
CO-40-19M					1			
CO-40-19R			1	0	2	1	0	
CO-40-20A		1	0	0	2	1	1	
CO-40-21			0	0	0	0		
CO-40-22A			0		2	0		
CO-40-22D								
CO-40-23A	0	0	0	0	0	0	0	0
CO-40-23B					2			
CO-40-25		0			1			
CO-40-26		0	0	1	2	1		
CO-40-27		1	0	0	1			
CO-40-28		1						
CO-40-28-1		4	1	1	5	0		
CO-40-31-1C					2	1	2	
CO-40-31A			1	1	2		2	
CO-40-31C					2.5			
CO-40-31E					0		0	
CO-40-31G					1	0	0.5	
CO-40-32					2			
CO-40-68E/adult					4			
CO-40-77				3	3	2		
CO-40-79b69			1	2	3.5	1		2

Accession Number	L Soleus	L Squatting facet	L Achilles Tendon	L Heel Spur	L Ext Halluc brev	R Ex Aud Exotoses	R Deltoid	R Costo-clavicular	R Sub-clavius
CO-40-1	0	2	0		0				
CO-40-1A									
CO-40-1AB						0		1	1
CO-40-1B						0			
CO-40-1E	1.5	2				0			
CO-40-3	0	1				0			
CO-40-3-1	1					0			
CO-40-4	1	0				0		1	0
CO-40-5						0			1
CO-40-6A									
CO-40-6B						0			
CO-40-13		1	1	1	0	0			
CO-40-15A									
CO-40-15B	1								
CO-40-15C						0			
CO-40-15E						0	2	2	
CO-40-17									
CO-40-18A	0					0			
CO-40-18B	2					0			
CO-40-19A					0				
CO-40-19P			0	0		0			
CO-40-19M						0			
CO-40-19R			0	0					
CO-40-20A		0			0	0			
CO-40-21									
CO-40-22A	0		0		1		1		0
CO-40-22D						0			
CO-40-23A	0	0	0	0	0				
CO-40-23B	1								
CO-40-25									
CO-40-26	1	0					3	3	4
CO-40-27		0	0	0	0				4
CO-40-28	0								
CO-40-28-1									
CO-40-31-1C									
CO-40-31A			0	0	0	0		1	2
CO-40-31C						0	1	2	1
CO-40-31E						0			
CO-40-31G					1	0		2	
CO-40-32	2					0			1
CO-40-68E/adult	3		2		0		1	1	1
CO-40-77									
CO-40-79b69	0		2				3	3	1

Accession Number	R Trapezoid	R Conoid	R Trapezius	R Supra-spinatus	R Infra-spinatus	R Teres minor	R Sub-scapularis	R Teres Major	R Latissius Dorsi
CO-40-1								0	0
CO-40-1A									
CO-40-1AB	1	1		1	1	1			
CO-40-1B									
CO-40-1E									
CO-40-3			0					1	0
CO-40-3-1								0	0
CO-40-4	1	1	0					0	0
CO-40-5	1	1						0	0
CO-40-6A									
CO-40-6B									
CO-40-13	1								
CO-40-15A									
CO-40-15B									
CO-40-15C									
CO-40-15E	0								
CO-40-17									
CO-40-18A			1						
CO-40-18B								0	0
CO-40-19A	1	1							
CO-40-19P									
CO-40-19M				0	0	0		1	0
CO-40-19R									
CO-40-20A			1					1	1
CO-40-21									
CO-40-22A			2.5				2	3	2
CO-40-22D									
CO-40-23A									
CO-40-23B									
CO-40-25									
CO-40-26	0	1	1	0	0	0	0	0	0
CO-40-27			0						
CO-40-28									
CO-40-28-1									
CO-40-31-1C									
CO-40-31A	1	1		1	1	1	1	1	0
CO-40-31C	1.5	0	2						
CO-40-31E	1	1						5	0
CO-40-31G									1
CO-40-32	1	0	0						
CO-40-68E/adult	2	2							
CO-40-77	4.5	2.5							
CO-40-79b69	3	3							

Accession Number	R Pectoralis major	R Deltoids	R Coraco-brachialis	R C Extensors	R C Flexors	R Septal Aperature	R Deltoid Tuberosity Width	R Supinator R
CO-40-1	1	1	1		0		1	
CO-40-1A								
CO-40-1AB								
CO-40-1B								
CO-40-1E	1	1	0	1	0	0	1	0
CO-40-3	2	2	1		1	0	2	
CO-40-3-1	2	2	2					
CO-40-4	1	1	0	0	0		0	0
CO-40-5	1	1	0					
CO-40-6A								
CO-40-6B								
CO-40-13		2	0	1.5	1			
CO-40-15A	1	1					1	
CO-40-15B		1						
CO-40-15C								
CO-40-15E								
CO-40-17					1			
CO-40-18A				1				
CO-40-18B	1	2	1			0	0	1
CO-40-19A		0						
CO-40-19P								
CO-40-19M	1	1	0	0	1		0	
CO-40-19R								
CO-40-20A	1	1	0		0	0	1	0
CO-40-21		1.5		1	0	1		0
CO-40-22A	2	2	1	2	1	0	2	0.5
CO-40-22D								
CO-40-23A	1	1					1	
CO-40-23B								
CO-40-25		1	0	1				
CO-40-26	0	2	0	0	0	0	1	0
CO-40-27								
CO-40-28								1
CO-40-28-1								
CO-40-31-1C				0	0			
CO-40-31A	1	2	1	1	1	0	1	0
CO-40-31C								2
CO-40-31E	2	1	0	0	0		0	0
CO-40-31G	1	1	1	0		0	1	
CO-40-32		2		1	1			0
CO-40-68E/adult			1	0	0	1		
CO-40-77				1	1	1		1
CO-40-79b69								

Left and Right Muscoskeletal Stress Markers

Accession Number	R Biceps brachii	R Pronator teres	R Bicipital Tub Width	R Triceps brachii	R Brachialis	R Supinator U	R Prox Phalange	R Middle Phalange	R Rectus femoris
CO-40-1			1			1			
CO-40-1A				0	1	0			
CO-40-1AB									
CO-40-1B									
CO-40-1E	1.5	1	1						0
CO-40-3								0	
CO-40-3-1				0	1				0
CO-40-4	1	1	0		2	0			
CO-40-5							2	1	
CO-40-6A							1		
CO-40-6B									
CO-40-13				1	1		1	0	
CO-40-15A					0	0			
CO-40-15B									
CO-40-15C					1	1			
CO-40-15E				0	1				
CO-40-17		1					1	1	
CO-40-18A		1		1	2	0			
CO-40-18B	1	1	1			1			1
CO-40-19A		0		0	1	0	1	0	
CO-40-19P	3	1	2						0
CO-40-19M		0							
CO-40-19R									
CO-40-20A	1	1	1	0	1	1	1	0	
CO-40-21	2	1	1	0		1	0	0	
CO-40-22A	1	1	1	0	1.5		1	1	
CO-40-22D									
CO-40-23A					1	1			
CO-40-23B									
CO-40-25									
CO-40-26	2	1	1	1	1				
CO-40-27							2	1	
CO-40-28	1		1						
CO-40-28-1				0	1	2			2
CO-40-31-1C						1			
CO-40-31A	1	1	1				0	0	1
CO-40-31C	2	2	1				1	0.5	
CO-40-31E	1	0	0	0	1	1			
CO-40-31G		4.5		0	1	1			
CO-40-32	2		2	0	0	2	1	1	
CO-40-68E/adult		1.5				1			
CO-40-77	1	1	1	0		1			
CO-40-79b69		0				2			

Accession Number	R External obliques	R Obturator-externus P	R Adductor magus	R Gluteus medias	R Obturator externus F	R Gluteus maximus	R Psoas major iliacus	R Gastro-cenmius
CO-40-1						1		4
CO-40-1A				0	0	1	0	0
CO-40-1AB								
CO-40-1B								
CO-40-1E			1	1	1	1.5	1	0
CO-40-3						2		
CO-40-3-1	0					2		1
CO-40-4			1			1		1
CO-40-5			0					
CO-40-6A						1.5		
CO-40-6B						3		
CO-40-13								
CO-40-15A						1.5		
CO-40-15B							0	
CO-40-15C								
CO-40-15E								
CO-40-17						2.5		1
CO-40-18A						2		
CO-40-18B			1			1		
CO-40-19A						1		1
CO-40-19P			0			2	1	
CO-40-19M						1		0
CO-40-19R				1	0	2		0
CO-40-20A	1		1.5	0	0	2	1	1
CO-40-21								
CO-40-22A			0			2		
CO-40-22D								
CO-40-23A								
CO-40-23B						2		
CO-40-25								
CO-40-26			0	1	1	2	0	0
CO-40-27			1					
CO-40-28			1					
CO-40-28-1			4			2		
CO-40-31-1C						2		
CO-40-31A				1	1	2	0	1
CO-40-31C						2.5		
CO-40-31E				0	0	1	0	
CO-40-31G						1		0.5
CO-40-32				1	1	2		2
CO-40-68E/adult						2		
CO-40-77					4	3.5		
CO-40-79b69				1	3	3		1

Accession Number	R Tibial tuberosity	R Soleus	R Squatting facet	R Achilles Tendon	R Heel Spur	R Ext Halluc brev
CO-40-1						0
CO-40-1A						
CO-40-1AB						
CO-40-1B						
CO-40-1E	1	1	0	0		
CO-40-3		0				
CO-40-3-1			0			
CO-40-4	0	1	0			
CO-40-5						
CO-40-6A						
CO-40-6B						
CO-40-13			0	0	0	0
CO-40-15A						
CO-40-15B						
CO-40-15C						
CO-40-15E						
CO-40-17						
CO-40-18A		0	0	1		
CO-40-18B		2				
CO-40-19A						0
CO-40-19P						
CO-40-19M						
CO-40-19R				0	0	
CO-40-20A			0			0
CO-40-21				0	0	
CO-40-22A		0.5		0		1
CO-40-22D						
CO-40-23A						
CO-40-23B		2				
CO-40-25						
CO-40-26	0	1	0	2	1	
CO-40-27		0	0	0	0	0
CO-40-28						
CO-40-28-1						
CO-40-31-1C						
CO-40-31A	1	2	1	0	0	0
CO-40-31C		3		0	0	
CO-40-31E		2.5				
CO-40-31G						
CO-40-32						
CO-40-68E/adult	1	1.5				0
CO-40-77	0	1				
CO-40-79b69	3	0		1		

Cross-sectional geometry

Accession Number	Age	Sex		TA	CA	Xbar	Ybar	Ix	Iy
CO-40-1	35-50	F	Femur	407.50	295.02	114.18	106.47	14532.26	10873.16
CO-40-1E	35-50	M	Humerus	249.34	197.42	112.58	130.04	5206.11	4221.61
CO-40-1E	35-50	M	Femur	503.28	410.71	115.84	106.48	19519.82	20175.59
CO-40-19A	20-35	F	Femur	487.33	362.82	116.20	111.36	16986.07	18706.63
CO-40-19A	20-35	F	Humerus	256.52	178.07	109.20	122.31	4462.68	4917.12
CO-40-20A	20-35	F?	Femur	606.11	479.21	114.92	100.53	28629.44	28802.42
CO-40-26	35-50	M	Humerus	277.69	231.19	118.95	127.70	6734.65	5442.10
CO-40-26	35-50	M	Femur	500.88	418.84	117.67	110.73	22095.34	17592.02
CO-40-31A	20-35	M?	Femur	548.52	455.64	115.23	108.67	26680.35	20596.05
CO-40-31G	ADULT	?	Humerus	235.54	161.69	116.13	109.56	4123.58	3952.64

Cross-sectional geometry

Accession Number	Imax	Imin	Zx	Zy	MaxXrad	MaxYrad
CO-40-1	15483.36	9922.06	1009.05	913.18	11.91	14.40
CO-40-1E	5219.52	4208.20	522.77	463.66	9.11	9.96
CO-40-1E	21657.14	18038.28	1343.31	1469.47	13.73	14.53
CO-40-19A	20166.11	15526.60	1279.56	1355.66	13.80	13.28
CO-40-19A	5215.91	4163.88	476.70	474.47	10.36	9.36
CO-40-20A	33618.77	23813.09	1727.95	1909.51	15.08	16.57
CO-40-26	7110.15	5066.60	672.60	558.52	9.74	10.02
CO-40-26	22126.02	17561.34	1438.40	1381.21	12.74	15.36
CO-40-31A	26760.97	20515.43	1701.74	1631.31	12.63	15.68
CO-40-31G	4467.46	3608.77	412.41	430.79	9.18	10.00

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Burial	L Frontal	R Frontal	L Parietal	R Parietal	L Occipital	R Occipital	L Temporal	R Temporal	L TMJ
CO-40-1	1									
CO-40-1A	1	1	1	2	2	1	2	1	1	
CO-40-1AB	1			3	3		2		1	
CO-40-1B	1	1	2	1	1	1	2	1	1	1
CO-40-1D	1			1	1	1	1	2		
CO-40-1E	1			1	1	2	2	1	1	1
CO-40-2	2	1	1	2	1					
CO-40-3	3	1	1		1	1	1	1	1	
CO-40-3-1	3	3	3						1	
CO-40-4	4	1	1	1	1	1	1	2	2	
CO-40-5	5	2	2	2	2	3	3	2	2	
CO-40-6A	6					1	1		2	
CO-40-6B	6	2	2	2	2	2	2	2	2	1
CO-40-6C	6			2	2	2	2		1	
CO-40-6D	6									
CO-40-13	13			1	1	1	1	1	1	1
CO-40-15A	15	2	2	2	2	1	1	1	1	1
CO-40-15B	15	1	1	2	1			3		
CO-40-15C	15		1					1	1	3
CO-40-15D	15	1	1	3						
CO-40-15E	15		3					1	1	
CO-40-16A	16						2	2	2	
CO-40-16B	16									
CO-40-16C	16	1	1		1					
CO-40-16D	16	2	2	1	1			1	1	
CO-40-16E	16						2			
CO-40-17	17	1	1	1	1	1	1	2	2	2
CO-40-18A	18	2	3			3	1	1		1
CO-40-18B	18	1	1	1	1	1	1	1	2	1
CO-40-19A	19	2	2	1	1	1	2	1	2	1
CO-40-19B	19	1								
CO-40-19E	19	2	3			3	3	3		
CO-40-19F	19					3	3	2	2	
CO-40-19H	19	3								
CO-40-19I	19	2	2	2	2					
CO-40-19J	19					3	3	2	2	
CO-40-19K	19									
CO-40-19L	19									
CO-40-19M	19								1	
CO-40-19P	19				1	1	1	1	1	
CO-40-19R	19		2	2		1	1	2	2	
CO-40-20A	20	1	1	1	2	1	2	2	2	3
CO-40-21	21		2	1	1	1	1			
CO-40-22A	22	1	1	3	2	3	3			
CO-40-22B juven	22	2							2	
CO-40-22B adult	22									
CO-40-22C	22	2	2	2	2	2	2	2	2	
CO-40-22D	22	3	3	2	2	2	2	1	1	
CO-40-22E	22			1	1	1	1	1	1	
CO-40-23A	23			1	1	2	2	2	2	
CO-40-23B	23									
CO-40-24	24			1	1	2	2	2	2	

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	Burial	L Frontal	R Frontal	L Parietal	R Parietal	L Occipital	R Occipital	L Temporal	R Temporal	L TMJ
CO-40-25	25									
CO-40-25-1	25									
CO-40-26	26	1	1	1	1	1	1	2		
CO-40-27	27	1	1			3	3			
CO-40-28	28									
CO-40-29A	29	3	3	3	3			2	2	
CO-40-29B	29							2		
CO-40-30	30	2	2	2	2	2	2	2	2	2
CO-40-31A	31	3	1	1	1	1	1		1	
CO-40-31B	31	1	1	1	1	1	1	2	2	
CO-40-31B1	31									
CO-40-31C	31	1	1	1	1	2	2	1	2	1
CO-40-31-1C	31			1	1	2	2	2	2	
CO-40-31D	31	3	3	3	3	3	3	3	3	
CO-40-31D1	31	3	3	3	3	3	3	3	3	
CO-40-31E	31	1	1	1	1	1	1	1		1
CO-40-31F	31	1	1	1	1	1	1	1	1	1
CO-40-31G	31	2	2	1	2	2	2	1	1	1
CO-40-31H	31	3	3	1	1	2	2	1	1	1
CO-40-31I	31									
CO-40-32A	32	1	1	2	2	2	2	1	1	1
CO-40-32B	32					1	1			
CO-40-Prov? Skull	1	1	1	1	1	1	1	1	1	1
CO-40-68C/infant	P	3	3	3	3	3	3	3	3	
CO-40-68C/3yo	P	3	3	3	3	3	3	3	3	
CO-40-68C/7yo	P									
CO-40-68E/fetal	P									
CO-40-68E/child6y	P	3	3	3	3	3	3	3	3	
CO-40-68E/adult	P	3	3	3	3	2	2	3	3	
CO-40-68W/infant	P									
CO-40-68W/9yo	P					3	3	3	3	
CO-40-68W/adult	P	3	3	3	3	2	2	2	2	1
CO-40-69/neonate	P									
CO-40-69/1yo	P	2	2	2	2	2	2	2	2	
CO-40-69/4yo	P							2	2	
CO-40-69/adult	P	1	1	2	2	2	2	1	1	
CO-40-71	P									
CO-40-77	P	1	1	1	1	1	1	1	1	
CO-40-79B69	P	2	2	1	1	1	2	1	1	1
CO-40-79	P									
CO-40-82b	P									

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R TMJ	L Sphenoid	R Sphenoid	L Zygomatic	R Zygomatic	L Maxilla	R Maxilla	L Palatine	R Palatine
CO-40-1									
CO-40-1A	1				2				
CO-40-1AB	1								
CO-40-1B	1					1			
CO-40-1D									
CO-40-1E	1	2	2	2	2	1	1	1	1
CO-40-2				1					
CO-40-3				1		1	1	1	1
CO-40-3-1									
CO-40-4		2	2			1	1	1	1
CO-40-5		3	3	1	1	3	3	3	3
CO-40-6A	3			1		3	3		
CO-40-6B	1					3	3	3	3
CO-40-6C	1					3	3		
CO-40-6D						3	3		
CO-40-13	1			1	1	1	2	1	1
CO-40-15A	1			3	3	2	2	3	3
CO-40-15B				1	1				
CO-40-15C	3								
CO-40-15D									
CO-40-15E				1	1				
CO-40-16A							3		
CO-40-16B									
CO-40-16C						2	1	2	1
CO-40-16D							2		
CO-40-16E						3	3		
CO-40-17	2			1	1				
CO-40-18A						2		3	
CO-40-18B		1		1	1	1	1	1	1
CO-40-19A				2	2	3	3		
CO-40-19B				2					
CO-40-19E								3	
CO-40-19F							3		
CO-40-19H									
CO-40-19I									
CO-40-19J									
CO-40-19K									
CO-40-19L									
CO-40-19M						1	1	1	1
CO-40-19P									
CO-40-19R									
CO-40-20A	3			2	2	1	1	2	2
CO-40-21				1	1				
CO-40-22A		3	3	1	3	1	2	1	1
CO-40-22B juven					1		3		3
CO-40-22B adult									
CO-40-22C									
CO-40-22D		3	3	1	2				
CO-40-22E		2		2					
CO-40-23A									
CO-40-23B									
CO-40-24						2	2		

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R TMJ	L Sphenoid	R Sphenoid	L Zygomatic	R Zygomatic	L Maxilla	R Maxilla	L Palatine	R Palatine
CO-40-25									
CO-40-25-1						2	2	3	3
CO-40-26				1		2	2	2	2
CO-40-27		2	2			1	1	1	1
CO-40-28									
CO-40-29A		3	3			1	1		
CO-40-29B									
CO-40-30	2	2	2						
CO-40-31A	1					1	1	1	1
CO-40-31B			1						
CO-40-31B1						3			
CO-40-31C	1			1		1	1	1	1
CO-40-31-1C									
CO-40-31D									
CO-40-31D1									
CO-40-31E		2	2			1	1	1	1
CO-40-31F	1	1	1	1	1	1	1	1	1
CO-40-31G	1	3	2	1	1	1	1	1	1
CO-40-31H	1	3	3						
CO-40-31I									
CO-40-32A	1			1	1	1	1	1	1
CO-40-32B									
CO-40-Prov? Skull	1	1	1	1	1	1	1	1	1
CO-40-68C/infant									
CO-40-68C/3yo									
CO-40-68C/7yo									
CO-40-68E/fetal									
CO-40-68E/child6y						3	3		
CO-40-68E/adult						3			
CO-40-68W/infant									
CO-40-68W/9yo									
CO-40-68W/adult	1	3	3	3					
CO-40-69/neonate									
CO-40-69/1yo									
CO-40-69/4yo									
CO-40-69/adult						1	1		
CO-40-71									
CO-40-77		1	1			3	3		
CO-40-79B69	1					2	2		
CO-40-79									
CO-40-82b									

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Mandible	R Mandible	L Clavicle	R Clavicle	L Scapula Body	R Scapula Body	L Scapula Glenoid Fossa	R Scapula Glenoid Fossa	L Patella
CO-40-1				1					
CO-40-1A									
CO-40-1AB	1	3	1	1	3		1		
CO-40-1B		1							
CO-40-1D									
CO-40-1E	3	1			2	2	1	1	1
CO-40-2	1	1	2	3	1		1		
CO-40-3	1	1			3	3	2	1	1
CO-40-3-1	1	1							
CO-40-4	1	1		1	3	3	1	1	
CO-40-5	2	1	1	1	3	3	1	1	
CO-40-6A	1	1							1
CO-40-6B	1	1							
CO-40-6C	1	1							
CO-40-6D	2	1							
CO-40-13	1	2	3	3	2	3	1		1
CO-40-15A									
CO-40-15B	1	1						2	
CO-40-15C		1							
CO-40-15D	3	1							
CO-40-15E			2	2					
CO-40-16A		2							
CO-40-16B									
CO-40-16C	2	1			3	3	1		
CO-40-16D	1	1			3		1		
CO-40-16E				1					
CO-40-17	2	2							
CO-40-18A	1	1			2	2			
CO-40-18B	1	1	2		3	3	1	1	
CO-40-19A	1	1		2	2		1	1	1
CO-40-19B	1	1	2	2	3		1		
CO-40-19E	1	1			1		1		1
CO-40-19F	1	3		3	3	3	1	1	
CO-40-19H	1	1		1					
CO-40-19I									
CO-40-19J									
CO-40-19K			1						
CO-40-19L									
CO-40-19M	1	1	3	2					
CO-40-19P			1				1		1
CO-40-19R	1	1							
CO-40-20A	1	1	1			2		1	1
CO-40-21	1				1	3	1	1	1
CO-40-22A			2	2	3	3	1	1	
CO-40-22B juven	3	1							
CO-40-22B adult									
CO-40-22C	2	2							
CO-40-22D	1	3							
CO-40-22E									
CO-40-23A									
CO-40-23B									
CO-40-24	1	1							

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Mandible	R Mandible	L Clavicle	R Clavicle	L Scapula Body	R Scapula Body	L Scapula Glenoid Fossa	R Scapula Glenoid Fossa	L Patella
CO-40-25	3	2	1						
CO-40-25-1	2	2							
CO-40-26	1	1	2	1	3	3	1	2	
CO-40-27	1	1	1	2	2	2	1	1	1
CO-40-28									
CO-40-29A	1	1	2	2					
CO-40-29B									
CO-40-30	2	2							
CO-40-31A	1	1	1	1	2	2	1	1	1
CO-40-31B	1			2		3		1	
CO-40-31B1	2	2							
CO-40-31C	1	1	1	1	2	2	2		1
CO-40-31-1C	1	1				3		1	
CO-40-31D									
CO-40-31D1		2							
CO-40-31E	1	1	1	1	3	2		2	1
CO-40-31F	1	1	2	2		3		1	
CO-40-31G	1	1	1	2	3		1		1
CO-40-31H	3								
CO-40-31I					3		1		
CO-40-32A	1	1	1	1	2	3	1		
CO-40-32B	1	1							
CO-40-Prov? Skull	1	1							
CO-40-68C/infant			1	1					
CO-40-68C/3yo									
CO-40-68C/7yo									
CO-40-68E/fetal									
CO-40-68E/child6y	3	3			3				
CO-40-68E/adult			2	1	3				
CO-40-68W/infant									
CO-40-68W/9yo									
CO-40-68W/adult									
CO-40-69/neonate	1	1							
CO-40-69/1yo									
CO-40-69/4yo									
CO-40-69/adult									
CO-40-71									
CO-40-77	1	1				1		1	
CO-40-79B69	1	1	1	1					
CO-40-79									
CO-40-82b									

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	R Patella	L Sacrum	R Sacrum	L Ilium	R Ilium	L Ischium	R Ischium	L Pubis	R Pubis	L Aceabulum
CO-40-1				2						
CO-40-1A										
CO-40-1AB		3			2		1			3
CO-40-1B										
CO-40-1D				2	3		1			3
CO-40-1E				1	2		1			2
CO-40-2		1	1	3	1	1	1	1	2	
CO-40-3	1	1	1	1	1					1
CO-40-3-1		1	1	2	1	2	2			2
CO-40-4				2	2	1	1			1
CO-40-5	1			3	3	1	1			
CO-40-6A										
CO-40-6B										
CO-40-6C										
CO-40-6D										
CO-40-13	2			2	2	3		1	2	2
CO-40-15A	1			3	3					2
CO-40-15B										
CO-40-15C										
CO-40-15D										
CO-40-15E	1				2					
CO-40-16A								1		
CO-40-16B				1	1					
CO-40-16C		3	3	1	2	1	1			
CO-40-16D				1	2			1	1	
CO-40-16E										
CO-40-17										
CO-40-18A	1	2	2							
CO-40-18B				1	1	2	2			2
CO-40-19A	1			3	2	1				
CO-40-19B	1	3	3	2						3
CO-40-19E	1									
CO-40-19F				1			1			1
CO-40-19H										
CO-40-19I										
CO-40-19J										
CO-40-19K						1	1			
CO-40-19L										
CO-40-19M				3	2					
CO-40-19P	1			2	2	1				2
CO-40-19R										
CO-40-20A	1	1	2	2	2	1	1	2	2	1
CO-40-21	1	2	2	1	1	1		1	1	1
CO-40-22A		3	3				2			
CO-40-22B juven					3					
CO-40-22B adult				3	3					
CO-40-22C								1		
CO-40-22D		3	3	1	2					1
CO-40-22E										
CO-40-23A	1			2	3					
CO-40-23B	1									
CO-40-24										

Inventory Recording Form for Complete Skeletons (At   tachment 1)

Accession Number	R Patella	L Sacrum	R Sacrum	L Ilium	R Ilium	L Ischium	R Ischium	L Pubis	R Pubis	L Aceabulum
CO-40-25				3		3			2	3
CO-40-25-1										
CO-40-26		2	2	1	2	1	2	1	1	2
CO-40-27	1	3	3	1	2	1	1			1
CO-40-28										
CO-40-29A				1	1					
CO-40-29B						1	1		1	
CO-40-30										
CO-40-31A	1	3	2	2	1	3	3			1
CO-40-31B	2									
CO-40-31B1				1	1					1
CO-40-31C	2	3	3							
CO-40-31-1C				2		1				1
CO-40-31D										
CO-40-31D1										
CO-40-31E	1				1		3			2
CO-40-31F		3	3							
CO-40-31G		3	3							
CO-40-31H										
CO-40-31I										
CO-40-32A	1	3	3	2	3					1
CO-40-32B				1	3		1			1
CO-40-Prov? Skull										
CO-40-68C/infant				3	3					3
CO-40-68C/3yo				1	1					1
CO-40-68C/7yo										
CO-40-68E/fetal										
CO-40-68E/child6y				3	3					
CO-40-68E/adult		3	3	3	3	3	3	3	3	3
CO-40-68W/infant										
CO-40-68W/9yo										
CO-40-68W/adult										
CO-40-69/neonate										
CO-40-69/1yo										
CO-40-69/4yo										
CO-40-69/adult										
CO-40-71										
CO-40-77		2	2	2	2	1	1	3		3
CO-40-79B69										
CO-40-79					3					
CO-40-82b										

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Aceabulum	L Auricular Surface	R Auricular Surface	C1 Centrum	C1 Neural Arch	C2 Centrum	C2 Neural Arch	C7 Centrum	C7 Neural Arch
CO-40-1							2		
CO-40-1A									
CO-40-1AB	3		1			3	3		
CO-40-1B									
CO-40-1D		2	3						
CO-40-1E	2	2	2	1	1	1	1		
CO-40-2									
CO-40-3	1	3			2	1	1		
CO-40-3-1	2		1						
CO-40-4	2	3	2	1	1	1	1		
CO-40-5		3	3		2	2	2		
CO-40-6A									
CO-40-6B									
CO-40-6C									
CO-40-6D									
CO-40-13	2	3	3	1	1	1	1		
CO-40-15A	2								
CO-40-15B									
CO-40-15C									
CO-40-15D									
CO-40-15E			2						
CO-40-16A									
CO-40-16B									
CO-40-16C		1				1	1		
CO-40-16D		1	1						
CO-40-16E									
CO-40-17									
CO-40-18A									
CO-40-18B	2	3	1	1	1	2	1	1	
CO-40-19A		3	1			1	1		
CO-40-19B		1							
CO-40-19E									
CO-40-19F		1							
CO-40-19H									
CO-40-19I									
CO-40-19J									
CO-40-19K					2		3		
CO-40-19L					1				
CO-40-19M		3	2						
CO-40-19P	2	1	1						
CO-40-19R									
CO-40-20A	1	1	1						
CO-40-21	1	1	1					1	1
CO-40-22A	3			1	3	1	1		
CO-40-22B juven	0		3						
CO-40-22B adult									
CO-40-22C		3							
CO-40-22D	2	2	3					1	
CO-40-22E									
CO-40-23A									
CO-40-23B									
CO-40-24									

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	R Aceabulum	L Auricular Surface	R Auricular Surface	C1 Centrum	C1 Neural Arch	C2 Centrum	C2 Neural Arch	C7 Centrum	C7 Neural Arch
CO-40-25		1							
CO-40-25-1						2	2		
CO-40-26	1	1	1	3	3	3	3	3	3
CO-40-27			1	1	1	1	1		
CO-40-28									
CO-40-29A									
CO-40-29B									
CO-40-30									
CO-40-31A	1	2	2	1	1	1	1	1	
CO-40-31B	1		1						
CO-40-31B1	1	1	1						
CO-40-31C				1	1	1	1	1	
CO-40-31-1C		2						1	
CO-40-31D									
CO-40-31D1									
CO-40-31E	1		3						
CO-40-31F		2	3		3	1	1	1	
CO-40-31G				1	1				
CO-40-31H									
CO-40-31I									
CO-40-32A		1	2		2	1	1		
CO-40-32B		1							
CO-40-Prov? Skull									
CO-40-68C/infant	3								
CO-40-68C/3yo	1					3	3		
CO-40-68C/7yo									
CO-40-68E/fetal									
CO-40-68E/child6yo									
CO-40-68E/adult	3	3	3	2	2	2	2		
CO-40-68W/infant									
CO-40-68W/9yo									
CO-40-68W/adult									
CO-40-69/neonate									
CO-40-69/1yo									
CO-40-69/4yo									
CO-40-69/adult									
CO-40-71									
CO-40-77	3	3		1	1	1	1	2	2
CO-40-79B69									
CO-40-79		2							
CO-40-82b									

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	T10 Centrum	T10 Neural Arch	T11 Centrum	T11 Neual Arch	T12 Centrum	T12 Neural Arch	L1 Centrum	L1 Neural Arch	L2 Centrum	L2 Neural Arch
CO-40-1										
CO-40-1A										
CO-40-1AB			3	1						
CO-40-1B										
CO-40-1D										
CO-40-1E	1	1								
CO-40-2										
CO-40-3		2	1	1	1					
CO-40-3-1			1	1	1	1	1	1		
CO-40-4										
CO-40-5										
CO-40-6A										
CO-40-6B										
CO-40-6C										
CO-40-6D										
CO-40-13										
CO-40-15A										
CO-40-15B										
CO-40-15C										
CO-40-15D										
CO-40-15E										
CO-40-16A										
CO-40-16B										
CO-40-16C										
CO-40-16D										
CO-40-16E										
CO-40-17										
CO-40-18A										
CO-40-18B										
CO-40-19A										
CO-40-19B										
CO-40-19E										
CO-40-19F										
CO-40-19H										
CO-40-19I										
CO-40-19J										
CO-40-19K										
CO-40-19L										
CO-40-19M										
CO-40-19P									1	
CO-40-19R										
CO-40-20A										
CO-40-21			1	1	1	1				
CO-40-22A				2		3		1		1
CO-40-22B juven										
CO-40-22B adult										
CO-40-22C										
CO-40-22D										
CO-40-22E										
CO-40-23A										
CO-40-23B										
CO-40-24										

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	T10 Centrum	T10 Neural Arch	T11 Centrum	T11 Neual Arch	T12 Centrum	T12 Neural Arch	L1 Centrum	L1 Neural Arch	L2 Centrum	L2 Neural Arch
CO-40-25										
CO-40-25-1										
CO-40-26							2	2	2	2
CO-40-27			2	2						
CO-40-28										
CO-40-29A										
CO-40-29B										
CO-40-30										
CO-40-31A	2					1	1	1		1
CO-40-31B										
CO-40-31B1										
CO-40-31C			2	2						
CO-40-31-1C										
CO-40-31D										
CO-40-31D1										
CO-40-31E							1	1		
CO-40-31F										
CO-40-31G										
CO-40-31H										
CO-40-31I										
CO-40-32A		1								
CO-40-32B										
CO-40-Prov? Skull										
CO-40-68C/infant										
CO-40-68C/3yo										
CO-40-68C/7yo										
CO-40-68E/fetal										
CO-40-68E/child6y										
CO-40-68E/adult				1		1				
CO-40-68W/infant										
CO-40-68W/9yo										
CO-40-68W/adult										
CO-40-69/neonate										
CO-40-69/1yo										
CO-40-69/4yo										
CO-40-69/adult										
CO-40-71										
CO-40-77				3		3				
CO-40-79B69										
CO-40-79										
CO-40-82b										

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	L3 Centrum	L3 Neural Arch	L4 Centrum	L4 Neural Arch	L5 Centrum	L5 Neural Arch	C3-6 Centra Present	C3-6 Centra Complete	C3-6 Neural Arches Present
CO-40-1									
CO-40-1A									
CO-40-1AB						1			
CO-40-1B									
CO-40-1D									
CO-40-1E					1				
CO-40-2									
CO-40-3			1	1	1	1			1
CO-40-3-1									
CO-40-4							2	2	
CO-40-5									
CO-40-6A									
CO-40-6B									
CO-40-6C									
CO-40-6D									
CO-40-13									4
CO-40-15A									
CO-40-15B									
CO-40-15C									
CO-40-15D									
CO-40-15E									
CO-40-16A									
CO-40-16B									
CO-40-16C									2
CO-40-16D									
CO-40-16E									
CO-40-17									
CO-40-18A									
CO-40-18B							4	4	4
CO-40-19A									
CO-40-19B									
CO-40-19E							2	2	2
CO-40-19F							3	2	2
CO-40-19H									
CO-40-19I									
CO-40-19J									
CO-40-19K									
CO-40-19L									
CO-40-19M									
CO-40-19P	1	1			1				
CO-40-19R	1		1	1	2				
CO-40-20A					1	1	3	2	4
CO-40-21	1		1		1		2	2	2
CO-40-22A									
CO-40-22B juven									
CO-40-22B adult									
CO-40-22C									
CO-40-22D			1		1	1	2	2	
CO-40-22E									
CO-40-23A									
CO-40-23B									
CO-40-24									

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L3 Centrum	L3 Neural Arch	L4 Centrum	L4 Neural Arch	L5 Centrum	L5 Neural Arch	C3-6 Centra Present	C3-6 Centra Complete	C3-6 Neural Arches Present
CO-40-25									
CO-40-25-1									
CO-40-26	2	2	2	2	2	2	2	2	2
CO-40-27							4	3	
CO-40-28									
CO-40-29A									
CO-40-29B									
CO-40-30									
CO-40-31A	1	1	1	1	1		3	3	3
CO-40-31B									
CO-40-31B1									
CO-40-31C							3	2	3
CO-40-31-1C									
CO-40-31D									
CO-40-31D1									1
CO-40-31E			1	1	2	2			
CO-40-31F							4	4	3
CO-40-31G									
CO-40-31H									
CO-40-31I									
CO-40-32A									
CO-40-32B									
CO-40-Prov? Skull									
CO-40-68C/infant									
CO-40-68C/3yo									
CO-40-68C/7yo									
CO-40-68E/fetal									
CO-40-68E/child6yo									
CO-40-68E/adult									
CO-40-68W/infant									
CO-40-68W/9yo									
CO-40-68W/adult									
CO-40-69/neonate									
CO-40-69/1yo									
CO-40-69/4yo									
CO-40-69/adult									
CO-40-71									
CO-40-77							4	0	
CO-40-79B69									
CO-40-79									
CO-40-82b									

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	C3-6 Neural Arches Complete	T1-9 Centra Present	T1-9 Centra Complete	T1-9 Neural Arches Present	T1-9 Neural Arches Complete	Manubrium	Sternum body	L 1st Rib
CO-40-1								
CO-40-1A				1	0			
CO-40-1AB		1	1	1	1			
CO-40-1B								
CO-40-1D								
CO-40-1E		4	3	3	1	2		
CO-40-2							1	1
CO-40-3	0	1	1	6	3			
CO-40-3-1								
CO-40-4		8	8	8	8			3
CO-40-5								
CO-40-6A								
CO-40-6B								
CO-40-6C								
CO-40-6D								
CO-40-13	4						3	
CO-40-15A								
CO-40-15B								
CO-40-15C								
CO-40-15D								
CO-40-15E								
CO-40-16A								
CO-40-16B		8	8					
CO-40-16C	2						3	
CO-40-16D								
CO-40-16E								
CO-40-17								
CO-40-18A								
CO-40-18B	3							
CO-40-19A								
CO-40-19B								
CO-40-19E	2							
CO-40-19F	0	2	2	2	2			
CO-40-19H								1
CO-40-19I								
CO-40-19J								
CO-40-19K								
CO-40-19L								
CO-40-19M								
CO-40-19P								
CO-40-19R								
CO-40-20A	0	2	2	10	1	2		
CO-40-21	2	8	7	2	2	1	1	2
CO-40-22A		4	2	3	2			1
CO-40-22B juven								
CO-40-22B adult								
CO-40-22C								
CO-40-22D								
CO-40-22E								
CO-40-23A								
CO-40-23B								
CO-40-24								

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	C3-6 Neural Arches Complete	T1-9 Centra Present	T1-9 Centra Complete	T1-9 Neural Arches Present	T1-9 Neural Arches Complete	Manubrium	Sternum body	L 1st Rib
CO-40-25								
CO-40-25-1								
CO-40-26	2							
CO-40-27								
CO-40-28								
CO-40-29A								
CO-40-29B								
CO-40-30								
CO-40-31A	3	7	6	6	6			
CO-40-31B								
CO-40-31B1								
CO-40-31C	2	5	3	9	5			
CO-40-31-1C								
CO-40-31D								
CO-40-31D1	0							
CO-40-31E								
CO-40-31F	3	4	3	4	4			
CO-40-31G								
CO-40-31H								
CO-40-31I								
CO-40-32A		4	4					
CO-40-32B								
CO-40-Prov? Skull								
CO-40-68C/infant								
CO-40-68C/3yo								
CO-40-68C/7yo								
CO-40-68E/fetal								
CO-40-68E/child6yo								
CO-40-68E/adult								
CO-40-68W/infant								
CO-40-68W/9yo								
CO-40-68W/adult								
CO-40-69/neonate								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult								
CO-40-71								
CO-40-77		5	5					
CO-40-79B69								
CO-40-79								
CO-40-82b								

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	R 1st Rib	L 2nd Rib	R 2nd Rib	L 11h Rib	R 11th Rib	L 12th Rib	R 12th Rib	L Ribs 3 10 Present	L Ribs 3-10 Complete	R Ribs 3-10 Present	R Ribs 3-10 Complete	Ribs 3-10 Unsided
CO-40-1												
CO-40-1A												
CO-40-1AB												
CO-40-1B												
CO-40-1D												
CO-40-1E												
CO-40-2	1							1	0	4	0	
CO-40-3												
CO-40-3-1						1						
CO-40-4												
CO-40-5												
CO-40-6A												
CO-40-6B												
CO-40-6C												
CO-40-6D												
CO-40-13												
CO-40-15A												
CO-40-15B												
CO-40-15C												
CO-40-15D												
CO-40-15E												
CO-40-16A								1	0	3	0	
CO-40-16B								1	0	3	3	
CO-40-16C	1				1		1			3	0	
CO-40-16D												
CO-40-16E												
CO-40-17												
CO-40-18A												
CO-40-18B												
CO-40-19A												
CO-40-19B												
CO-40-19E												
CO-40-19F												
CO-40-19H												
CO-40-19I												
CO-40-19J												
CO-40-19K												
CO-40-19L												
CO-40-19M												
CO-40-19P												
CO-40-19R												
CO-40-20A												
CO-40-21								7	0	4	0	
CO-40-22A	1											
CO-40-22B juven												
CO-40-22B adult												
CO-40-22C												
CO-40-22D												
CO-40-22E												
CO-40-23A												
CO-40-23B												
CO-40-24												

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R 1st Rib	L 2nd Rib	R 2nd Rib	L 11h Rib	R 11th Rib	L 12th Rib	R 12th Rib	L Ribs 3 10 Present	L Ribs 3-10 Complete	R Ribs 3-10 Present	R Ribs 3-10 Complete	Ribs 3-10 Unsided
CO-40-25												
CO-40-25-1												
CO-40-26												
CO-40-27												
CO-40-28												
CO-40-29A												
CO-40-29B												
CO-40-30												
CO-40-31A	2							4	0	4	0	
CO-40-31B												
CO-40-31B1												
CO-40-31C												
CO-40-31-1C												
CO-40-31D												
CO-40-31D1										1	0	
CO-40-31E										2	2	
CO-40-31F												
CO-40-31G												
CO-40-31H												
CO-40-31I												
CO-40-32A								3	0	2	0	
CO-40-32B	2							3	0			
CO-40-Prov? Skull												
CO-40-68C/infant												
CO-40-68C/3yo												
CO-40-68C/7yo												
CO-40-68E/fetal												
CO-40-68E/child6y												
CO-40-68E/adult	2							3	0	6	0	
CO-40-68W/infant												
CO-40-68W/9yo												
CO-40-68W/adult												
CO-40-69/neonate												
CO-40-69/1yo												
CO-40-69/4yo												
CO-40-69/adult												
CO-40-71												
CO-40-77								1	0	6	0	
CO-40-79B69												
CO-40-79												
CO-40-82b												

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	comments
CO-40-1	
CO-40-1A	
CO-40-1AB	
CO-40-1B	
CO-40-1D	temporal: pars p. fused to squamous, age 1+. Concre tions fused neural arches together, but too weathe tell if actually consecutive verts
CO-40-1E	
CO-40-2	
CO-40-3	
CO-40-3-1	created by me in AR based on presence of older, fem ale remains commingled with burial 3, PMD to ce of vertebra. Some almost look lytic, but white edge s show PMD. Superior articular facets for T12 are u L is vertical, R is turned (see inv. 2).
CO-40-4	
CO-40-5	Verts: C1 arch, C2 dens + some body, 1 thoracic spi nous process, 10 cent frgs, 4 whole-ish. Some m commingled with 16A/commingled child.
CO-40-6A	
CO-40-6B	
CO-40-6C	
CO-40-6D	
CO-40-13	
CO-40-15A	
CO-40-15B	
CO-40-15C	
CO-40-15D	
CO-40-15E	
CO-40-16A	
CO-40-16B	
CO-40-16C	
CO-40-16D	
CO-40-16E	
CO-40-17	
CO-40-18A	Two sets of cervicals: C4-C7 & C6-C7 - not sure whi ch associated with 18A (
CO-40-18B	
CO-40-19A	
CO-40-19B	
CO-40-19E	
CO-40-19F	clavical frg PMD, prob R.
CO-40-19H	
CO-40-19I	
CO-40-19J	
CO-40-19K	
CO-40-19L	some dentition and vert only
CO-40-19M	
CO-40-19P	
CO-40-19R	
CO-40-20A	
CO-40-21	
CO-40-22A	
CO-40-22B juven	Unsided clavicle shaft (frg = 2)
CO-40-22B adult	
CO-40-22C	1 hyoid
CO-40-22D	
CO-40-22E	
CO-40-23A	
CO-40-23B	
CO-40-24	

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	comments
CO-40-25	
CO-40-25-1	Created from commingled frgs labeled II 4
CO-40-26	Cranium fragmented. Previously glued, but PMD cause d new breaks. Frontal internal table eroc
CO-40-27	
CO-40-28	
CO-40-29A	
CO-40-29B	
CO-40-30	
CO-40-31A	
CO-40-31B	
CO-40-31B1	
CO-40-31C	
CO-40-31-1C	
CO-40-31D	
CO-40-31D1	
CO-40-31E	
CO-40-31F	
CO-40-31G	
CO-40-31H	
CO-40-31I	
CO-40-32A	
CO-40-32B	
CO-40-Prov? Skull	provenence lost, hence accession number, since McG excavations. Always boxed with burial 1, bu corresponding indiviual with male chars.
CO-40-68C/infant	vertebrae frgs present, rib frgs.
CO-40-68C/3yo	
CO-40-68C/7yo	dentition only
CO-40-68E/fetal	
CO-40-68E/child6yo	rib frgs, vert frgs.
CO-40-68E/adult	ribs coded 2-12. seems 68E was in pothole 4B 80-90b d, but can't find in field notes. Notation from "(Mangote -summer 1979 field season-catelogue" found hand metacarpals +4 carpals &4 phalanges in "foo bag. Double checked and put in hand bag. (cont)
CO-40-68W/infant	
CO-40-68W/9yo	cranial, rib & vertebrae frgs.
CO-40-68W/adult	No long bones.
CO-40-69/neonate	
CO-40-69/1yo	rib, vert, cranial frgs. Cannot separate fully from CO-40-69
CO-40-69/4yo	rib, vert, cranial frgs. Cannot separate fully from CO-40-69
CO-40-69/adult	
CO-40-71	fragments only
CO-40-77	
CO-40-79B69	
CO-40-79	
CO-40-82b	1 probable sternebraul

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Humerus PE	L Humerus P1/3	L Humerus M1/3	L Humerus D1/3	L Humerus DE	R Humerus PE	R Humerus P1/3
CO-40-1	1	3	1	1	3	1	1
CO-40-1A	1	2				1	
CO-40-1AB						1	2
CO-40-1D							
CO-40-1E	1	1	1	1	1		2
CO-40-2		2	2	2			
CO-40-3	2		3	2	2	2	1
CO-40-3-1							2
CO-40-4	1	1	1	1	3	2	1
CO-40-5	1	1	1	1	1	1	2
CO-40-6A					3		
CO-40-6C							
CO-40-13		3	1	2			2
CO-40-15A		2	1	3	2		3
CO-40-15B							3
CO-40-15C							
CO-40-15D			1	2			
CO-40-15E							
CO-40-16A							
CO-40-16B							
CO-40-16C			1	1	1	1	1
CO-40-16D		1	1	1	1		
CO-40-16E			1	1	1		
CO-40-17							
CO-40-18A		2	1	1	1		
CO-40-18B		2	2	3	3		2
CO-40-19A			1	2			2
CO-40-19B			2	1	1	1	
CO-40-19E		2	1	2	2	1	1
CO-40-19F							
CO-40-19H						3	1
CO-40-19I							
CO-40-19M	1	1	2	2	2	2	1
CO-40-19P	1	2	1	1	1		
CO-40-19R							
CO-40-20A							2
CO-40-21		2	1	1	2		
CO-40-22A	1	2	1	1	1	1	1
CO-40-22B juven			2				1
CO-40-22B adult			2	1	3		2
CO-40-22C							
CO-40-22D							

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Humerus PE	L Humerus P1/3	L Humerus M1/3	L Humerus D1/3	L Humerus DE	R Humerus PE	R Humerus P1/3
CO-40-23A			1	2			3
CO-40-23B							
CO-40-25	1	1	1	2			2
CO-40-25-1							
CO-40-26	1	1	1	1	1	1	1
CO-40-27							
CO-40-29A	1	1	1	1	1	1	1
CO-40-29B							
CO-40-31A		1	1	1	1	1	1
CO-40-31B							
CO-40-31B1		2	1	1			2
CO-40-31C	1						
CO-40-31-1C				1			
CO-40-31D							
CO-40-31D1							
CO-40-31E	3	1	1	1	1		1
CO-40-31F		3	1	2		3	1
CO-40-31G	1	1	1	1	1	2	1
CO-40-31H							
CO-40-31I							
CO-40-32A		1	1	1	1		
CO-40-32B							
CO-40-68C/infant				1	1		
CO-40-68C/3yo							
CO-40-68E/child6yo				1			2
CO-40-68E/adult				1	1	2	
CO-40-68W/9yo							
CO-40-69/infant							
CO-40-77							
CO-40-79							
CO-40-79b69							
CO-40-82b							1

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Humerus M1/3	R Humerus D1/3	R Humerus DE	L Radius PE	L Radius P1/3	L Radius M1/3	L Radius D1/3	L Radius DE
CO-40-1	1	1	1	1	1	1	1	
CO-40-1A								
CO-40-1AB		2						
CO-40-1D								
CO-40-1E	1	1	1	1	1	1	3	1
CO-40-2								
CO-40-3	1	1	1					
CO-40-3-1	1							
CO-40-4	1	1	1	1	1	1	1	1
CO-40-5	1	1			2	2		
CO-40-6A		1	3		1	3		
CO-40-6C								
CO-40-13	1	1	1					
CO-40-15A	1	1	2					
CO-40-15B	1	2		2	1	2		
CO-40-15C								
CO-40-15D						1		
CO-40-15E								
CO-40-16A								
CO-40-16B	1	1	1	1	1	1	1	1
CO-40-16C	1	1	1	1	1	1	1	1
CO-40-16D		1	1					
CO-40-16E				1				
CO-40-17		2						
CO-40-18A		1						
CO-40-18B	1	2			3	1	2	
CO-40-19A	1				3	1	3	
CO-40-19B				3	1	3		
CO-40-19E	3							
CO-40-19F								
CO-40-19H	1	1						
CO-40-19I								
CO-40-19M	1	1	1					
CO-40-19P				1				
CO-40-19R								
CO-40-20A	1	1	1					
CO-40-21		3	1	1	1	1	2	2
CO-40-22A	1	1	1	1	1	1	1	
CO-40-22B juven	1	1						
CO-40-22B adult	1	1	1			2	1	
CO-40-22C								
CO-40-22D								

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	R Humerus M1/3	R Humerus D1/3	R Humerus DE	L Radius PE	L Radius P1/3	L Radius M1/3	L Radius D1/3	L Radius DE
CO-40-23A	1	2			2			
CO-40-23B								
CO-40-25	1	1	1					
CO-40-25-1								
CO-40-26	1	1	1	1	1	2		
CO-40-27			1		2	1	1	1
CO-40-29A	2	2	1	1	1	1	1	
CO-40-29B								
CO-40-31A	1	1	1		1	1	1	1
CO-40-31B								
CO-40-31B1	1							
CO-40-31C					2	1	2	
CO-40-31-1C		1						
CO-40-31D								
CO-40-31D1								
CO-40-31E	1	1	1	2	1	1	2	
CO-40-31F	1	1	3					
CO-40-31G	1	1	1	1	1	1	1	1
CO-40-31H								
CO-40-31I								
CO-40-32A	2	1	2	1	1			
CO-40-32B			1					
CO-40-68C/infant		1	1	1	1			
CO-40-68C/3yo								
CO-40-68E/child6yo	2	2						
CO-40-68E/adult	2	1	1	3	1	1	1	1
CO-40-68W/9yo								
CO-40-69/infant								
CO-40-77						2	2	1
CO-40-79								
CO-40-79b69					1	1	1	
CO-40-82b								

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Radius PE	R Radius P1/3	R Radius M1/3	R Radius D1/3	R Radius DE	L Ulna PE	L Ulna P1/3	L Ulna M1/3	L Ulna D1/3	L Ulna DE	R Ulna PE
CO-40-1	1	2	2	2		2	2	2	2		
CO-40-1A						1	1	1	1		1
CO-40-1AB											
CO-40-1D		2	1	3				1	1		
CO-40-1E	1	1	2			3	1	2			
CO-40-2		1	1	1			1	2	2		
CO-40-3											
CO-40-3-1											1
CO-40-4	3	1	1	1		1	1	1	1	2	2
CO-40-5		2	1	1	1	2	1	1	1		
CO-40-6A		3	3				3	3			
CO-40-6C											
CO-40-13				3	1	3	1	2			1
CO-40-15A						1	1	1			3
CO-40-15B	3	1	1								
CO-40-15C											
CO-40-15D						1	1				
CO-40-15E											1
CO-40-16A						2	1	1	1		2
CO-40-16B	1					1					1
CO-40-16C	1					1	1	1	1		1
CO-40-16D											1
CO-40-16E	1					1	1	1	1		1
CO-40-17			1								
CO-40-18A		1	1	1	1	1	1	1	1		1
CO-40-18B	1	1	1	1	1						
CO-40-19A		1	3	3		1	1	2			2
CO-40-19B		2	1	2							
CO-40-19E											
CO-40-19F											
CO-40-19H											3
CO-40-19I											
CO-40-19M			1	1	1						
CO-40-19P	1	1	1								
CO-40-19R						2	1	1	1		
CO-40-20A	1	1	1	1		3	1	1			1
CO-40-21	1	2	1	1	2	1	1	1	1		1
CO-40-22A		1	1	1	1	1	1	1	2		1
CO-40-22B juven											
CO-40-22B adult						2	1	1	1		2
CO-40-22C											
CO-40-22D											

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	R Radius PE	R Radius P1/3	R Radius M1/3	R Radius D1/3	R Radius DE	L Ulna PE	L Ulna P1/3	L Ulna M1/3	L Ulna D1/3	L Ulna DE	R Ulna PE
CO-40-23A		2	1	3							
CO-40-23B											
CO-40-25						2	1	1			
CO-40-25-1											
CO-40-26	1	1	1			1	1	2			1
CO-40-27											
CO-40-29A			1	1	1	1	1	1	1	1	
CO-40-29B											
CO-40-31A	1	1	1	1	2	1	1	1	1	1	
CO-40-31B											
CO-40-31B1							1	1			
CO-40-31C	1	1	1	1	1	1	1	1	3		
CO-40-31-1C								1			
CO-40-31D											
CO-40-31D1		1	2								
CO-40-31E	2	1	1	1	1	2	1	1	3		2
CO-40-31F			1	1		1	1	1	1	1	
CO-40-31G	1	1	1	1	1	2	1	1	2		1
CO-40-31H											
CO-40-31I											
CO-40-32A	1	2				1	1	1	2		1
CO-40-32B						1	1	1	1	3	1
CO-40-68C/infant	1	1									
CO-40-68C/3yo											
CO-40-68E/child6yo							2	2	2		
CO-40-68E/adult			2	1	1		3	3	1	2	1
CO-40-68W/9yo											
CO-40-69/infant											
CO-40-77	1	1	1	1	1	1	1	1	1		1
CO-40-79						3					1
CO-40-79b69		2	1	2							
CO-40-82b											

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Ulna P1/3	R Ulna M1/3	R Ulna D1/3	R Ulna DE	L Femur PE	L Femur P1/3	L Femur M1/3	L Femur D1/3	L Femur DE	R Femur PE
CO-40-1						3	1			1
CO-40-1A	1	1	1							1
CO-40-1AB										
CO-40-1D	1	1	1			2				
CO-40-1E	1				1	1	1	1	1	1
CO-40-2	1	1	1			1	1	1		
CO-40-3					2	2	1	3		1
CO-40-3-1	1	2				2	1	2	1	
CO-40-4	1	1	1	2	1	1	1	1	1	1
CO-40-5	2	2	3		1	2	1	1		2
CO-40-6A	3	3			1	1	1	2		1
CO-40-6C					3	2	1			
CO-40-13	1				1	2	1	3		
CO-40-15A	1	2				2	1	3		
CO-40-15B	2	2			1	2	1	2	3	1
CO-40-15C	2	1								1
CO-40-15D							2	1		
CO-40-15E	3					2	2			
CO-40-16A	1	1	1						1	
CO-40-16B					1	1	1	1	1	1
CO-40-16C	1	1	1	1	1	1	1	1	1	1
CO-40-16D	1	3			1	1	1	2		1
CO-40-16E	1	1								
CO-40-17	2	1				2	2	1		
CO-40-18A	1	1			3	2	1	2		3
CO-40-18B					2	1	1	2		2
CO-40-19A		2	1	1	1	1	1	1	1	1
CO-40-19B	2				2					2
CO-40-19E					1	2	1	2	3	1
CO-40-19F										
CO-40-19H	1	2								
CO-40-19I										
CO-40-19M		1			2	1	1			1
CO-40-19P										1
CO-40-19R					1	1	1	1	1	1
CO-40-20A	1	2	1		1	1	1	1	1	1
CO-40-21	2	1	1	1			2	2	1	1
CO-40-22A	1				1	1	1	2		2
CO-40-22B juven										
CO-40-22B adult	1	1	1							
CO-40-22C					3	2	2			1
CO-40-22D										

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	R Ulna P1/3	R Ulna M1/3	R Ulna D1/3	R Ulna DE	L Femur PE	L Femur P1/3	L Femur M1/3	L Femur D1/3	L Femur DE	R Femur PE
CO-40-23A										2
CO-40-23B						2	1	2		
CO-40-25			1	1	1	2				
CO-40-25-1										
CO-40-26	3				1	1	1	1		1
CO-40-27					1	1			1	
CO-40-29A		1	1	1	1	1	1	1	1	1
CO-40-29B										
CO-40-31A					1	1	1	1	1	1
CO-40-31B					1	1	1			1
CO-40-31B1						2				
CO-40-31C					1					1
CO-40-31-1C					2	1	1	1	1	
CO-40-31D										
CO-40-31D1										
CO-40-31E	2				3	2	1	1	1	1
CO-40-31F					3	1	1	1	3	
CO-40-31G	1	1	1	3	3	1	1	1	1	1
CO-40-31H										
CO-40-31I										
CO-40-32A	1	1	1	1	1	1	1	3	2	2
CO-40-32B	1	1	1	3						
CO-40-68C/infant										
CO-40-68C/3yo					1					
CO-40-68E/child6yo	2	2	2			2	1	2		
CO-40-68E/adult	1	3				1	1	1		3
CO-40-68W/9yo					1					1
CO-40-69/infant						3	1	1		
CO-40-77	1	2				1	1	1		
CO-40-79	2							3		
CO-40-79b69					2	1	2			1
CO-40-82b										

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Femur P1/3	R Femur M1/3	R Femur D1/3	R Femur DE	L Tibia PE	L Tibia P1/3	L Tibia M1/3	L Tibia D1/3	L Tibia DE	R Tibia PE	R Tibia P1/3
CO-40-1	1	1	1	1	3	2	2	2	1	3	2
CO-40-1A	1	1	1	1							
CO-40-1AB											
CO-40-1D						2	1	3			2
CO-40-1E	1		1	1		1	3	1	1	3	1
CO-40-2	1	1	2	1							
CO-40-3	2	1	3								
CO-40-3-1	3	2	2		1	1	1	2			
CO-40-4	1	1	1	1	1	1	1	1	1	1	1
CO-40-5	2	2	3			2	1	2			3
CO-40-6A	2	2	2								
CO-40-6C	3	1	2			2	1	2			3
CO-40-13	2	1	2					1	3		
CO-40-15A	1	1	2	2							3
CO-40-15B	1	1	1	3		1					2
CO-40-15C											
CO-40-15D			1	2							
CO-40-15E		2	2								2
CO-40-16A				1							
CO-40-16B	1	1	1	1				1	1	1	1
CO-40-16C	1	1	1	2	1	1	1	1	1	1	1
CO-40-16D	1	1	1	1		2	1	2		1	1
CO-40-16E											
CO-40-17	1	1	2			1					
CO-40-18A					3	2	2	2			2
CO-40-18B	1	1	2			2	1	2			2
CO-40-19A	1	1	1							1	
CO-40-19B										1	
CO-40-19E	1	1	1			2	1	2			
CO-40-19F											
CO-40-19H											
CO-40-19I											
CO-40-19M	1	1	1	1							
CO-40-19P	1	1	1	1							
CO-40-19R	1	1	1								
CO-40-20A	1	1	1	1							
CO-40-21	1	1	2	1	2				1	1	
CO-40-22A	1	1	2		3	1	1	1		3	1
CO-40-22B juven											
CO-40-22B adult	2	1	2				2				
CO-40-22C	1	2									
CO-40-22D											

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Femur P1/3	R Femur M1/3	R Femur D1/3	R Femur DE	L Tibia PE	L Tibia P1/3	L Tibia M1/3	L Tibia D1/3	L Tibia DE	R Tibia PE	R Tibia P1/3
CO-40-23A	1	2				3	1	2	3		2
CO-40-23B	2	1	2			1		2			2
CO-40-25											
CO-40-25-1											
CO-40-26	1	1	1	1		2	1	1	2	1	1
CO-40-27						2	1	1	1		1
CO-40-29A	1	1	2		1	1	1	1	1	1	1
CO-40-29B					3	1	1	1	1		
CO-40-31A	1	1	1	1						1	1
CO-40-31B	2	1									
CO-40-31B1	2										
CO-40-31C				3					3		
CO-40-31-1C	1	1	3				2	2			
CO-40-31D											
CO-40-31D1											
CO-40-31E	1	1	1	1	2	2	1	2			2
CO-40-31F	1	1	1			2	1	2			3
CO-40-31G	1	2	2	2							
CO-40-31H						2	1	2			
CO-40-31I											
CO-40-32A	1	1	1	1		2	1	2	2		
CO-40-32B	2	1	1	1			1	1	1	3	1
CO-40-68C/infant											
CO-40-68C/3yo											
CO-40-68E/child6yo	3	1	3			2	2	2			2
CO-40-68E/adult		2	2	1		2	1	2	2	2	1
CO-40-68W/9yo		1	1			1	1	1			1
CO-40-69/infant											
CO-40-77	1	1	3				2	1			2
CO-40-79											
CO-40-79b69	1	1	1	1	3	1	1	3			2
CO-40-82b											

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Tibia M1/3	R Tibia D1/3	R Tibia DE	L Fibula PE	L Fibula P1/3	L Fibula M1/3	L Fibula D1/3	L Fibula DE	R Fibula PE	R Fibula P1/3
CO-40-1	1	1	1			3	1	1		
CO-40-1A										
CO-40-1AB										
CO-40-1D										
CO-40-1E	1	1	1				2	1		
CO-40-2					2	1				1
CO-40-3								1		
CO-40-3-1	2	1	1							
CO-40-4	1	1	1		1	1	1			1
CO-40-5	3				1	1	1			1
CO-40-6A			1							
CO-40-6C	3									
CO-40-13	1		1				3	1		
CO-40-15A	1	3								
CO-40-15B	2	1								
CO-40-15C										
CO-40-15D			3							
CO-40-15E										
CO-40-16A						1				
CO-40-16B	1	1	1						1	1
CO-40-16C	1	1	3			1	3		1	1
CO-40-16D	1	1	1							
CO-40-16E				1	1	1	1			
CO-40-17										
CO-40-18A	2	3	2		2	1	1	2		
CO-40-18B	1	2				2				
CO-40-19A								1		
CO-40-19B										
CO-40-19E	1									
CO-40-19F										
CO-40-19H										
CO-40-19I										
CO-40-19M										
CO-40-19P										
CO-40-19R										
CO-40-20A							2			
CO-40-21								2		1
CO-40-22A	1	1	1		1	1	1	3		1
CO-40-22B juven										
CO-40-22B adult					2	1	2			
CO-40-22C										
CO-40-22D										

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Tibia M1/3	R Tibia D1/3	R Tibia DE	L Fibula PE	L Fibula P1/3	L Fibula M1/3	L Fibula D1/3	L Fibula DE	R Fibula PE	R Fibula P1/3
CO-40-23A	2				3	1	3			3
CO-40-23B	1	3			2	1	2			2
CO-40-25					1	2				
CO-40-25-1										
CO-40-26	1	1	1		2	2	2		1	1
CO-40-27	1	1	1	2			1	1	1	1
CO-40-29A	1	1	1		1	1	1	1		1
CO-40-29B										
CO-40-31A	1	1	1		1	1			3	1
CO-40-31B					2	1	1			
CO-40-31B1					1					1
CO-40-31C					1	1	2	1		
CO-40-31-1C	1									
CO-40-31D										
CO-40-31D1										
CO-40-31E	1	2								
CO-40-31F	1	3								1
CO-40-31G										
CO-40-31H					2					2
CO-40-31I										
CO-40-32A	2	2	2				2	1		
CO-40-32B	1	1	3							
CO-40-68C/infant										
CO-40-68C/3yo						1				
CO-40-68E/child6yo	2	2			2	2	2			2
CO-40-68E/adult	2		3							
CO-40-68W/9yo	1	1								
CO-40-69/infant										
CO-40-77	1									
CO-40-79										
CO-40-79b69	1	1								
CO-40-82b										

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Fibula M1/3	R Fibula D1/3	R Fibula DE	L Talus	R Talus	L Calcaneus	R Calcaneus	L Carpals Present
CO-40-1		3	1	2	2	2	2	
CO-40-1A								
CO-40-1AB								3
CO-40-1D								
CO-40-1E				1	1		2	
CO-40-2	1	1		1	1	1		
CO-40-3			1	1	1	2	2	
CO-40-3-1				1	1		1	
CO-40-4	1	1	1	1	1	1	1	0
CO-40-5	1	1						5
CO-40-6A								
CO-40-6C								
CO-40-13				1	1	1	2	4
CO-40-15A								
CO-40-15B								
CO-40-15C								
CO-40-15D								
CO-40-15E				1	2			
CO-40-16A						1	1	
CO-40-16B								
CO-40-16C	1	1	1	1	1	1	1	
CO-40-16D								
CO-40-16E	1							
CO-40-17								
CO-40-18A	1	1	1			3	2	
CO-40-18B	3		1	1	1	3	3	1
CO-40-19A				1	1		1	5
CO-40-19B				1	1			
CO-40-19E					1			
CO-40-19F				1			3	
CO-40-19H								
CO-40-19I								
CO-40-19M								
CO-40-19P				1	1	1		1
CO-40-19R						1	1	
CO-40-20A	2						3	
CO-40-21	1	1	3				1	8
CO-40-22A	1	1	1	1	1	2	2	2
CO-40-22B juven								
CO-40-22B adult								
CO-40-22C							1	
CO-40-22D								

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	R Fibula M1/3	R Fibula D1/3	R Fibula DE	L Talus	R Talus	L Calcaneus	R Calcaneus	L Carpals Present
CO-40-23A	1	2	2			3		
CO-40-23B	1	2						
CO-40-25					1			
CO-40-25-1								
CO-40-26	1	1	1	2	1	2	1	
CO-40-27	1	1	1	1	1	1	1	3
CO-40-29A	1	1	1					
CO-40-29B				1	1		1	
CO-40-31A	1	1	3	1	1	1	1	7
CO-40-31B								
CO-40-31B1								
CO-40-31C	1			1	2	2	1	5
CO-40-31-1C								
CO-40-31D								
CO-40-31D1								
CO-40-31E					1		3	
CO-40-31F								1
CO-40-31G				1	1			4
CO-40-31H	1	2						
CO-40-31I					1		2	
CO-40-32A		2	1					1
CO-40-32B								
CO-40-68C/infant								
CO-40-68C/3yo	1							
CO-40-68E/child6yo	2	2						
CO-40-68E/adult				1	1	1		2
CO-40-68W/9yo								
CO-40-69/infant								
CO-40-77					1		2	1
CO-40-79					1			
CO-40-79b69				1	1	3	1	1
CO-40-82b								

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Carpals Complete	R Carpals Present	R Carpals Complete	Unsided Carpals Present	Unsided Carpals Complete	L Metacarpals Present
CO-40-1						
CO-40-1A						
CO-40-1AB	3	1	1			1
CO-40-1D						
CO-40-1E						
CO-40-2						4
CO-40-3						
CO-40-3-1						2
CO-40-4	0	0	0	0	0	1
CO-40-5	5	2	2	0	0	4
CO-40-6A						
CO-40-6C						
CO-40-13	4	1	0			4
CO-40-15A						
CO-40-15B						
CO-40-15C						
CO-40-15D						
CO-40-15E						
CO-40-16A						
CO-40-16B						
CO-40-16C						3
CO-40-16D						
CO-40-16E						
CO-40-17						
CO-40-18A						
CO-40-18B	1	2	2			4
CO-40-19A	5	5	5			4
CO-40-19B						
CO-40-19E						
CO-40-19F						
CO-40-19H						
CO-40-19I						
CO-40-19M						
CO-40-19P	1	1	1			
CO-40-19R						
CO-40-20A						
CO-40-21	8	7	7			4
CO-40-22A	2					4
CO-40-22B juven						
CO-40-22B adult						
CO-40-22C				1	1	
CO-40-22D						

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Carpals Complete	R Carpals Present	R Carpals Complete	Unsided Carpals Present	Unsided Carpals Complete	L Metacarpals Present
CO-40-23A						
CO-40-23B						
CO-40-25						
CO-40-25-1						
CO-40-26						
CO-40-27	3	2	2			5
CO-40-29A						
CO-40-29B						
CO-40-31A	7	2	2			5
CO-40-31B						
CO-40-31B1						
CO-40-31C	5	5	5			3
CO-40-31-1C						
CO-40-31D						
CO-40-31D1				2	2	
CO-40-31E						
CO-40-31F	1	1	1			2
CO-40-31G	4	3	3			4
CO-40-31H						
CO-40-31I						
CO-40-32A	1					3
CO-40-32B						
CO-40-68C/infant						
CO-40-68C/3yo						
CO-40-68E/child6yo						
CO-40-68E/adult	2	2	2			2
CO-40-68W/9yo						
CO-40-69/infant						
CO-40-77	1					
CO-40-79						
CO-40-79b69	1					3
CO-40-82b						

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Metacarpals Complete	R Metacarpals Present	R Metacarpals Complete	Unsided Metacarpals Present	Unsided Metacarpals Complete
CO-40-1					
CO-40-1A					
CO-40-1AB	1	1	1		
CO-40-1D					
CO-40-1E					
CO-40-2	4	4	4		
CO-40-3					
CO-40-3-1	2	2	2		
CO-40-4	1	3	3	1	1
CO-40-5	4	3	3	0	0
CO-40-6A		1	0	4	0
CO-40-6C					
CO-40-13	2	1	0	2	0
CO-40-15A					
CO-40-15B					
CO-40-15C					
CO-40-15D					
CO-40-15E					
CO-40-16A					
CO-40-16B					
CO-40-16C	3				
CO-40-16D					
CO-40-16E					
CO-40-17					
CO-40-18A					
CO-40-18B	4	3	3		
CO-40-19A	4	2	2	3	0
CO-40-19B					
CO-40-19E		1	1		
CO-40-19F					
CO-40-19H					
CO-40-19I					
CO-40-19M					
CO-40-19P		1	1		
CO-40-19R					
CO-40-20A					
CO-40-21	2	4	4		
CO-40-22A	2	4	4	2	2
CO-40-22B juven					
CO-40-22B adult					
CO-40-22C					
CO-40-22D				1	1

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Metacarpals Complete	R Metacarpals Present	R Metacarpals Complete	Unsided Metacarpals Present	Unsided Metacarpals Complete
CO-40-23A					
CO-40-23B					
CO-40-25					
CO-40-25-1					
CO-40-26					
CO-40-27	5	5	5		
CO-40-29A					
CO-40-29B					
CO-40-31A	5	4	4		
CO-40-31B				1	1
CO-40-31B1					
CO-40-31C	3	2	2	2	2
CO-40-31-1C					
CO-40-31D					
CO-40-31D1					
CO-40-31E					
CO-40-31F	2				
CO-40-31G	4			1	1
CO-40-31H					
CO-40-31I					
CO-40-32A	3			1	1
CO-40-32B					
CO-40-68C/infant					
CO-40-68C/3yo					
CO-40-68E/child6yo				2	2
CO-40-68E/adult	2	3	3	1	0
CO-40-68W/9yo					
CO-40-69/infant					
CO-40-77		4	4	1	0
CO-40-79					
CO-40-79b69	3	3	3	2	9
CO-40-82b					

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Phalanges (Hand) Present	L Phalanges (Hand) Complete	R Phalanges (Hand) Present	R Phalanges (Hand) Complete	Unsided Phalanges (Hand) Present
CO-40-1					
CO-40-1A					
CO-40-1AB					1
CO-40-1D					
CO-40-1E					
CO-40-2	1	1	1	1	10
CO-40-3					1
CO-40-3-1					
CO-40-4					6
CO-40-5					12
CO-40-6A					5
CO-40-6C					
CO-40-13	6	5	7	7	
CO-40-15A					
CO-40-15B					
CO-40-15C					
CO-40-15D					
CO-40-15E					
CO-40-16A					
CO-40-16B					
CO-40-16C					9
CO-40-16D					
CO-40-16E					
CO-40-17					5
CO-40-18A					
CO-40-18B	2	2	2	2	9
CO-40-19A					10
CO-40-19B					
CO-40-19E					
CO-40-19F					
CO-40-19H					
CO-40-19I					
CO-40-19M					
CO-40-19P					
CO-40-19R					
CO-40-20A					
CO-40-21			10	10	1
CO-40-22A					11
CO-40-22B juven					
CO-40-22B adult					
CO-40-22C					2
CO-40-22D					

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	L Phalanges (Hand) Present	L Phalanges (Hand) Complete	R Phalanges (Hand) Present	R Phalanges (Hand) Complete	Unsided Phalanges (Hand) Present
CO-40-23A					
CO-40-23B					
CO-40-25					
CO-40-25-1					
CO-40-26					
CO-40-27	6	6	6	6	
CO-40-29A					
CO-40-29B					
CO-40-31A	6	6	9	9	
CO-40-31B					
CO-40-31B1					
CO-40-31C					11
CO-40-31-1C					
CO-40-31D					
CO-40-31D1					
CO-40-31E					
CO-40-31F					5
CO-40-31G	3	3			
CO-40-31H					
CO-40-31I					
CO-40-32A	1	1	1	1	8
CO-40-32B					
CO-40-68C/infant					
CO-40-68C/3yo					
CO-40-68E/child6yo					
CO-40-68E/adult					8
CO-40-68W/9yo					
CO-40-69/infant					
CO-40-77					15
CO-40-79					
CO-40-79b69					5
CO-40-82b					

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Unsided Phalanges (Hand) Complete	L Tarsals Present	L Tarsals Complete	R Tarsals Present	R Tarsals Complete	Unsided Tarsals Present
CO-40-1		1	1	0	0	
CO-40-1A						
CO-40-1AB	1					1
CO-40-1D						
CO-40-1E				1	1	
CO-40-2	10					
CO-40-3	1	1	1	1	1	1
CO-40-3-1						
CO-40-4	6	1	1	1	1	0
CO-40-5	11					
CO-40-6A	5					
CO-40-6C						
CO-40-13		7	7	7	7	
CO-40-15A		1	0			
CO-40-15B						
CO-40-15C						
CO-40-15D						
CO-40-15E						
CO-40-16A						
CO-40-16B						
CO-40-16C	9					
CO-40-16D						
CO-40-16E						
CO-40-17	5					
CO-40-18A				1	0	
CO-40-18B	9	4	4	5	5	
CO-40-19A	10	2	2	2	1	
CO-40-19B						
CO-40-19E						
CO-40-19F						
CO-40-19H						
CO-40-19I						
CO-40-19M						
CO-40-19P						
CO-40-19R						
CO-40-20A						
CO-40-21	1					
CO-40-22A	10	5	5	5	5	
CO-40-22B juven						
CO-40-22B adult						
CO-40-22C	2					
CO-40-22D						

Inventory Recording Form for Complete Skeletons (Attachment 1)

Accession Number	Unsided Phalanges (Hand) Complete	L Tarsals Present	L Tarsals Complete	R Tarsals Present	R Tarsals Complete	Unsided Tarsals Present
CO-40-23A		1	1			
CO-40-23B						
CO-40-25		3	3	2	2	
CO-40-25-1						
CO-40-26		3	3	5	5	
CO-40-27		2	2	2	2	
CO-40-29A						
CO-40-29B						1
CO-40-31A		3	3	4	4	
CO-40-31B						
CO-40-31B1						
CO-40-31C	11	4	4	4	4	
CO-40-31-1C				1	1	1
CO-40-31D						
CO-40-31D1						3
CO-40-31E						
CO-40-31F	5					
CO-40-31G		2	2	2	1	1
CO-40-31H						
CO-40-31I						
CO-40-32A	8					
CO-40-32B						
CO-40-68C/infant						
CO-40-68C/3yo						
CO-40-68E/child6yo						
CO-40-68E/adult	8	5	4	3	3	
CO-40-68W/9yo						
CO-40-69/infant						
CO-40-77	14			1	1	1
CO-40-79				1	1	
CO-40-79b69	4	5	5	3	3	1
CO-40-82b						

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Unsided Tarsals Complete	L Metatarsals Present	L Metatarsals Complete	R Metatarsals Present	R Metatarsals Complete	Unsided Metatarsals Present
CO-40-1		3	3	3	3	
CO-40-1A						
CO-40-1AB	0	2	2	2	2	
CO-40-1D						
CO-40-1E						
CO-40-2		3	3	3	3	
CO-40-3	1	3	3	2	2	1
CO-40-3-1						
CO-40-4	0	5	5	5	5	0
CO-40-5						
CO-40-6A						
CO-40-6C						1
CO-40-13		5	5	5	4	
CO-40-15A						
CO-40-15B						
CO-40-15C						
CO-40-15D						
CO-40-15E						
CO-40-16A						
CO-40-16B						
CO-40-16C		4	4	3	3	
CO-40-16D						
CO-40-16E						
CO-40-17						
CO-40-18A		2	2	3	3	
CO-40-18B		2	2	3	3	
CO-40-19A		5	5	5	4	
CO-40-19B						
CO-40-19E						
CO-40-19F						
CO-40-19H						
CO-40-19I						
CO-40-19M						
CO-40-19P						
CO-40-19R						
CO-40-20A						
CO-40-21						4
CO-40-22A		5	5	5	5	
CO-40-22B juven						
CO-40-22B adult						
CO-40-22C		1	1	2	2	
CO-40-22D						

Inventory Recording Form for Complete Skeletons (At   tachment 1)

Accession Number	Unsided Tarsals Complete	L Metatarsals Present	L Metatarsals Complete	R Metatarsals Present	R Metatarsals Complete	Unsided Metatarsals Present
CO-40-23A		1	1			
CO-40-23B						
CO-40-25		3	2	3	2	
CO-40-25-1						
CO-40-26		2	2			
CO-40-27		5	5	5	5	
CO-40-29A						1
CO-40-29B	1					
CO-40-31A		5	5	5	5	
CO-40-31B						1
CO-40-31B1						
CO-40-31C		5	5	3	3	
CO-40-31-1C	1			1	1	2
CO-40-31D						
CO-40-31D1	0					
CO-40-31E						
CO-40-31F						
CO-40-31G	1	4	4	2	2	
CO-40-31H						
CO-40-31I						
CO-40-32A						
CO-40-32B						
CO-40-68C/infant						
CO-40-68C/3yo						
CO-40-68E/child6yo						
CO-40-68E/adult	3 frgs	4	1	4	1	
CO-40-68W/9yo						
CO-40-69/infant						
CO-40-77	0			2	1	1
CO-40-79						
CO-40-79b69	0	5	4	4	3	0
CO-40-82b						

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Unsided Metatarsals Complete	L Phalanges (Foot) Present	L Phalanges (Foot) Complete	R Phalanges (Foot) Present	R Phalanges (Foot) Complete
CO-40-1		1	1	1	1
CO-40-1A					
CO-40-1AB					
CO-40-1D					
CO-40-1E					
CO-40-2					
CO-40-3	1				
CO-40-3-1					
CO-40-4	0				
CO-40-5					
CO-40-6A					
CO-40-6C	0				
CO-40-13		9	9	6	6
CO-40-15A					
CO-40-15B					
CO-40-15C					
CO-40-15D					
CO-40-15E					
CO-40-16A					
CO-40-16B					
CO-40-16C					
CO-40-16D					
CO-40-16E					
CO-40-17					
CO-40-18A					
CO-40-18B					
CO-40-19A					
CO-40-19B					
CO-40-19E					
CO-40-19F					
CO-40-19H					
CO-40-19I					
CO-40-19M					
CO-40-19P					
CO-40-19R					
CO-40-20A					
CO-40-21	4				
CO-40-22A					
CO-40-22B juven					
CO-40-22B adult					
CO-40-22C					
CO-40-22D					

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Unsided Metatarsals Complete	L Phalanges (Foot) Present	L Phalanges (Foot) Complete	R Phalanges (Foot) Present	R Phalanges (Foot) Complete
CO-40-23A					
CO-40-23B					
CO-40-25		1	1		
CO-40-25-1					
CO-40-26					
CO-40-27		5	5	2	2
CO-40-29A	0				
CO-40-29B					
CO-40-31A		5	5	7	7
CO-40-31B	1				
CO-40-31B1					
CO-40-31C					
CO-40-31-1C	0				
CO-40-31D					
CO-40-31D1					
CO-40-31E					
CO-40-31F					
CO-40-31G					
CO-40-31H					
CO-40-31I					
CO-40-32A					
CO-40-32B					
CO-40-68C/infant					
CO-40-68C/3yo					
CO-40-68E/child6yo					
CO-40-68E/adult	10 frgs	1	1	1	1
CO-40-68W/9yo					
CO-40-69/infant					
CO-40-77	0				
CO-40-79					
CO-40-79b69	0				
CO-40-82b					

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Unsided Phalanges (Foot) Present	Unsided Phalanges (Foot) Complete
CO-40-1		
CO-40-1A		
CO-40-1AB		
CO-40-1D		
CO-40-1E		
CO-40-2		
CO-40-3		
CO-40-3-1		
CO-40-4	2	2
CO-40-5		
CO-40-6A		
CO-40-6C	1	0
CO-40-13		
CO-40-15A		
CO-40-15B		
CO-40-15C		
CO-40-15D		
CO-40-15E		
CO-40-16A		
CO-40-16B		
CO-40-16C		
CO-40-16D		
CO-40-16E		
CO-40-17		
CO-40-18A		
CO-40-18B	1	1
CO-40-19A	7	7
CO-40-19B		
CO-40-19E		
CO-40-19F		
CO-40-19H		
CO-40-19I		
CO-40-19M		
CO-40-19P		
CO-40-19R		
CO-40-20A		
CO-40-21		
CO-40-22A	7	7
CO-40-22B juven		
CO-40-22B adult		
CO-40-22C	1	0
CO-40-22D	1	1

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Unsided Phalanges (Foot) Present	Unsided Phalanges (Foot) Complete
CO-40-23A		
CO-40-23B		
CO-40-25		
CO-40-25-1		
CO-40-26		
CO-40-27		
CO-40-29A		
CO-40-29B	6	6
CO-40-31A	1	1
CO-40-31B		
CO-40-31B1		
CO-40-31C	9	9
CO-40-31-1C	2	1
CO-40-31D		
CO-40-31D1	2	2
CO-40-31E		
CO-40-31F	1	1
CO-40-31G	1	1
CO-40-31H		
CO-40-31I		
CO-40-32A		
CO-40-32B		
CO-40-68C/infant		
CO-40-68C/3yo		
CO-40-68E/child6yo		
CO-40-68E/adult	1	1
CO-40-68W/9yo		
CO-40-69/infant		
CO-40-77	14	14
CO-40-79		
CO-40-79b69	2	2
CO-40-82b		

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Comments
CO-40-1	Yellowed, flakey commingled remains. Possible 1C si nce that was never found from TX. Need to put foot bones from notes into sheet.
CO-40-1A	Possible L ulna DE frg, but PMD means I can't manua lly articula
CO-40-1AB	Lots of commingled elements - burial appears to con tain elements from a fetus, child, adult male (burial 1AB), and female.
CO-40-1D	
CO-40-1E	
CO-40-2	fibula unsided, labeling/recording side is arbitrar y. Humerus DE frg, unsided; 8 round spongy bone elements - probably a combo of carpals, tarsals. 2 unk MC or MT. 100+ misc frgs (mostly long bone/pelvis), 3 unk frgs
CO-40-3	
CO-40-3-1	morphology, with R curved. Different facets on righ t side + defect (bone lipping) suggest possible trauma to right side of spine. Ribs: 5 R r ibs, 4 L ribs. Suspect rest are comm with CO-40-3
CO-40-4	1MC, probably LMC5 (based on size), but no base & e roded
CO-40-5	3 unIDed possible carpals, 3 possible tarsals, but all PMD & designation based on size of fragments - can't ID which carpal/tarsal.
CO-40-6A	L/R radius, L/R ulna highly fragmented, hand phalan ges =prox, 1 unsided radius head, 1 M1/3 tibia shaft frg (no path). 1 calcaneus frg, un sided
CO-40-6C	phalanx is prox.
CO-40-13	overall, long bones have been squashed flat and the n fused together with concretions. Bag of 100+ small frgs - mostly long bone. At least 10 are DE tibia frgs, 1 sternal frg, 1 C4 articular facet, L articular facet, 10+ T na frgs
CO-40-15A	
CO-40-15B	1 unsided parital frg has large pores. Inner table is eroded. Only frg with pores. L radius M1/3 - 2 lesions. Lat and ant (on crest). Well heal ed about flat and pores (40x14). Lat=bump, no margins but sup portion PMD (30x13). S ome porosity. R=no path/arth
CO-40-15C	
CO-40-15D	
CO-40-15E	
CO-40-16A	L calc length: 24.75; R calc length: 25.39
CO-40-16B	no secondary epips present
CO-40-16C	Secondary epip present: L/R PE tibia, 1 PE hum, 1 R fem
CO-40-16D	no secondary epips present
CO-40-16E	fib siding is tentative
CO-40-17	
CO-40-18A	
CO-40-18B	
CO-40-19A	
CO-40-19B	secondary epiphs:R humerus, L/R femurs, L/R tibia DE, ulna DE, fibula PE/DE. 1 head MT/MC; 2 probable MT/MC shafts
CO-40-19E	
CO-40-19F	
CO-40-19H	
CO-40-19I	
CO-40-19M	no measure - PMD
CO-40-19P	RMT1, 1st prox; LMT1, occipital = pinprick porosity . Femur prox shaft expansion D1/3. Pinprick and healed woven bone. Medial (photos + X- ray) 1 frg long bone (poss tib with flakey perio and pin 14x36)
CO-40-19R	See forms for notes
CO-40-20A	
CO-40-21	
CO-40-22A	
CO-40-22B juven	
CO-40-22B adult	
CO-40-22C	1 talus frg, 1 unsided carpal - too generalized to
CO-40-22D	unsided MC5 frg, 1st tow phalanx frg

Inventory Recording Form for Complete Skeletons (At tachment 1)

Accession Number	Comments
CO-40-23A	
CO-40-23B	
CO-40-25	4 calcaueus frgs (MNI - 2, but can't determine if L /R from frgs). 2 MT heads (1 labeled L, 1 labeled R). Phalanx labeled L.
CO-40-25-1	
CO-40-26	(con;t from inv. 1) PMD near shows possible bone ex pansion? Pinprick porosity on and above nuchal crest. Coalescing as move superior, an d more healed/diffuse. Strange fossa in sphenooccipital syncondrosiss. Sinus? non-metric : hypoglossial canal L=2, R = incomplete bridging. Flaring of inferior ramus, pro nounced MSM bilaterally.
CO-40-27	
CO-40-29A	
CO-40-29B	1 unsided calcaneus (labeld R, so listed as R, but not enough present to definitivly side). 2 foot phalanges are middle.
CO-40-31A	
CO-40-31B	MC/MT have no heads (unfused), sorted based on shaf t roundness (MC) or thinness (MT). 1 hum PE (secondary) unsided, 1 humerus M1/3 (unsid ed)
CO-40-31B1	
CO-40-31C	Phalanges have written labels, see notes.
CO-40-31-1C	unsided calcaneus frg
CO-40-31D	
CO-40-31D1	
CO-40-31E	1 inferior portion calcaneus unsided.
CO-40-31F	
CO-40-31G	long bones look gracile, skull looks intermediary.
CO-40-31H	
CO-40-31I	fused on talus (16+). Can't find age est by sex of talus, but 344 Schuler shows scapula fusion at 18+. Consistent with scapula frg because lower border is last to fuse and is fused in 31I.
CO-40-32A	
CO-40-32B	
CO-40-68C/infant	1 unsided ulna shaft (M1/3-DE, no secondary epip), 1 humerus shaft frg (does not articulate w/ present), 1 fibula shaft with shell a dhesions, 1 unsided femur head
CO-40-68C/3yo	unsided secondary epips, unsided tibia M1/3 & DE, u nsided femur shaft & PE, unsided phalanges (can't tell if hand or foot, no secondary fused)
CO-40-68E/child6yo	1 humerus shaft (M1/3), 1 radius shaft, secondary P
CO-40-68E/adult	
CO-40-68W/9yo	DE femur frg (2), tibia DE, unsided fib frg, unfuse d uln
CO-40-69/infant	
CO-40-77	
CO-40-79	less than 25% complete. Mostly long bone frgs 100+. 1 unsided ulna shaft frg. 3 unsided tibia shaft frgs. 1 unsided medial tibia frg (PE=3, P1/3=3)
CO-40-79b69	
CO-40-82b	2 fibula frgs, 4 long bone shafts, 2 secondary PE, long bone frgs, 2 secondary DE

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Bone	Side	Segment	Complete-ness	MNI	Count	Age	Sex
CO-40-1	Temporal		petrous	1	1	1	child	
CO-40-1	Cranium					50	adult	
CO-40-1	Maxillary	L/R		1	1	1	adult	
CO-40-1	Mandible	L/R		1	1	1	adult	?
CO-40-1	Vault	L/R	Near bregma	1	1	2	adult	?
CO-40-1	Temporal	L/R	squamous/petrous	1	1	2	adult	M
CO-40-1	Humerus	U	shaft	3	1	1	Child	
CO-40-1	Fibula	R	D1/3+DE	3, 1	1	1	adult	U
CO-40-1AB	Cranium	U	vault	3	1	35	juvenile	
CO-40-1AB	Cranium	U				3	Fetus	
CO-40-1AB	occipital		basilar w/ synchondrosis	2	1	1		
CO-40-1AB	Scapula	L	body	2	1	2		
CO-40-1AB	Clavicle	U		2	1	1	adult	F
CO-40-1AB	Vertebrae		Cervical	2		1		
CO-40-1AB	Vertebrae		process	2	1	1		
CO-40-1AB	Vertebrae		Thoracic	2	1	4		
CO-40-1AB	Vertebrae		Lumbar	2	1	1		
CO-40-1AB	Vertebrae		neural arches	2	1	3		
CO-40-1AB	Rib		shaft	3	1	9		
CO-40-1AB	Ilium	R	auricular surface	1	1	1	35-50	F
CO-40-1AB	Sacrum		S1, ala, 3 frgs	2	1	5		
CO-40-1AB	Humerus	R	P1/3 - D1/3	1, 1, 1			Fetus	
CO-40-1AB	Femur	U	D1/3	2			Fetus	
CO-40-1AB	Long bone fragments	U				3	Child	
CO-40-1AB	Unk.							
CO-40-1D	Vertebrae	U		2	1	7	1yr	U
CO-40-1D	Femur	L	P1/3 - D1/3	1	1	1	1yr	U
CO-40-1D	Femur	R	P1/3 - D1/3	1	1	1	1yr	U
CO-40-1D	Femur	U	PE	1	1	2	child	U
CO-40-1D	Humerus	U	P1/3 - D1/3	1	1	1	1yr	
CO-40-1E	Dentition	L		1	1	3	adult	U
CO-40-3	Scapula	U	body	2	1	1	adult	U
CO-40-1D	Long bone fragments	U		3	1	1	U	U
CO-40-3-1	Tibia	L	shaft	2	1	2	adult	U

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Bone	Side	Segment	Complete-ness	MNI	Count	Age	Sex
CO-40-3-1	Humerus	L	shaft	2	1	2	adult	U
CO-40-4	Rib	U	Head	3	1	1	U	U
CO-40-4	Humerus	U	P1/3	3	1	2	U	U
CO-40-5	Ulna	U	DE	3	1	1	child	U
CO-40-6B	Cranium	U		3	1	5	child	U
CO-40-6B	Rib	U	shaft	3	1	4	U	U
CO-40-6B	Ulna	R	P1/3 - M1/3	2, 2	1	1	infant	U
CO-40-6B	Femur	U	P1/3	2	1	1	child	U
CO-40-6B	Long bone fragments	U		3	1	1	child	
CO-40-6B	Long bone fragments	U		3	1	5	adult	U
CO-40-6C	Cranium	U		3	1	4	adult	U
CO-40-18A	Metatarsal	L/R		1	2	4	adult	U
CO-40-18B	Radius	R	P1/3	2	1	1	adult	U
CO-40-18B	Clavicle	U	shaft	2	1	1	adult	U
CO-40-19F	occipital	U	pars basilaris	1	1	1	2yrs	U
CO-40-21	Dentition	L/R	max/mand	2	1	7	adult	U
CO-40-21	Maxillary	U	alveolar	3	1	2	adult	U
CO-40-22B	Frontal	L/R	squamous/orbit	2	1	5	juvenile	U
CO-40-22B	Parietal	U		2	1	4	U	U
CO-40-22B	Vertebrae	U	Lumbar	3	1	2	U	U
CO-40-22B	Rib	U	shaft	3	1	12	U	U
CO-40-22B	Ilium	U		3	1	2	U	U
CO-40-22B	Ischium	U		3	1	2	U	U
CO-40-22B	Unk.	U		3	1	30	U	U
CO-40-22	Scapula	R	body	3	1	1	U	U
CO-40-22	Vertebrae	U	Cervical	1	1	1	U	U
CO-40-22	Vertebrae	U	U	3	1	4	U	U
CO-40-22	Rib	U	shaft	3	1	3	U	U
CO-40-22	Ilium	U	U	3	1	4	U	U
CO-40-22	Acetabulum	U		3	1	1	U	U
CO-40-22	Femur	L	PE	2	1	1	adult	U
CO-40-22	Femur	R	PE	2	1	1	adult	U
CO-40-22	Talus	U	U	3	1	1	U	U
CO-40-22	Metatarsal	U	Head	3	1	3	U	U
CO-40-22	Carpals	L/R		1	1	8	U	U
CO-40-22	Metacarpals	U	base	3	1	6	U	U
CO-40-22	Phalanges	U	hand	1	1	5	U	U
CO-40-22	Phalanges	U	foot	1	1	6	U	U
CO-40-22	Long bone fragments	U		3	1	4	U	U
CO-40-22	Long bone fragments	U		3	1	24	U	U
CO-40-22	Unk.	U	U	3	1	2	U	U

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Bone	Side	Segment	Complete-ness	MNI	Count	Age	Sex
CO-40-23A	Tibia	U	M1/3	3	1	1	U	U
CO-40-23A	Fibula	U	shaft	3	1	2	U	U
CO-40-23A	Long bone fragments	U		3	1	8	U	U
CO-40-23	Femur	L	P1/3 - D1/3	1, 1, 2	3	3	U	U
CO-40-23	Femur	L	P1/3 - M1/3	2, 2	3	3	U	U
CO-40-23	Femur	L	P1/3, D1/3	3, 3	3	3	U	U
CO-40-23	Femur	U					U	U
CO-40-23	Long bone fragments	U		3	1	15	U	U
CO-40-25	Femur	R	P1/3	2	3	1	U	U
CO-40-25	Femur	R	P1/3 - D1/3	3, 1, 2	3	1	U	U
CO-40-25	Femur	R	P1/3	2	3	1	U	U
CO-40-28	Clavicle	R		2	1	1	U	U
CO-40-28	Os Coxae	L/R	ilium, ischium, acetabulum	1	1	6	adult	F
CO-40-28	Radius	R		2	1	1	U	U
CO-40-28	Ulna	L/R		2	1	2	U	U
CO-40-28	Femur	R	M1/3 - D1/3	2, 2	1	1	U	F
CO-40-28	Femur	R	D1/3 - DE	2, 2	1	2	U	F
CO-40-28	Fibula	L	shaft	2	1	1	U	F
CO-40-29A	Phalanx	U	hand	1	1	1	adult	U
CO-40-31-1C	Cranium	U	petrous	1	1	1	birth	U
CO-40-31-1C	Tibia	L	P1/3 - D1/3	2, 1, 2	2	3	adult	U
CO-40-31	Temporal	R		2	1	1	child	U
CO-40-31	MN1	L			1	1	child	U
CO-40-31	MN1	R			1	1	child	U
CO-40-31	Scapula	R	Glenoid fossa	1	1	1	U	U
CO-40-31	Ilium	L		3	1	1	U	U
CO-40-31	Ilium	R		3	1	1	U	U
CO-40-31	Vertebrae	U	Lumbar	3	1	1	U	U

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Bone	Side	Segment	Complete-ness	MNI	Count	Age	Sex
CO-40-31	Rib	U	shaft	3	1	2	U	U
CO-40-31	Humerus	L		2	1	1	child	U
CO-40-31	Humerus	R	D1/3	3	1	1	adult	U
CO-40-31	Ulna	L	M1/3	2	1	1	U	U
CO-40-31	Femur	L	D1/3	2	1	1	U	U
CO-40-31	Femur	L		3	1	3	U	U
CO-40-31	Femur	L	DE		1	1	17	F
CO-40-31	Femur	L/R		3	1	2	child	U
CO-40-31	Tibia	L	M1/3	2	1	1	U	U
CO-40-68C/3yo	Frontal	U	orbit	3	1	2	child	U
CO-40-68C/3yo	Temporal	U	petrous	1	1	2	child	U
CO-40-68C/3yo	Clavicle	U			2	2	U	U
CO-40-68C/3yo	Maxillary	L	dentition		1	1	0-5	U
CO-40-68C/3yo	Maxillary	L	dentition		1	1	0-5	U
CO-40-68C/3yo	Ischium	U		1	1	1	0yrs	U
CO-40-68C/3yo	Radius	U	PE	1	1	1	infant	U
CO-40-68C/3yo	Femur	U	PE	1	1	1	adult	U
CO-40-68C/3yo	Long bone fragments	U			1	2	infant	U
CO-40-68E/6yo	Rib	U	Head	3	1	2	adult	U
CO-40-68E/6yo	Ulna	U			1	1	infant	U
CO-40-68E/6yo	Long bone fragments	U			1	2	infant	U
CO-40-68W	Cranium	U	Temporal	3			5+	U
CO-40-68W	I1	R		1	1	1	child	U
CO-40-68W	Sphenoid	U		3	1	1	child	U
CO-40-68W	Vertebrae	U	neural arches	3	2	3	U	U
CO-40-68W	Vertebrae	C2		1	1	5	U	U
CO-40-68W	Rib	U	shaft	3	1	30	adult	U
CO-40-68W	Rib	U	shaft	3	1	8	infant	U
CO-40-68W	Tibia	U	DE	3	1	1	adult	U
CO-40-68W	Fibula	R	DE	1	1	1	adult	U
CO-40-68W	MT	U	Head	3	1	1	adult	U
CO-40-68W	MT2	R		1	1	1	adult	U
CO-40-68W	Long bone fragments	L/R	shaft	2	1	310	infant	U
CO-40-68W	Concretion							

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Bone	Side	Segment	Complete-ness	MNI	Count	Age	Sex
CO-40-69	Rib	U	shaft	3	2	50		U
CO-40-69	Femur	U	shaft	3	1	1	adult	U
CO-40-69	Ulna	U	M1/3	3	1	2	U	U

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Description
CO-40-1	fused, but small
CO-40-1	50+ skull frgs from CO-40 prov? Skull
CO-40-1	
CO-40-1	Gonial angle 90, square. Mental eminance – 3
CO-40-1	Flattening of parietals at bregma. 2 parietal foram en. 5 ossicles at lambda and 2 in sutures – symmetrical L/R near temporals. Occipital almost se ems to have a "bun" from being pushed ou much in cranial shaping. Nuchal = 1-2 (may be exagg erated from cranial shaping); Supraorbital margins: 3-4
CO-40-1	Mastoids L/R = 4-5
CO-40-1	Possible child humerus frg
CO-40-1	Unlike ulna and radii, normal thickness, so does no t appear to be associated with rest of CO-40-1. Possible trauma at MSM – small patch of periostits anterior to MSM with well healed margins, fine diffuse porosity and minimal discoloration. Slight raised bump in area.
CO-40-1AB	Cranial frgs very thin cortex.
CO-40-1AB	
CO-40-1AB	1 occipital frg (basilar with accessory condyle and synchondrosis)
CO-40-1AB	
CO-40-1AB	Sternal end fused
CO-40-1AB	centrum
CO-40-1AB	1 transverse thoracic process
CO-40-1AB	2 are transitional thoracic neural arches (probably 11 + 12); 3 neural arch frgs, 1 centrum (probable middle thoracic
CO-40-1AB	Probable L1 centrum + neural arch
CO-40-1AB	
CO-40-1AB	
CO-40-1AB	superior demiface has dense bone and depressed. Ape x has no activity. The inferior border has minimal buildup of dense bone. Coarse granularity b ut, very small area (possibly due more to P than face change). No billowing. Possible that the dense bone is from pathology; however, pre sacral frg is L ala, not R. Also, note that feature s for auricular surface and associated GSN =1=female
CO-40-1AB	
CO-40-1AB	metaphysis present, no secondary epiphysis: measure s about 54 mm with PMD to PE/DE = 32 weeks to birth. Taph = bone adhesions, D1/3 has rod ent gnaw.
CO-40-1AB	pressure lesion PMD + bone adhesions
CO-40-1AB	2 prob fib, 1 prob tib. 1 fibula (probably DE) with periostitis. Fib 2 (midshaft)=shaft expansion with side 1,2,3 = elongated pores and well incorporated bone matrix. 3 = pinprick + diffuse with hint of 4's margins. 4 = woven active bone (51.18x6.61) mar gins but mid = active. Prob 1 lesion in multiple stages. Prob tibia – well healed with diff use porosity. Some undulating bone, but no margins. Small (25x7) more active patch of scleroti c in middle of fragment.
CO-40-1AB	1 unknown frg (prob na frg)
CO-40-1D	unfused base/spinous processes
CO-40-1D	147mm length = 1 yo
CO-40-1D	149 mm = 1 yo
CO-40-1D	femur secondary proximal epiphysis and fragment of secondary proximal epiph
CO-40-1D	119 mm = 1 yo
CO-40-1E	LI2, LPM1, LPM2
CO-40-3	fragile, and porous looking– poss 3-1 based on othe r osteoporosis-looking bones, but have no documentation, so left as commingled.
CO-40-1D	
CO-40-3-1	

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Description
CO-40-3-1	
CO-40-4	Possible commingled rib. Probably head (PMD to area). Bone adhesions on surface with red coloration from taph. Poss related to commingled hu merus. Much larger than all other present rib frgs.
CO-40-4	intertuberosity groove. Color of frg is reddish wit h bone/shell adhesi
CO-40-5	unfused secondary epiphysis
CO-40-6B	
CO-40-6B	
CO-40-6B	
CO-40-6B	neck + P1/3, medial only. With remodeled lesion (17 .5 x 19) with healed woven without porosity. Unknown dx since small frg.
CO-40-6B	porosity and thin cortical bone of shaft
CO-40-6B	
CO-40-6C	Commingled dentition (roots only) and occipital frg (ac
CO-40-18A	2 sets of L/RMT 3 (1 set commingled, one belongs to
CO-40-18B	R radius P1/3 (mostly tuberosity)
CO-40-18B	Shaft. Much smaller than associated 18B clavicle. P ossible
CO-40-19F	Unfused. Measurements: 2: 17, 3: 23.66 = 2yrs, 3 mo
CO-40-21	Maxillary dentition worn to roots, but can ID mandi bular dentition: LPM1 (wear = 7), LC (wear = 6), LI2 (wear = 5), LI1 (wear = 7), RC (wear = 7), RPM? (wear = 7). No caries, shell/bone adhesions prevent dx of calculus.
CO-40-21	fragments only, associated with above commingled de ntition. Shell and bone concretions present.
CO-40-22B	L orbit has active CO (pinprick and larger porosity , no bone growth). Size suggests probable juvenile
CO-40-22B	imilar erosion/nodule taphonomy as 22A/E
CO-40-22B	2 lumbar neural arches
CO-40-22B	
CO-40-22B	
CO-40-22B	
CO-40-22B	30+ unsided microfrgs
CO-40-22	Eroded
CO-40-22	C7 centrum
CO-40-22	2 centrum frgs, 2 neural arch frgs
CO-40-22	
CO-40-22	
CO-40-22	
CO-40-22	Neck and greater trochanter
CO-40-22	Head concreted into acetabulum
CO-40-22	
CO-40-22	
CO-40-22	L/R scaphoid (lipping on articular surface); L luna te (lipping on articular surface); L triquatrate, R frg; 1 lesser multiangle frg; L/R hamate
CO-40-22	MC1 frg base, 5 probable MC shaft frgs
CO-40-22	2 distal, 2 middle, 1 prox
CO-40-22	2 1st distal toe, 4 prox toe.
CO-40-22	4 shafts, eroded, probable fibula.
CO-40-22	
CO-40-22	2 unknown: 1 = bone/shell fusion; 1 = robust bone " spike) – large spinous process? Coracoid human?

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Description
CO-40-23A	1 tibia frg shaft (M1/3). IDed base on posterior cr est/flat part with curve. Morphology of lamellar bone is consistent with a healed lesion. There is a raised bump in the shaft with will incorporated bone matrix surrounding. Whole area covered in diff use pinprick porosity. No woven or sclerotic present. The dark staining and the robust size are not consistent with 23A (despite writing on bone of CO-40-23A).
CO-40-23A	One fragment has CO-40-SK2 written on it. May have had more, but lost to PMD; second is a twice the size of present fib frgs for CO-40-23A. C annot articulate with any present piece.
CO-40-23A	3 are really eroded and dark taphonomic coloration. Maybe associated with commingled tibia shaft frg?
CO-40-23	L femur shafts: P1/3 (1) M1/3 (1) D1/3 (2). Glut li ne = 2. morphology of MSM is odd—sclerotic looking with pinprick porosity. Possible woven bone on lateral aspect of midshaft. No discernable difference in morphology of shaft or bone, but area of elongated pores, following long axis of bone.(Each femur listed separately)
CO-40-23	L femur: P1/3(2) M1/3(2). PMD to inferior glut line , but superior glut may have some necrosing pit (4) however, since surrounded by PMD, scored as 2 (no ridge, so can't be 3). Clean perpendicular cut at M1/3, sampled? Check Norr.
CO-40-23	L femur: found 3 frgs (1 P1/3, 2 D1/3) D1/3 frgs OK , P1/3 has poss sclerotic bone formation inferior to neck of femur (11x20 mm). Medial edges well incorporated, lateral still spiculed.
CO-40-23	Poss femur frg (shaft, no landmarks). Based on shap e and perpendicular cut, may mat second femur (with transverse cut), but not enough of frag to manually articulate.
CO-40-23	
CO-40-25	Sided with glut: originally labeled as L. Glut = 1. (femurs listed sepa
CO-40-25	Overlapping glut areas with femur (1). Glut = 1. Po sterior midshaft on linea aspera - rodent gnawing
CO-40-25	1 femur head – R with frg of lesser trochanter (MSM
CO-40-28	Acromial end only. Trapeziud and conoid =1. Acromia l articulation is flattened in morphology and has indication of possible eburnation. Not sure if M or F, sorted commingled.
CO-40-28	Lighter in color than the male in 28, more gracile with GSN = 5 – very wide. 1 = F, ilium R/L = 1, ischium R/L = 1. no pubes present. Acetabulum =2, a uricular L/R = 2. L/R acetabulum have slight erosion and faint porosity on superior posterior ri m of acetabulum ~ 20 mm long.
CO-40-28	R radius could belong to either juvenile or female
CO-40-28	L/R ulna could belong to either juvenile or female
CO-40-28	Very rounded shaft with slight linea aspera. Sorted wi
CO-40-28	DE=2 frgs (manually articulates). Possible woven bo ne on anterior crest (17 x 7) some active bo on lateral posterior side, but near fibular articul ation. - Female, gracile
CO-40-28	Much smaller than fibula assoc with 28, with more r ound shaft. Less crest, rounded angle – F because smaller.
CO-40-29A	middle hand phalanx
CO-40-31-1C	Size suggests child (possibly around birth)
CO-40-31-1C	Periostitis with bone expansion
CO-40-31	Pinprick porosity superior to external auditory mea tus. No sure of age, so may be growth.
CO-40-31	out of occlusion, PMD to roots, but at least R1/2 i n development, wear = 4 (none on lingual c b groove pit, no abscess, no calc. Measurements:11. 80; 9.67; 8.31; Appear to match each other. Child is 6-12 yo, no wear on where M2s would articu late
CO-40-31	out of occlusion, PMD to roots, but at least R1/4 i n development, wear = 4 (none on lingual c b groove pit, no abscess, no calc. measurements: 12 .20; 10.21; 7.76; Appear to match each o Child is 6-12 yo, no wear on where M2s would articu late
CO-40-31	glenoid fossa rim complete, spine/coracoid/acromion PMD.
CO-40-31	GSN with superior apex of auricular surface, but PM
CO-40-31	R ilum – anterior inferior iliac spine (3) + some b
CO-40-31	L1 na frgs – PMD to L superior articulation, R appe ars to be fused PMD to

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Description
CO-40-31	1 rib (2 frgs): no path/arth
CO-40-31	Oriented based on nutrient foramen – cortical bone eroded (especially superior 1/3 and media aspect.
CO-40-31	R humerus D1/3 (3) – adult size
CO-40-31	shaft expantion M1/3 near superior PM break. Well remodeled, no margins, only indication – irregular morphology and posterior aspect has faint undulating bone with diffuse healed porosity. Supinator = .5
CO-40-31	shaft expansion/perio. Desc on commingled form.
CO-40-31	3 L femur frgs: 2 shaft frgs can be articulated, head frg can't with present frgs. Glut = 1; labeled 1C, size, if adult, suggests female. No path/arth
CO-40-31	rodent gnawing. Posterior DE fused, size suggests F .
CO-40-31	L/R femur shafts – eroded cortical (especially inferior) with longitudinal weathering cracks and PMD. Size suggests child (9ish)
CO-40-31	M1/3 shaft (2): shaft expansion. Sided L based on crest leaning laterally. Desc on commingled form.
CO-40-68C/3yo	2 orbit, small = infant?
CO-40-68C/3yo	2 petrus fused to squamous. Stage C tubercles, not connected – 5-11 mo
CO-40-68C/3yo	2 clavicles bagged together. I find it unlikely that they belong to the same individual, since 1 clavicle is almost twice the size of the other. (acromion process width: 17.7 v 11.24)
CO-40-68C/3yo	1 max Lm2—CR3/4 = 6-9mo
CO-40-68C/3yo	1 max Li1 R1/4, no facets, unerupted. Birth +/- 2 mo – 6 mo +/- 2 mo
CO-40-68C/3yo	length: 9.89 = 28 weeks prenatal*
CO-40-68C/3yo	1 radius PE (no secondary fusion)-size suggests infant
CO-40-68C/3yo	1 adult femur head (fused)
CO-40-68C/3yo	
CO-40-68E/6yo	2 rib heads, adult (25+ head tubercle fused)
CO-40-68E/6yo	1 ulna shaft, small, probable infant.
CO-40-68E/6yo	2 bone shafts—unID—possible infant (small)
CO-40-68W	Temporal frg: mastoid forming (5+)
CO-40-68W	root broken, 1, no calc, caries, LEH. M9.05, B5.71, C11.21 (poss another child? Goes with tibia shafts? 9-10ish?), double shovel. Checked the teeth (not listed, see above note), does not match with RI, so probably another kid.
CO-40-68W	Sphenoid: Spheno-occipital synchondrosis frg, but synchon is open. Age <
CO-40-68W	3 na frgs, 1 unfused (1 infant, 2 ?)
CO-40-68W	C2 w/ dens and centrum. (1 cent (?)unfused, 1 na unfused concreted to bone), 3 na frgs
CO-40-68W	
CO-40-68W	
CO-40-68W	
CO-40-68W	
CO-40-68W	
CO-40-68W	
CO-40-68W	L and R ulna, humerus shaft (unsided), unsided radius shaft
CO-40-68W	Cranial, T cent + T na 1 rib, 1 infant long bone shaft, nonhuman (shell, long bone). Cranial sinuses – I think sphenoid and some maxilla, but bone fusion with shell makes hard to tell.

Inventory Recording Form for Commingled Remains and Isolated Bones (Attachment 2)

Accession number	Description
CO-40-69	Rib frgs, but 2 sizes, suggesting older child and i r
CO-40-69	1 femur (frg, unside)
CO-40-69	2 probable ulna shafts (M1/3)

* measurements based on Schiller et al. 2009

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	L Ventral Arc	R Ventral Arc	L Subpupic Concavity	R Subpupic Concavity	L Ischiopubic Ramus Ridge	R Ischiopubic Ramus Ridge	L Greater Sciatic Notch
CO-40-1							1
CO-40-1A							
CO-40-1AB							
CO-40-1B							
CO-40-1E							5
CO-40-3							5
CO-40-3-1							1
CO-40-4							1
CO-40-5							3
CO-40-6A							1
CO-40-6B							
CO-40-13	3	3	3	3	2	2	4
CO-40-15A							2
CO-40-15B							
CO-40-15C							
CO-40-15D							
CO-40-15E							
CO-40-17							
CO-40-18A							
CO-40-18B							2
CO-40-19A							
CO-40-19B							1
CO-40-19M							1

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	L Ventral Arc	R Ventral Arc	L Subpupic Concavity	R Subpupic Concavity	L Ischiopubic Ramus Ridge	R Ischiopubic Ramus Ridge	L Greater Sciatic Notch
CO-40-19P							4
CO-40-19R							
CO-40-20A						1	1
CO-40-21							4
CO-40-22A							
CO-40-22B adult							
CO-40-22D							5
CO-40-22E							
CO-40-23A							2
CO-40-24							
CO-40-25				1		1	3
CO-40-26	3	3			3		4
CO-40-27							2-3
CO-40-30							
CO-40-31A							4
CO-40-31C							
CO-40-31-1C							2
CO-40-31E							4
CO-40-31F							
CO-40-31G							

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	L Ventral Arc	R Ventral Arc	L Subpupic Concavity	R Subpupic Concavity	L Ischiopubic Ramus Ridge	R Ischiopubic Ramus Ridge	L Greater Sciatic Notch
CO-40-32A							5
CO-40-68E/adult			1				
CO-40-68W/adult							
CO-40-69/adult							
CO-40-77							4
CO-40-79							
CO-40-79b69							5
CO-40-Prov?Skull							

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	R Greater Sciatic Notch	L Preauricular Sulcus	R Preauricular Sulcus	Estimated Sex, Pelvis	Nuchal Crest	L Mastoid Process	R Mastoid Process
CO-40-1				F			
CO-40-1A					2	3	5
CO-40-1AB	4			M?			5
CO-40-1B					2	3	3
CO-40-1E	5		0	M	4	5	4
CO-40-3				M	5	5	5
CO-40-3-1	1		1	F	1		1
CO-40-4	1			F		1	1
CO-40-5				?		3-4	3-4
CO-40-6A	1			F	1		1
CO-40-6B					5	5	5
CO-40-13	4			M	3	3	3
CO-40-15A	2			F?	1	2	2
CO-40-15B						5	
CO-40-15C						4	5
CO-40-15D							
CO-40-15E	1		1	F			2
CO-40-17					5	4	
CO-40-18A					4		
CO-40-18B	2		1	F	1	1	1
CO-40-19A	1			F	1		
CO-40-19B							
CO-40-19M	1			F			2

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	R Greater Sciatic Notch	L Preauricular Sulcus	R Preauricular Sulcus	Estimated Sex, Pelvis	Nuchal Crest	L Mastoid Process	R Mastoid Process
CO-40-19P	4			M?	4	5	5
CO-40-19R				M	4	4	4
CO-40-20A	1	3	3	F	1	2	2
CO-40-21	4	trace		M?			
CO-40-22A							
CO-40-22B adult	2			F?			
CO-40-22D	4-5		4ish	M		4	4
CO-40-22E					4	5	5
CO-40-23A				F?			2-3
CO-40-24						5	5
CO-40-25				F			
CO-40-26	4	4	4	M?	5	5	
CO-40-27	2-3			?			
CO-40-30					4	4	5
CO-40-31A	4			M?			5
CO-40-31C						4	4
CO-40-31-1C				M?	4	5	5
CO-40-31E				M?		3	4
CO-40-31F					1	2	2
CO-40-31G						3	3

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	R Greater Sciatic Notch	L Preauricular Sulcus	R Preauricular Sulcus	Estimated Sex, Pelvis	Nuchal Crest	L Mastoid Process	R Mastoid Process
CO-40-32A				M	4+	4+	5
CO-40-68E/adult				F			
CO-40-68W/adult						4	3
CO-40-69/adult							
CO-40-77				M?		4	
CO-40-79							
CO-40-79b69	5			M			5
CO-40-Prov?Skull					1-2	4-5	4-5

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	L Supraorbital Margin	R Supraorbital Margin	L Glabella	R Glabella	Mental Eminence	Estimated Sex, Skull	Estimated Sex
CO-40-1							F
CO-40-1A	5	5	4	4	?	?	?
CO-40-1AB					4	M?	M?
CO-40-1B	2				2	F?	F?
CO-40-1E		4	3	3	3	M?	M
CO-40-3	5	5	5	5		M	M
CO-40-3-1					3	F	F
CO-40-4	3	2	2-3		2	F?	F
CO-40-5	5				5	M	M?
CO-40-6A						F	F
CO-40-6B		5			5	M	M
CO-40-13	5	5			3	M?	M
CO-40-15A						F?	F?
CO-40-15B	5	5	5	5	3	M	M
CO-40-15C	3		5	5		M	M
CO-40-15D	5	5	5	5	5	M	M
CO-40-15E		1-2					F
CO-40-17	4	4	5	5	4	M	M
CO-40-18A			5	5	5	M	M
CO-40-18B	1	1	1	1	3	F	F
CO-40-19A					2	F	F
CO-40-19B							
CO-40-19M					2	F?	F?

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	L Supraorbital Margin	R Supraorbital Margin	L Glabella	R Glabella	Mental Eminence	Estimated Sex, Skull	Estimated Sex
CO-40-19P						M	M
CO-40-19R					5	M?	M
CO-40-20A	3	3	3	3	4	?	F?
CO-40-21	5	5			M	M?	M?
CO-40-22A	5	5	4			M	M
CO-40-22B adult							F?
CO-40-22D		4	3+	3+	5	M?	M
CO-40-22E						M?	M?
CO-40-23A		3		3		F?	F?
CO-40-24					5	M	M
CO-40-25					3	F?	F
CO-40-26	5	5	5	5	4-5	M	M
CO-40-27	5				5	M	M?
CO-40-30	5		3	3	5	M?	M?
CO-40-31A		5			4	M?	M?
CO-40-31C	5	5			5	M	M
CO-40-31-1C					4	M?	M?
CO-40-31E	3	3	3	3	4	?	M?
CO-40-31F	3	3	2	2	3	F?	F
CO-40-31G	4	4			3	?	?

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	L Supraorbital Margin	R Supraorbital Margin	L Glabella	R Glabella	Mental Eminence	Estimated Sex, Skull	Estimated Sex
CO-40-32A	5	5	5	5	5	M	M
CO-40-68E/adult						-	F?
CO-40-68W/adult	4					M?	M?
CO-40-69/adult					4	M	M
CO-40-77	5	5	5	5	4	M	M
CO-40-79					4+	M?	M?
CO-40-79b69	5				5	M	M
CO-40-Prov?Skull	3-4	3-4			3	M?	M?

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Comments for Sex	L Todd	R Todd	L Suchey Brooks
CO-40-1	only have GSN			
CO-40-1A	R mastoid looks strange. Seems to have a dimple whe normally comes to a point. Possible bone growth pos terior – looks like small nodule with overhang over mastoid groove sure if pathological, but not normal mastoid morpho logy.			
CO-40-1AB	mastoid is wide, but not long. Gonial angle = 90, w ide/square jaw. Initial pelvis with individual was F, reassoci ated correct pelvis			
CO-40-1B	Cerro Mangote skulls tend to have more robust masto ids ignored.			
CO-40-1E	narrow gsn. Mastoid: long and wide. L is wider. Ind eterm square-ness, angle is 90.			
CO-40-3				
CO-40-3-1	R preaur sulcus wide and deep. Bones porous and lig ht (osteoporosis?)			
CO-40-4	V shaped with obtuse gonial angle, but angle may be compromised due to antemortem loss of M3			
CO-40-5	gonial =90, mandible =square			
CO-40-6A	almost no nuchal, R mastoid is only half present PM			
CO-40-6B	on record sheet, L supraorbital marked as 5, but ca n't crossed off. Check			
CO-40-13	Ischio=wide/flat, but pinched in directly under sym . Fa Narrow subpubic. Narrow GSN, but frgs (maybe 5, but conservative =4).gonial =90, square jaw, but antemo rtem tooth loss. Mastoids long and narrow-ish			3
CO-40-15A				
CO-40-15B	gonial angle is 90, shape irrelevant (dentition)			
CO-40-15C	gonial angle is obtuse-ish, but dentition is resorb ing/PM lo Molars appear PM loss, but RM3 congenitally missing - may explain angle.			
CO-40-15D	gonial angle = 90 degrees			
CO-40-15E				
CO-40-17	gonial PMD, chin is wide/square-ish, but resorbtion of dentit has affected.			
CO-40-18A	Square chin, gonial angle PMD			
CO-40-18B	obtuse gonial angle, narrow chin.			
CO-40-19A				
CO-40-19B				
CO-40-19M	gonial angle = 90; chin = intermediate			

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Comments for Sex	L Todd	R Todd	L Suchey Brooks
CO-40-19P	L/R auricular surfaces have minimum billowing, grai ny appearance, no retroauricular activity, some transv erse organization, no apical activity			
CO-40-19R	ischiopubic ramus = broad (check score). Square jaw , goni 90	8-9		5
CO-40-20A	mastoids are long, but narrow. Rounded chin, gonial =90ish			
CO-40-21				
CO-40-22A				
CO-40-22B adult				
CO-40-22D	L Auricular surface has a depressed face to apex, s ome c granularity, but restricted to middle of face. No p orosity, no transverse organization. R: some apical activity. D ense bone, no organization. Dense bone and some rugged near ap ex.			
CO-40-22E				
CO-40-23A				
CO-40-24	gonial angle =90 ish (M2 lost, so some remodeling)			
CO-40-25	Mandible is V shaped. Mental eminance is pronounced but wide. Narrow ischiopubic ramus ridge. PMD, but appe ars concave. GSN has PMD, but frg present looks wide-is h. Scored as 3, but probably 2.		2-3	
CO-40-26	margins =round. Nucal extends 2 cm to ext occ crest mastiod broad, below ext. aud. meadus. Gonial angle = 90. m eminance square & raised. ventral arc =slight ridge . L ischo ridge =broad/flat. R=similar but PMD. Notch =narrow . Sulcus=narrow/trace	8-9	8-9	late 4-5
CO-40-27				
CO-40-30				
CO-40-31A				
CO-40-31C	gonial angle is 90, square jaw			
CO-40-31-1C	Chin intermediate, gonial angle is 90.			
CO-40-31E	since juvenile, going with M? (as other features ma indeterminate due to age); also, epip fusion makes more s using M ages.			
CO-40-31F	V-shaped with obtuse angle			
CO-40-31G	ME is palpable bump. L/R mastoids wide, but not lon g. G angle is intermediate, no glabella (PMD), nuchal pr esent, but PMD to area, so unscored.			

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Comments for Sex	L Todd	R Todd	L Suchey Brooks
CO-40-32A	PMD to 4+ areas, but M. Gonial angle is obtuse (see dentition loss), jaw square.			
CO-40-68E/adult	subpubic=concave/arching back. Some frgs of R. GSN, looks wide, but too frg to be sure. Coded F? based on sub pub & lack of markers	10		6
CO-40-68W/adult	unsided orbit inputted as L; wide and rounded, but small frg, so scored 4 (instead of 5), L mastoid present & complete, extends past ex. Aud. Mead. & is wide. R mastiod =frg, present portion extends past ex. Aud. Meat., cannot determine width.			
CO-40-69/adult	square chin, 90 degree gonial angle			
CO-40-77	all dentition resorbed or resorbing. Jaw appears square with more obtuse gonial angle, but due to resorbtion, not weighted in estimate.	8+		4+
CO-40-79				
CO-40-79b69	No dentition, but note in packet suggests removed postmo for analysis. Molars resorbing/resorbed, so gonial angle not weighted in estimate.			
CO-40-Prov?Skull	flattening at bregma and occipital bun			

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	R Suchey Brooks	L Auricular Surface	R Auricular Surface	Midlamb-doid	Lambda	Obelion	Anterior Sagittal	Bregma	Midcoronal
CO-40-1									
CO-40-1A									
CO-40-1AB			3-4						
CO-40-1B									
CO-40-1E		4-5	4-5						
CO-40-3		middle adult					2-3	1-2	1-2
CO-40-3-1			5-6	2-3					
CO-40-4			2-3						
CO-40-5		1-2	1-2						
CO-40-6A									
CO-40-6B				2			2	2-3	2-3
CO-40-13									
CO-40-15A		2-3	2-3						
CO-40-15B									
CO-40-15C									
CO-40-15D								0	0
CO-40-15E			6-7						
CO-40-17							2	2	2
CO-40-18A							1		
CO-40-18B		4-5	4-5						
CO-40-19A		2-3	2-3						
CO-40-19B									
CO-40-19M		3							

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	R Suchey Brooks	L Auricular Surface	R Auricular Surface	Midlamb-doid	Lambda	Obelion	Anterior Sagittal	Bregma	Midcoronal
CO-40-19P		2-3	2-3						
CO-40-19R									
CO-40-20A				2	3		3	2	pmd
CO-40-21	1	1							
CO-40-22A									
CO-40-22B adult									
CO-40-22D		7	7						
CO-40-22E									
CO-40-23A		2-3	2-3	1	1				
CO-40-24									
CO-40-25	1	1-2							
CO-40-26	late 4-5	5-6	5-6						
CO-40-27			5-6						
CO-40-30									
CO-40-31A		2-3	2-3						
CO-40-31C				1	1		2	3	3
CO-40-31-1C		2-3							
CO-40-31E									
CO-40-31F		4-5							
CO-40-31G									

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	R Suchey Brooks	L Auricular Surface	R Auricular Surface	Midlamb-doid	Lambda	Obelion	Anterior Sagittal	Bregma	Midcoronal
CO-40-32A		2-3	2-3						
CO-40-68E/adult		older	older						
CO-40-68W/adult									
CO-40-69/adult									
CO-40-77									
CO-40-79		5-6							
CO-40-79b69		3-4	3-4	1		2	3	3	2
CO-40-Prov?Skull									

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Pterion	Spheno-frontal	Inferior Spheno-temporal	Superior Spheno-temporal	Incisive	Anterior Median Palatine	Posterior Median Palatine	Transverse Palatine	Sagittal
CO-40-1									
CO-40-1A									
CO-40-1AB									
CO-40-1B									
CO-40-1E									
CO-40-3									
CO-40-3-1									
CO-40-4									
CO-40-5									
CO-40-6A									
CO-40-6B									
CO-40-13									
CO-40-15A									
CO-40-15B									
CO-40-15C									
CO-40-15D									
CO-40-15E									
CO-40-17									
CO-40-18A									2
CO-40-18B									
CO-40-19A									
CO-40-19B									
CO-40-19M									

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Pterion	Spheno-frontal	Inferior Spheno-temporal	Superior Spheno-temporal	Incisive	Anterior Median Palatine	Posterior Median Palatine	Transverse Palatine	Sagittal
CO-40-19P									
CO-40-19R									
CO-40-20A	pmd	pmd	pmd	pmd					
CO-40-21									
CO-40-22A									
CO-40-22B adult									
CO-40-22D									
CO-40-22E									
CO-40-23A									
CO-40-24									
CO-40-25									
CO-40-26									
CO-40-27									
CO-40-30									
CO-40-31A									
CO-40-31C									
CO-40-31-1C									
CO-40-31E									
CO-40-31F									
CO-40-31G									

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Pterion	Spheno-frontal	Inferior Spheno-temporal	Superior Spheno-temporal	Incisive	Anterior Median Palatine	Posterior Median Palatine	Transverse Palatine	Sagittal
CO-40-32A									
CO-40-68E/adult									
CO-40-68W/adult									
CO-40-69/adult									
CO-40-77									
CO-40-79									
CO-40-79b69									
CO-40-Prov?Skull									

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Left Lambdoid	Left Coronal	Estimated Age	Absolute Age
CO-40-1			50+	
CO-40-1A			20-35	
CO-40-1AB			20-35	
CO-40-1B			U	
CO-40-1E			35-50	
CO-40-3			35-50	
CO-40-3-1			50+	40-50+
CO-40-4			20-35	
CO-40-5			20-35	20-29
CO-40-6A			15-20	
CO-40-6B			35-50	
CO-40-13			35-50	
CO-40-15A			20-35	
CO-40-15B			35-50	
CO-40-15C			adult	
CO-40-15D		2	Unknown	
CO-40-15E			35-50	45-50+
CO-40-17			35-50	
CO-40-18A			20-35	
CO-40-18B			35-50	35-44
CO-40-19A			20-35	25-29
CO-40-19B				
CO-40-19M			20-35	30-34

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Left Lambdoid	Left Coronal	Estimated Age	Absolute Age
CO-40-19P			20-35	25-34
CO-40-19R			35-50	
CO-40-20A			20-35	
CO-40-21			15-20	17-22
CO-40-22A			U	
CO-40-22B adult			U	
CO-40-22D			50+	
CO-40-22E			35-50	
CO-40-23A			20-35	
CO-40-24			Adult	
CO-40-25			20-35	
CO-40-26			35-50	
CO-40-27			35-50	
CO-40-30			35-50	
CO-40-31A			20-35	
CO-40-31C	3		35-50	
CO-40-31-1C			20-35	
CO-40-31E			U	
CO-40-31F			35-50	
CO-40-31G			Adult	

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Left Lambdoid	Left Coronal	Estimated Age	Absolute Age
CO-40-32A			20-35	
CO-40-68E/adult			35-50+	
CO-40-68W/adult			20-35	
CO-40-69/adult				
CO-40-77			35-50	
CO-40-79			35-50	40-49
CO-40-79b69			35-50	
CO-40-Prov?Skull				

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Comments for Age
CO-40-1	notes in ntbk indicate older adult based on L aur, find desc.also, R clavicle sternal end fused.
CO-40-1A	present sutures (lambdoid and frontal mostly) look o ish.
CO-40-1AB	vertical PMD break through face and PMD to area. No apical activity, slight retroauricular activity, un iform granularity, coarse with faint billowing on inferio r demiface and some straie, but losing organization. 3-4. based on straie, probable 35 or less.
CO-40-1B	
CO-40-1E	
CO-40-3	Small frg of L aur: superior demi only, no billowin uniform granularity, no dense bone. Stage 4
CO-40-3-1	R aur: no transverse. Moderate retroaur, minimal ap Inferior looks pathological, some granularity and d ense bone
CO-40-4	
CO-40-5	aur stage determined from 3 present fragments as a whole (since so much PMD). No granularity or pores; slight billowing and furrows.
CO-40-6A	see bone union form
CO-40-6B	
CO-40-13	small frg of aur demiface - dense bone and granular ity with some/little organization. Probable middle adul t. L/R p.sym - see notes
CO-40-15A	
CO-40-15B	sutures are mostly obliterated, but given fragmenta tion, can't determine which sutures is where
CO-40-15C	
CO-40-15D	
CO-40-15E	
CO-40-17	
CO-40-18A	
CO-40-18B	open sutures, but lots of PMD to skull - so no sequences for age est.
CO-40-19A	R aur: some billowing w/ minimal transverse, fine granularity, superior demi apex and some retro (inf=eroded/PMD). No retro activity. L frg=billowin g (sup demi corner only) no retro
CO-40-19B	not sure why this one is here - check.
CO-40-19M	aur need scores. R aur - no retro, no apical. Fine w/transverse org present only patches present (PMD) <35. L aur = 3. still billowy on inferior demi near apex

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Comments for Age
CO-40-19P	L/R aur: min billowing, grainy, no retro, some transverse, no apical. Open sutures
CO-40-19R	Lps: tub formed. Vent rim erosion and craggily supe surface. Inf = flat-ish. No face depression.
CO-40-20A	S1-S2 fusing. Early fusion of cranial sutures? Poss to path/remodel
CO-40-21	L aur: most concretions, but no retro, billowing ve clear. R p sym - concretions, but very billowy. Sta ge 1 or less; see Bone Union.
CO-40-22A	See permenant dentition for age.
CO-40-22B adult	
CO-40-22D	seems to be duplicate 22D sex/age. Check.
CO-40-22E	Spheno-occipital synchon = PMD, suture frgs closing but not oblit
CO-40-23A	R mastiod extends past external auditory meatus, bu not particularly wide
CO-40-24	
CO-40-25	
CO-40-26	PMD @sutures. pub sym (s)=ligamentus w/ ventral fac progressing back to tubercle. No depression of face ventral face erosion, macro/micro porosity. Aur sur (s) =both PMD. Present portion=no straie, no porosity, mostly dense bone, minimal retro activity
CO-40-27	
CO-40-30	sutures are closed on the internal surface and have significant closure on external. Given fragmentatio n, can't score in tradiitonal manner w/ bone adhesions on internal surface.
CO-40-31A	R aur: sup and mostly apex. No apical, uniform coar se, min billows. L: sup with apec, but aur at apex and inf = PMD. No apical, more defined superior border, but coarse granularity without transverse org. min bill owing.
CO-40-31C	cranial sutures only, and only a few sutures presen
CO-40-31-1C	open to minimally closed sutures. L aur = 1 frg at with slight billowing. No apical, superior patches have initial granularity. Iliac crest, DE femur, ischial tub, ann rings all fused (21+)
CO-40-31E	Age based on bone union; see chart for age.
CO-40-31F	R: eroded; L moderate retro and dense bone with little/no transverse. Some trans org near apex. 1 p ore. Some border on interior demi and slight on superior demi
CO-40-31G	

Adult Age and Sex Recording Form (Attachment 11)

Accession Number	Comments for Age
CO-40-32A	sutures frgs =open-min. L aur: inf = gran. Sup+apic =slight billowing w/ increasing gran & no transverse; inf has min trans. No apical. Retro = PMD. Prob closer to 35. Not older than 35 b/c no apical. R aur: sup only=billows w/increase gran. Min retro
CO-40-68E/adult	clavicles fused ®. Probably old adult, but not enoug auricular surface & only 1 frg of ventral aspect of L psymp, so using 35-50+ to be safe. L aur=PMD, but areas present =dense bone.
CO-40-68W/adult	open sutures (at least present ones, mostly points on parietals), synchondrosis unfused
CO-40-69/adult	
CO-40-77	ligamentous outgrowth/tubercle beginning, but not complete (so prob not over 50). Too much shell adhesions to observe face.
CO-40-79	L aur sur: PMD. No billowing or transverse org. Surface cairly uniform w/ dense bone. No granularity or porosity.
CO-40-79b69	
CO-40-Prov?Skull	

Immature Measurements Recording Form (Attachment 13)

Accession Number	L Clavicle length	R Clavicle length	Ilium Length L	Ilium Width L	Ilium Length R	Ilium Width R	Ischium Length L	Ischium Width L	Ischium Length R	Ischium Width R
CO-40-2					58.84	65.12			37.21	20.26
CO-40-16A										
CO-40-16B			28.3	29.44						
CO-40-16C			78.8	34.84			51.37	34.84	50.54	32.94
CO-40-16D					51.95	50.25				
CO-40-16E		57.92								
CO-40-19F										
CO-40-22C										
CO-40-29A			84	89	82					
CO-40-29B										
CO-40-31B										
CO-40-68C/Infant	64.36									
CO-40-69/neonate										
CO-40-69/1yo										

Immature Measurements Recording Form (Attachment 13)

Accession Number	L Pubis length	R Pubis Length	Humerus Length L	Humerus Width L	Humerus Diameter L	Humerus Length R	Humerus Width R	Humerus Diameter R	Ulna Length L
CO-40-2									
CO-40-16A		27.31							
CO-40-16B									
CO-40-16C			169.89						43.95
CO-40-16D	37.48	38.41							
CO-40-16E									68.79
CO-40-19F									
CO-40-22C									
CO-40-29A			176						152.2
CO-40-29B		30.57							
CO-40-31B									
CO-40-68C/Infant									
CO-40-69/neonate									
CO-40-69/1yo									

Immature Measurements Recording Form (Attachment 13)

Accession Number	Ulna Diameter L	Ulna Length R	Ulna Diameter R	Radius Length L	Radius Diameter L	Radius Length R	Radius Diameter R	Femur Length L	L Femur Width
CO-40-2									
CO-40-16A		59.64							
CO-40-16B				52.5				76.04	6.11
CO-40-16C						132.43		234.39	
CO-40-16D		71.33							
CO-40-16E									
CO-40-19F									
CO-40-22C									
CO-40-29A								238	
CO-40-29B									
CO-40-31B									
CO-40-68C/Infant									
CO-40-69/neonate									
CO-40-69/1yo									

Immature Measurements Recording Form (Attachment 13)

Accession Number	Femur Diameter L	Femur Length R	Femur Width R	Femur Diameter R	Tibia Length L	Tibia Diameter L	Tibia Length R	Tibia Diameter R
CO-40-2								
CO-40-16A								
CO-40-16B		75.28	5.96				67.04	
CO-40-16C								
CO-40-16D		132.55	10.55 ML/9.9AP				114.9	
CO-40-16E								
CO-40-19F								
CO-40-22C								
CO-40-29A					203.5		206.9	
CO-40-29B								
CO-40-31B								
CO-40-68C/Infant								
CO-40-69/neonate								
CO-40-69/1yo								

Immature Measurements Recording Form (Attachment 13)

Accession Number	Comments
CO-40-2	P. 242 - 2-3 years (length should have a bit more - PMD to area)
CO-40-16A	R ulna w/ PMD DE, between birth - 1.5 (ulna length) . Calca resembles 3 mo in S/B p312 R pars lateralis 27.83 x 14.74 (w/PMD on lat aspect)
CO-40-16B	lengths=38-40 wks
CO-40-16C	
CO-40-16D	ages consistent with approx 1 yr. Ulna = PMD, so le ngth =6mo+
CO-40-16E	R humerus M1/3-DE =69.23 (1.5+); L ulna PMD to DE. Clavicle = mo; pars lateralis 38.74 x 20.96
CO-40-19F	L talus: 43.57mm long
CO-40-22C	calcaneus = 48.83 mm long
CO-40-29A	
CO-40-29B	L Talus: 32.87; calc (unsided): 45.67 x 23.52
CO-40-31B	unsided pars basilaris portion = 19.28 mm
CO-40-68C/Infant	Petrous portions measure 32.5 x 18.12 mm with PMD (40+ weeks). Pars basilaris measurements: 17.04 x 14.88 x 19.56 mm (consistent with 1yr, 1 mo)
CO-40-69/neonate	mandible: ramus length: 17.97 (38-40 prenatal)
CO-40-69/1yo	pars basilaris (unsided): MW: 20.37, BL: 15.84, ML: 20.19 (consistent with ages 1 - 1yr, 1mo); R ramus = 22.19, after 40 weeks

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM3 Presence	RM3 Develop-ment	RM3 Wear	RM3 Caries	RM3 Abscess	RM3 Calculus	RM3 Calculus Affected	RM2 Presence
CO-40-1								
CO-40-1A								7
CO-40-1AB								
CO-40-1B								
CO-40-1D								
CO-40-1E								
CO-40-2								
CO-40-3	5							2
CO-40-3-1								
CO-40-4	4							5
CO-40-5	1	PMD	5	2	0	0		1
CO-40-6A	1	9	4	0	0	0		1
CO-40-6B	5							5
CO-40-6C								1
CO-40-6D								
CO-40-13	5							2
CO-40-15A	PMD							5
CO-40-15B								
CO-40-15D								
CO-40-16C								2
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM3 Presence	RM3 Develop-ment	RM3 Wear	RM3 Caries	RM3 Abscess	RM3 Calculus	RM3 Calculus Affected	RM2 Presence
CO-40-17								
CO-40-18A								
CO-40-18B	2		12x	1	0	3	lingual crown	2
CO-40-19A								
CO-40-19B								1
CO-40-19E								
CO-40-19F								
CO-40-19H								1
CO-40-19I								1
CO-40-19M	5							1
CO-40-19R								
CO-40-20A	2		16	0	0	1	lingual/buccal @CEJ	5
CO-40-22A	PMD							1
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24	5							5
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM3 Presence	RM3 Develop-ment	RM3 Wear	RM3 Caries	RM3 Abscess	RM3 Calculus	RM3 Calculus Affected	RM2 Presence
CO-40-25-1								
CO-40-27	6							2
CO-40-29A								
CO-40-30	5							1
CO-40-31A	1	11	12	0	0	0		1
CO-40-31B								
CO-40-31C	1	14	15	3	0	1	distal at CEJ	1
CO-40-31-1C	1		12	0		0		
CO-40-31D1								
CO-40-31E	5							2
CO-40-31F	1		14	0	0	0		5
CO-40-31G	2		4	0	0	0		5
CO-40-32								
CO-40-Prov? Skull	1		15	0	0	3	buccal crown + CEJ	1
CO-40-68C/7yo								1
CO-40-68C/3yo								
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								1
CO-40-69/adult	5							5
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM2 Develop-ment	RM2 Wear	RM2 Caries	RM2 Abscess	RM2 Calculus	RM2 Calculus Affected	RM1 Presence	RM1 Develop-ment	RM1 Wear
CO-40-1									
CO-40-1A							4		
CO-40-1AB									
CO-40-1B									
CO-40-1D							1	9	0
CO-40-1E							1	14	26
CO-40-2							1	7	4
CO-40-3		16	0	0	1	buccal below CEJ	2		20
CO-40-3-1									
CO-40-4							2		17
CO-40-5	PMD	15	0	0	0	poss on buccal crown, but PMD to enamel	1	14	16
CO-40-6A		15	0	0	0		1		16
CO-40-6B							1	PMD	18
CO-40-6C	6	4							
CO-40-6D							1	R1/2	4
CO-40-13		18	0	0	2	buccal/mesial @ and under CEJ	5		
CO-40-15A							2		8
CO-40-15B									
CO-40-15D									
CO-40-16C	6						2		4
CO-40-16D							1	4	4

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM2 Develop-ment	RM2 Wear	RM2 Caries	RM2 Abscess	RM2 Calculus	RM2 Calculus Affected	RM1 Presence	RM1 Develop-ment	RM1 Wear
CO-40-17									
CO-40-18A									
CO-40-18B		26	0	0	3	buccal/lingual CEJ + crown	2		32
CO-40-19A									
CO-40-19B	7	4	0	0	0		1	11	4
CO-40-19E									
CO-40-19F									
CO-40-19H	3						1	7	
CO-40-19I	10	4	0	0	0				
CO-40-19M	14	16	0	0	0		5		
CO-40-19R									
CO-40-20A							2		23
CO-40-22A	14	17	0	0	1-2	Prob was circ @ CEJ, now patches on all surfaces	2		23
CO-40-22B juvenile									
CO-40-22C							1	4	
CO-40-22D									
CO-40-24							2		19
CO-40-25									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM2 Develop-ment	RM2 Wear	RM2 Caries	RM2 Abscess	RM2 Calculus	RM2 Calculus Affected	RM1 Presence	RM1 Develop-ment	RM1 Wear
CO-40-25-1									
CO-40-27		7x	1	0	1	distal at CEJ	2		17
CO-40-29A							2	11	4
CO-40-30		19	1	0	0		1		21
CO-40-31A	14	10	0	0	0		2		16
CO-40-31B							1	Ri	4
CO-40-31C	14	17	0	0	0		1		29
CO-40-31-1C									
CO-40-31D1							1	CR1/2	
CO-40-31E		11	0	0	0		2		11
CO-40-31F							1		15
CO-40-31G							2		13
CO-40-32									
CO-40-Prov? Skull		18	0	0	3	buccal crown + CEJ	1		25
CO-40-68C/7yo	8						1	6+	4
CO-40-68C/3yo							8	6	
CO-40-68E/adult									
CO-40-68W/child9yo									
CO-40-68W/infant							1	5	
CO-40-69/1yo							1	C1/2	0
CO-40-69/4yo	4								
CO-40-69/adult							2		16
CO-40-77									
CO-40-79									
CO-40-79B69									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM1 Caries	RM1 Abscess	RM1 Calculus	RM1 Calculus Affected	RPM2 Presence	RPM2 Develop-ment	RPM2 Wear	RPM2 Caries
CO-40-1					2	14	6	2
CO-40-1A					4			
CO-40-1AB								
CO-40-1B								
CO-40-1D	0							
CO-40-1E	0	0	0		5			
CO-40-2								
CO-40-3	0	0	1	buccal below CEJ	2		4	0
CO-40-3-1								
CO-40-4	0	0	2	buccal/distal crown to below CEJ	2		2	0
CO-40-5	0	0	2	buccal crown to CEJ	1	PMD	3	0
CO-40-6A	0	0	0		1		2	0
CO-40-6B	0	0	1	circ at CEJ (lingual =2 at CEJ)	5			
CO-40-6C					8	6		
CO-40-6D					8	6	0	
CO-40-13					4			
CO-40-15A	0	0	1	buccal, mesial crown	1	6	1	0
CO-40-15B								
CO-40-15D								
CO-40-16C	0	0	0					
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM1 Caries	RM1 Abscess	RM1 Calculus	RM1 Calculus Affected	RPM2 Presence	RPM2 Develop-ment	RPM2 Wear	RPM2 Caries
CO-40-17								
CO-40-18A								
CO-40-18B	0	0	3	bluccal/lingual CEJ + crown	5			
CO-40-19A								
CO-40-19B	0	0	0		8	9		
CO-40-19E								
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M					5			
CO-40-19R								
CO-40-20A	0	0	2	buccal/distal/lingual @ and below CEJ	2		5	0
CO-40-22A	0	0	1	Prob was circ @ CEJ, now patches on all surfaces	2		4	0
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24	1	0	1	buccal, lingual @ CEJ	2			
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RM1 Caries	RM1 Abscess	RM1 Calculus	RM1 Calculus Affected	RPM2 Presence	RPM2 Develop-ment	RPM2 Wear	RPM2 Caries
CO-40-25-1								
CO-40-27		0	1	distal at and below CEJ	2		4	0
CO-40-29A	0	0	0					
CO-40-30	0	0	2	buccal below CEJ	5			
CO-40-31A	0	0	1	distal crown	2		2	0
CO-40-31B								
CO-40-31C	0	0	0		2		6	0
CO-40-31-1C								
CO-40-31D1								
CO-40-31E	0	0	0		2		1	0
CO-40-31F	0	0	2	at and below buccal CEJ	5			
CO-40-31G	0	0	0		5			
CO-40-32								
CO-40-Prov? Skull	0	0	2	buccal crown + CEJ	1		3	0
CO-40-68C/7yo	0	0	0					
CO-40-68C/3yo								
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo	0	0	0					
CO-40-69/4yo								
CO-40-69/adult	0	0	0		5			
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPM2 Abscess	RPM2 Calculus	RPM2 Calculus Affected	RPM1 Presence	RPM1 Develop-ment	RPM1 Wear	RPM1 Caries	RPM1 Abscess
CO-40-1	0	0		1	PMD			
CO-40-1A				4				
CO-40-1AB								
CO-40-1B								
CO-40-1D								
CO-40-1E				5				
CO-40-2								
CO-40-3	0	0		1		4	0	0
CO-40-3-1								
CO-40-4	0	1	buccal crown	2		1	0	0
CO-40-5	0	1	buccal crown to CEJ	1	PMD	2	0	0
CO-40-6A	0	0						
CO-40-6B				5				
CO-40-6C				8	6			
CO-40-6D				1	6	0		
CO-40-13				4				
CO-40-15A	0	0		1	PMD	2	0	0
CO-40-15B								
CO-40-15D								
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPM2 Abscess	RPM2 Calculus	RPM2 Calculus Affected	RPM1 Presence	RPM1 Develop-ment	RPM1 Wear	RPM1 Caries	RPM1 Abscess
CO-40-17								
CO-40-18A								
CO-40-18B				2		8		
CO-40-19A								
CO-40-19B								
CO-40-19E								
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M				5				
CO-40-19R								
CO-40-20A	0	1	buccal @ and below CEJ	2		7	0	0
CO-40-22A	0	2	Prob was circ, now patches on all surfaces & below	2		5	0	0
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24				2				
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPM2 Abscess	RPM2 Calculus	RPM2 Calculus Affected	RPM1 Presence	RPM1 Develop-ment	RPM1 Wear	RPM1 Caries	RPM1 Abscess
CO-40-25-1				2	5			
CO-40-27	0	0		2		5	0	0
CO-40-29A								
CO-40-30				5				
CO-40-31A	0	0		2		2	0	0
CO-40-31B								
CO-40-31C	0	0		2		7	0	0
CO-40-31-1C								
CO-40-31D1								
CO-40-31E	0	0		2		1	0	0
CO-40-31F				5				
CO-40-31G				2		2	0	0
CO-40-32								
CO-40-Prov? Skull	0	2	buccal crown + CEJ	1		4	0	0
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult				1		6	1	0
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult				2		2	0	0
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPM1 Calculus	RPM1 Calculus Affected	RC Presence	RC Develop-ment	RC Wear	RC Caries	RC Abscess	RC Calculus
CO-40-1			2	14	4	0	0	0
CO-40-1A			4					
CO-40-1AB								
CO-40-1B								
CO-40-1D								
CO-40-1E			5					
CO-40-2								
CO-40-3	0		1		4	0	0	0
CO-40-3-1								
CO-40-4	1	buccal/mesial crown	2		2	0	0	1
CO-40-5	1	buccal crown to CEJ	2		2	0	0	1
CO-40-6A			1		1	0	0	0
CO-40-6B			5					
CO-40-6C								
CO-40-6D								
CO-40-13			4					
CO-40-15A	0		5					
CO-40-15B								
CO-40-15D								
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPM1 Calculus	RPM1 Calculus Affected	RC Presence	RC Develop-ment	RC Wear	RC Caries	RC Abscess	RC Calculus
CO-40-17								
CO-40-18A								
CO-40-18B	2	CEJ and below	2		8			
CO-40-19A								
CO-40-19B			1	9	0			
CO-40-19E								
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M			5					
CO-40-19R								
CO-40-20A	2	circ @ and below CEJ	2		7	0	0	2
CO-40-22A	1	Prob was circ, now patches on all surfaces & below	1		6	0	0	1
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24			2		2	0	0	1
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPM1 Calculus	RPM1 Calculus Affected	RC Presence	RC Develop-ment	RC Wear	RC Caries	RC Abscess	RC Calculus
CO-40-25-1			2					
CO-40-27	0		2		7	0	0	1
CO-40-29A								
CO-40-30			5					
CO-40-31A	0		2		1	0	0	1
CO-40-31B			1	5	0			
CO-40-31C	0		2		7	0	0	0
CO-40-31-1C								
CO-40-31D1								
CO-40-31E	0		5					
CO-40-31F			5					
CO-40-31G	1	b crown, d interprox crown	5					
CO-40-32								
CO-40-Prov? Skull	0	Postmortem cleaning?	1		4	0	0	1
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult	1	under CEJ, b, d, l	1		8	0	0	0
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo			2	7				
CO-40-69/adult	0		2	14	2	0		0
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RC Calculus Affected	RI2 Presence	RI2 Develop-ment	RI2 Wear	RI2 Caries	RI2 Abscess	RI2 Calculus	RI2 Calculus Affected
CO-40-1		2	14	7	1	0	0	
CO-40-1A		4						
CO-40-1AB								
CO-40-1B								
CO-40-1D								
CO-40-1E		5						
CO-40-2								
CO-40-3	5							
CO-40-3-1								
CO-40-4	buccal crown	5						
CO-40-5	buccal crown to CEJ	1	PMD	3	0	0	1	buccal crown to CEJ
CO-40-6A		1		1	0	0	1	buccal crown
CO-40-6B		5						
CO-40-6C		1	9	1				
CO-40-6D		1	10	1				
CO-40-13		4						
CO-40-15A		5						
CO-40-15B								
CO-40-15D								
CO-40-16C		8	4					
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RC Calculus Affected	RI2 Presence	RI2 Develop-ment	RI2 Wear	RI2 Caries	RI2 Abscess	RI2 Calculus	RI2 Calculus Affected
CO-40-17								
CO-40-18A								
CO-40-18B		2		8	1			
CO-40-19A								
CO-40-19B		1	11	1	0	0	0	
CO-40-19E								
CO-40-19F		1	6	0				
CO-40-19H								
CO-40-19I		1	12	1	0	0	0	
CO-40-19M		5						
CO-40-19R								
CO-40-20A	buccal/lingual/mesial @ and below CEJ	5						
CO-40-22A	buccal at CEJ	PMD						
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24	buccal on crown	1	14	3	0	0	0	
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RC Calculus Affected	RI2 Presence	RI2 Develop-ment	RI2 Wear	RI2 Caries	RI2 Abscess	RI2 Calculus	RI2 Calculus Affected
CO-40-25-1		2						
CO-40-27	mesial/buccal at and below CEJ	2		7	0	0	0	
CO-40-29A								
CO-40-30		5						
CO-40-31A	buccal crown	2		1	0	0	0	
CO-40-31B								
CO-40-31C		2		7	0	0	0	
CO-40-31-1C								
CO-40-31D1		1	6					
CO-40-31E		5						
CO-40-31F		5						
CO-40-31G		5						
CO-40-32								
CO-40-Prov? Skull	@ CEJ	5						
CO-40-68C/7yo								
CO-40-68C/3yo		8	7					
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo		1	7	0	0	0	0	
CO-40-69/4yo		2	6					
CO-40-69/adult		5						
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RI1 Presence	RI1 Develop-ment	RI1 Wear	RI1 Caries	RI1 Abscess	RI1 Calculus	RI1 Calculus Affected	LI1 Presence
CO-40-1	1	PMD	6	0	0	0		
CO-40-1A	4							
CO-40-1AB								
CO-40-1B								5
CO-40-1D								
CO-40-1E	1	PMD	7	0	0	0		5
CO-40-2								
CO-40-3	1	14	7	0	0	0		5
CO-40-3-1								
CO-40-4	2		3	0	0	1	buccal crown	1
CO-40-5	5							2
CO-40-6A	1		1	0	0	0		1
CO-40-6B	5							5
CO-40-6C								
CO-40-6D								
CO-40-13	4							4
CO-40-15A	5							5
CO-40-15B								
CO-40-15D								
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RI1 Presence	RI1 Develop-ment	RI1 Wear	RI1 Caries	RI1 Abscess	RI1 Calculus	RI1 Calculus Affected	LI1 Presence
CO-40-17								
CO-40-18A								
CO-40-18B	5							5
CO-40-19A								
CO-40-19B	1	9	1	0	0	0		
CO-40-19E								
CO-40-19F								1
CO-40-19H	1	6						
CO-40-19I								
CO-40-19M	5							5
CO-40-19R								
CO-40-20A	5							5
CO-40-22A	1		7	1	0	1	poss buccal at CEJ, but PMD	PMD
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24								
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RI1 Presence	RI1 Develop-ment	RI1 Wear	RI1 Caries	RI1 Abscess	RI1 Calculus	RI1 Calculus Affected	LI1 Presence
CO-40-25-1	1	7						1
CO-40-27	2		7	0	0	0		5
CO-40-29A								
CO-40-30	5							5
CO-40-31A	2		2	0	0	1	buccal crown	2
CO-40-31B								
CO-40-31C	1		7	0	0	0		5
CO-40-31-1C								
CO-40-31D1								1
CO-40-31E	5							1
CO-40-31F	5							5
CO-40-31G	5							5
CO-40-32								
CO-40-Prov? Skull	5							PMD
CO-40-68C/7yo								
CO-40-68C/3yo	8	6						1
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo	1	4	0	0	0	0		
CO-40-69/4yo	1	7						1
CO-40-69/adult	5							5
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LI1 Develop-ment	LI1 Wear	LI1 Caries	LI1 Abscess	LI1 Calculus	LI1 Calculus Affected	LI2 Presence	LI2 Develop-ment	LI2 Wear
CO-40-1									
CO-40-1A									
CO-40-1AB									
CO-40-1B							5		
CO-40-1D									
CO-40-1E							2		8
CO-40-2									
CO-40-3							5		
CO-40-3-1									
CO-40-4		4	0	0	1	buccal, distal, mesial crown	1		2
CO-40-5		2	0	0	1	slight on buccal crown	5		
CO-40-6A		1	0	0	0		1		1
CO-40-6B							5		
CO-40-6C									
CO-40-6D									
CO-40-13							4		
CO-40-15A							5		
CO-40-15B									
CO-40-15D									
CO-40-16C									
CO-40-16D									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LI1 Develop-ment	LI1 Wear	LI1 Caries	LI1 Abscess	LI1 Calculus	LI1 Calculus Affected	LI2 Presence	LI2 Develop-ment	LI2 Wear
CO-40-17									
CO-40-18A									
CO-40-18B							5		
CO-40-19A									
CO-40-19B									
CO-40-19E									
CO-40-19F	6	0							
CO-40-19H									
CO-40-19I									
CO-40-19M							5		
CO-40-19R									
CO-40-20A							2		7
CO-40-22A							5		
CO-40-22B juvenile									
CO-40-22C									
CO-40-22D									
CO-40-24									
CO-40-25									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LI1 Develop-ment	LI1 Wear	LI1 Caries	LI1 Abscess	LI1 Calculus	LI1 Calculus Affected	LI2 Presence	LI2 Develop-ment	LI2 Wear
CO-40-25-1	7						1	7	
CO-40-27							2		7
CO-40-29A									
CO-40-30							5		
CO-40-31A		2	0	0	1	buccal crown	2		1
CO-40-31B									
CO-40-31C							2		7
CO-40-31-1C									
CO-40-31D1	4						1	4	
CO-40-31E		2	0	0	0		2		1
CO-40-31F							5		
CO-40-31G							5		
CO-40-32									
CO-40-Prov? Skull							PMD		
CO-40-68C/7yo									
CO-40-68C/3yo	6	0	0	0	0		1	7	
CO-40-68E/adult									
CO-40-68W/child9yo									
CO-40-68W/infant									
CO-40-69/1yo									
CO-40-69/4yo	7						2		
CO-40-69/adult							5		
CO-40-77									
CO-40-79									
CO-40-79B69									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LI2 Caries	LI2 Abscess	LI2 Calculus	LI2 Calculus Affected	LC Presence	LC Develop-ment	LC Wear	LC Caries	LC Abscess
CO-40-1									
CO-40-1A									
CO-40-1AB									
CO-40-1B					2		4	0	0
CO-40-1D									
CO-40-1E	0	0	0		1	14	6	0	0
CO-40-2									
CO-40-3					5				
CO-40-3-1									
CO-40-4	0	0	1	buccal, mesial crown	2				
CO-40-5					1	PMD	2	0	0
CO-40-6A	0	0	1	buccal crown	1		1	0	0
CO-40-6B					1	14	6	0	0
CO-40-6C					1	9	0		
CO-40-6D									
CO-40-13					2		8		0
CO-40-15A					5				
CO-40-15B									
CO-40-15D									
CO-40-16C					1	7			
CO-40-16D									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LI2 Caries	LI2 Abscess	LI2 Calculus	LI2 Calculus Affected	LC Presence	LC Develop-ment	LC Wear	LC Caries	LC Abscess
CO-40-17									
CO-40-18A					4				
CO-40-18B					2		7	0	0
CO-40-19A									
CO-40-19B					1	9	0		
CO-40-19E					1	11	1	0	0
CO-40-19F									
CO-40-19H									
CO-40-19I					1	9	0	0	0
CO-40-19M					5				
CO-40-19R									
CO-40-20A	0	0	1	buccal @ and below CEJ	2		6	0	0
CO-40-22A					2		6	0	0
CO-40-22B juvenile									
CO-40-22C									
CO-40-22D									
CO-40-24									
CO-40-25									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LI2 Caries	LI2 Abscess	LI2 Calculus	LI2 Calculus Affected	LC Presence	LC Develop-ment	LC Wear	LC Caries	LC Abscess
CO-40-25-1									
CO-40-27	0	0	1	buccal below CEJ	2		7	0	0
CO-40-29A									
CO-40-30					5				
CO-40-31A	0	0	1	buccal crown	2		1	0	0
CO-40-31B					1	5	0		
CO-40-31C	0	0	0		2		6	0	0
CO-40-31-1C									
CO-40-31D1									
CO-40-31E	0	0	0		1		1	0	0
CO-40-31F					2	PMD			
CO-40-31G					5				
CO-40-32									
CO-40-Prov? Skull					5				
CO-40-68C/7yo									
CO-40-68C/3yo									
CO-40-68E/adult					1		6	0	0
CO-40-68W/child9yo									
CO-40-68W/infant									
CO-40-69/1yo									
CO-40-69/4yo					2				
CO-40-69/adult					5				
CO-40-77									
CO-40-79									
CO-40-79B69									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LC Calculus	LC Calculus Affected	LPM1 Presence	LPM1 Develop-ment	LPM1 Wear	LPM1 Caries	LPM1 Abscess	LPM1 Calculus
CO-40-1								
CO-40-1A								
CO-40-1AB								
CO-40-1B	0		2		2	0	0	0
CO-40-1D								
CO-40-1E	0		2		6	0	0	0
CO-40-2								
CO-40-3			2		4	0	0	1
CO-40-3-1								
CO-40-4			2		1	0	0	1
CO-40-5	1	buccal crown	2		3	0	0	1
CO-40-6A	0		1		1	0	0	1
CO-40-6B	0		1		5	0	0	1
CO-40-6C								
CO-40-6D			1	6				
CO-40-13			4					
CO-40-15A			5					
CO-40-15B								
CO-40-15D								
CO-40-16C			1	6				
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LC Calculus	LC Calculus Affected	LPM1 Presence	LPM1 Develop-ment	LPM1 Wear	LPM1 Caries	LPM1 Abscess	LPM1 Calculus
CO-40-17								
CO-40-18A			4					
CO-40-18B	2	buccal CEJ and below	2		6	0	0	2
CO-40-19A								
CO-40-19B			8	7				
CO-40-19E	0							
CO-40-19F								
CO-40-19H								
CO-40-19I	0							
CO-40-19M			5					
CO-40-19R								
CO-40-20A	1	buccal @ and below CEJ	2		6	0	0	1
CO-40-22A	1	interprox mesial crown	2			0		
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24								
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LC Calculus	LC Calculus Affected	LPM1 Presence	LPM1 Develop-ment	LPM1 Wear	LPM1 Caries	LPM1 Abscess	LPM1 Calculus
CO-40-25-1								
CO-40-27	0		2		5	0	0	0
CO-40-29A								
CO-40-30			5					
CO-40-31A	0		2		1	0	0	0
CO-40-31B								
CO-40-31C	1	mesial crown	2		7	0	0	1
CO-40-31-1C								
CO-40-31D1								
CO-40-31E	0		5					
CO-40-31F			5					
CO-40-31G			2		2	0	0	1
CO-40-32								
CO-40-Prov? Skull			1		4	0	0	1
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult	0							
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult			1		1	0	0	0
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LPM1 Calculus Affected	LPM2 Presence	LPM2 Develop-ment	LPM2 Wear	LPM2 Caries	LPM2 Abscess	LPM2 Calculus	LPM2 Calculus Affected
CO-40-1								
CO-40-1A								
CO-40-1AB								
CO-40-1B		5						
CO-40-1D								
CO-40-1E		2		6	0	0	0	
CO-40-2								
CO-40-3	below CEJ	2		4	0	0	2	below below CEJ + crown
CO-40-3-1								
CO-40-4	anat. buccal, but turned, so act. M	2		1	0	0	1	mesial crown
CO-40-5	buccal crown	2		2	0	0	0	buccal crown
CO-40-6A	buccal crown	1		2	0	0	0	
CO-40-6B	circ at CEJ	1	5	0	0	0	1	circ at CEJ
CO-40-6C								
CO-40-6D		1	6					
CO-40-13		1		8	0	0	0	
CO-40-15A		5						
CO-40-15B								
CO-40-15D								
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LPM1 Calculus Affected	LPM2 Presence	LPM2 Develop-ment	LPM2 Wear	LPM2 Caries	LPM2 Abscess	LPM2 Calculus	LPM2 Calculus Affected
CO-40-17								
CO-40-18A		4						
CO-40-18B	buccal CEJ and below	2		5	0	0	2	buccal CEJ and below
CO-40-19A								
CO-40-19B		1	7					
CO-40-19E								
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M		1	14	2	0	0	0	
CO-40-19R								
CO-40-20A	buccal @ and below CEJ	1		5	0	0	1	buccal, below CEJ
CO-40-22A		2		5	0	0	2	buccal below CEJ
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D								
CO-40-24								
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LPM1 Calculus Affected	LPM2 Presence	LPM2 Develop-ment	LPM2 Wear	LPM2 Caries	LPM2 Abscess	LPM2 Calculus	LPM2 Calculus Affected
CO-40-25-1								
CO-40-27		2		3	0	0	0	
CO-40-29A								
CO-40-30		5						
CO-40-31A		2		2	0	0	0	
CO-40-31B								
CO-40-31C	mesial crown	2		6	0	0	0	
CO-40-31-1C								
CO-40-31D1								
CO-40-31E		5						
CO-40-31F		4						
CO-40-31G	b & d crown	2		2	0	0	1	b/d/m crown
CO-40-32								
CO-40-Prov? Skull	under CEJ	1		4	0	0	0	PMD
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult		1		5	1	0	0	
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult		5						
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM1 Presence	LM1 Develop-ment	LM1 Wear	LM1 Caries	LM1 Abscess	LM1 Calculus	LM1 Calculus Affected	LM2 Presence
CO-40-1								
CO-40-1A								
CO-40-1AB								
CO-40-1B	2		15	0	0	0		2
CO-40-1D	1	9	0	0				
CO-40-1E	4							4
CO-40-2								
CO-40-3	2		19	0	0	1	distal cusp to CEJ	2
CO-40-3-1								
CO-40-4	2		13	0	0	1	b l crown + below CEJ	2
CO-40-5	5							5
CO-40-6A	1		17	0	0	0		1
CO-40-6B	1	PMD	17	0	0	0		1
CO-40-6C								
CO-40-6D	1	11	4					
CO-40-13	1		32	0	1	0		1
CO-40-15A	1		17	0	0	0		2
CO-40-15B								
CO-40-15D								
CO-40-16C	2	11	4	0	0	0		
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM1 Presence	LM1 Develop-ment	LM1 Wear	LM1 Caries	LM1 Abscess	LM1 Calculus	LM1 Calculus Affected	LM2 Presence
CO-40-17								
CO-40-18A	4							4
CO-40-18B	1		35	1	1	0		2
CO-40-19A								
CO-40-19B	1	11	4	0	0	0		1
CO-40-19E	2	12	5	0	0	0		
CO-40-19F	1	6	4					
CO-40-19H	1	7						1
CO-40-19I								
CO-40-19M	1	14	17	0	0	1	mb cusp	1
CO-40-19R								
CO-40-20A	2		30	0	0	2	circ @ and below CEJ	2
CO-40-22A	2		23	0	0	PMD		2
CO-40-22B juvenile								
CO-40-22C	1	4						
CO-40-22D								
CO-40-24	2		12	0	0	2	buccal, lingual @ and under CEJ	2
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM1 Presence	LM1 Develop-ment	LM1 Wear	LM1 Caries	LM1 Abscess	LM1 Calculus	LM1 Calculus Affected	LM2 Presence
CO-40-25-1								
CO-40-27	2		16	0	0	0		2
CO-40-29A	2	11	4	0	0	0		
CO-40-30	5							5
CO-40-31A	2		14	0	0	1	mesial crown	1
CO-40-31B								
CO-40-31C	1		20	0	0	0		2
CO-40-31-1C								
CO-40-31D1								
CO-40-31E	5							5
CO-40-31F	2							4
CO-40-31G	2		12	0	0	1	b/d/m crown	2
CO-40-32								
CO-40-Prov? Skull	1		28	0	0	1	buccal crown + CEJ	1
CO-40-68C/7yo	2	6+	5	0	0	0		2
CO-40-68C/3yo	1	6						
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant	1	5						
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult	1		16	0	0	0		5
CO-40-77								
CO-40-79								
CO-40-79B69								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM2 Develop-ment	LM2 Wear	LM2 Caries	LM2 Abscess	LM2 Calculus	LM2 Calculus Affected	LM3 Presence	LM3 Develop-ment	LM3 Wear
CO-40-1									
CO-40-1A									
CO-40-1AB									
CO-40-1B		13	0	0	0		5		
CO-40-1D									
CO-40-1E							4		
CO-40-2									
CO-40-3		16	0	0	2	buccal crown. mesial/distal @ CEJ =1.	2		15
CO-40-3-1									
CO-40-4		10	0	0	0		4		
CO-40-5							5		
CO-40-6A		15	0	0	0		1	9	4
CO-40-6B		16	0	0	0		5		
CO-40-6C									
CO-40-6D									
CO-40-13		30	0	0	0		2		31
CO-40-15A	14	10	1	0	0		2	12	6
CO-40-15B									
CO-40-15D									
CO-40-16C									
CO-40-16D									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM2 Develop-ment	LM2 Wear	LM2 Caries	LM2 Abscess	LM2 Calculus	LM2 Calculus Affected	LM3 Presence	LM3 Develop-ment	LM3 Wear
CO-40-17									
CO-40-18A							4		
CO-40-18B		22	0	0	2	circumfirential CEJ and below	2		16
CO-40-19A									
CO-40-19B	7	4	0						
CO-40-19E									
CO-40-19F									
CO-40-19H	3								
CO-40-19I									
CO-40-19M		16	0	0	0		5		
CO-40-19R									
CO-40-20A		20	0	0	1	buccal/distal/lingual @ and below CEJ	5		
CO-40-22A		20	0	0	1	at root bifurcation	5		
CO-40-22B juvenile									
CO-40-22C									
CO-40-22D									
CO-40-24		10	0	0	1	buccal, lingual @ and under CEJ	2		8
CO-40-25									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM2 Develop-ment	LM2 Wear	LM2 Caries	LM2 Abscess	LM2 Calculus	LM2 Calculus Affected	LM3 Presence	LM3 Develop-ment	LM3 Wear
CO-40-25-1									
CO-40-27		10	1	0	0		3		
CO-40-29A									
CO-40-30							5		
CO-40-31A	14	10	0	0	0		1	11	9
CO-40-31B									
CO-40-31C		16	0	0	0		2		13
CO-40-31-1C									
CO-40-31D1									
CO-40-31E							5		
CO-40-31F				1			5		
CO-40-31G		10	0	0	1	b crown	2		4
CO-40-32									
CO-40-Prov? Skull		7x		0			1		12
CO-40-68C/7yo									
CO-40-68C/3yo									
CO-40-68E/adult									
CO-40-68W/child9yo									
CO-40-68W/infant									
CO-40-69/1yo									
CO-40-69/4yo									
CO-40-69/adult							5		
CO-40-77									
CO-40-79									
CO-40-79B69									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM3 Caries	LM3 Abscess	LM3 Calculus	LM3 Calculus Affected	LMN3 Presence	LMN3 Develop-ment	LMN3 Wear	LMN3 Caries
CO-40-1								
CO-40-1A								
CO-40-1AB					5			
CO-40-1B								
CO-40-1D								
CO-40-1E					4			
CO-40-2								
CO-40-3	0	0	0		1		13	0
CO-40-3-1								
CO-40-4					4			
CO-40-5					1	PMD	12	0
CO-40-6A	0	0	0		1	7	4	0
CO-40-6B					5			
CO-40-6C								
CO-40-6D								
CO-40-13	0	0	1	buccal under CEJ	4			
CO-40-15A	1	0	0					
CO-40-15B					4			
CO-40-15D								
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM3 Caries	LM3 Abscess	LM3 Calculus	LM3 Calculus Affected	LMN3 Presence	LMN3 Develop-ment	LMN3 Wear	LMN3 Caries
CO-40-17					4			
CO-40-18A					4			
CO-40-18B	0	0	1	buccal CEJ, lingual crown +CEJ	2		19	1
CO-40-19A					5			
CO-40-19B								
CO-40-19E					8			
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M					5			
CO-40-19R					5			
CO-40-20A					2		16	0
CO-40-22A								
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D					4			
CO-40-24	0	0	1	circ @ and under CEJ	2		12	0
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LM3 Caries	LM3 Abscess	LM3 Calculus	LM3 Calculus Affected	LMN3 Presence	LMN3 Develop-ment	LMN3 Wear	LMN3 Caries
CO-40-25-1								
CO-40-27					6			
CO-40-29A								
CO-40-30					PMD			
CO-40-31A	0	0	0		2		9	0
CO-40-31B								
CO-40-31C	1	0	1	lingual and distal CEJ	2		12x	1
CO-40-31-1C					5			
CO-40-31D1								
CO-40-31E					6			
CO-40-31F					PMD			
CO-40-31G	0	0	0		5			
CO-40-32					2			
CO-40-Prov? Skull	0	0	1	buccal crown	1		13	0
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult					2		10	0
CO-40-77					4			
CO-40-79								
CO-40-79B69					4			

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN3 Abscess	LMN3 Calculus	LMN3 Calculus Affected	LMN2 Presence	LMN2 Develop-ment	LMN2 Wear	LMN2 Caries	LMN2 Abscess
CO-40-1								
CO-40-1A								
CO-40-1AB	0			2	PMD	13	4	0
CO-40-1B								
CO-40-1D								
CO-40-1E				4				
CO-40-2								
CO-40-3	0			1		16	0	0
CO-40-3-1								
CO-40-4				5				
CO-40-5	0	0		1	PMD	16	1	0
CO-40-6A	0	0		2		6	0	0
CO-40-6B				2		16	0	0
CO-40-6C								
CO-40-6D								
CO-40-13				4				
CO-40-15A								
CO-40-15B				4				
CO-40-15D								
CO-40-16C				8				
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN3 Abscess	LMN3 Calculus	LMN3 Calculus Affected	LMN2 Presence	LMN2 Develop-ment	LMN2 Wear	LMN2 Caries	LMN2 Abscess
CO-40-17				4				
CO-40-18A				4				
CO-40-18B	0	3	buccal crown, 2 lingual crown	2		40		0
CO-40-19A				5				
CO-40-19B				1	7	4		
CO-40-19E				5				
CO-40-19F								
CO-40-19H				1	3			
CO-40-19I								
CO-40-19M				5				
CO-40-19R				5				
CO-40-20A	0	1	lingual crown	5				
CO-40-22A								
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D				4				
CO-40-24	0	2	buccal, lingual, distal CEJ to under	4				
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN3 Abscess	LMN3 Calculus	LMN3 Calculus Affected	LMN2 Presence	LMN2 Develop-ment	LMN2 Wear	LMN2 Caries	LMN2 Abscess
CO-40-25-1				2	5			
CO-40-27				2		7xx	1	0
CO-40-29A								
CO-40-30				2		40		
CO-40-31A	0	0		1				
CO-40-31B				1	7	4		
CO-40-31C	0	0		2		11x	1	0
CO-40-31-1C				2		6 5 4 4	0	0
CO-40-31D1								
CO-40-31E				5				
CO-40-31F				3				
CO-40-31G				2		14	2	0
CO-40-32				4				
CO-40-Prov? Skull	0		removed PMD @ buccal CEJ	1		21	0	0
CO-40-68C/7yo				1	7			
CO-40-68C/3yo								
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult	0	0		2		12	1	0
CO-40-77				4				
CO-40-79								
CO-40-79B69				4				

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN2 Calculus	LMN2 Calculus Affected	LMN1 Presence	LMN1 Develop-ment	LMN1 Wear	LMN1 Caries	LMN1 Abscess	LMN1 Calculus
CO-40-1								
CO-40-1A								
CO-40-1AB	1	lateral crown	2	PMD	15	0	0	0
CO-40-1B								
CO-40-1D								
CO-40-1E			4					
CO-40-2			1	7	4			
CO-40-3	1	lingual @ CEJ	1		21	0	0	1
CO-40-3-1			4					
CO-40-4			2		17	0	0	0
CO-40-5	1	buccal crown	1	PMD	18	0	0	1
CO-40-6A	0		2		13	0	0	0
CO-40-6B	1	circ at CEJ and mesial crown	2		22	0	0	1
CO-40-6C								
CO-40-6D			1	11	4	0	0	0
CO-40-13			4					
CO-40-15A								
CO-40-15B			4					
CO-40-15D								
CO-40-16C			2		4	0	0	0
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN2 Calculus	LMN2 Calculus Affected	LMN1 Presence	LMN1 Develop-ment	LMN1 Wear	LMN1 Caries	LMN1 Abscess	LMN1 Calculus
CO-40-17			4					
CO-40-18A			4					
CO-40-18B	0		4					
CO-40-19A			5					
CO-40-19B			1	11	4	0	0	0
CO-40-19E			5					
CO-40-19F			1	6	4			
CO-40-19H			2	7				
CO-40-19I								
CO-40-19M			5					
CO-40-19R			5					
CO-40-20A			2		23	0	0	2
CO-40-22A								
CO-40-22B juvenile								
CO-40-22C			1	4				
CO-40-22D			4					
CO-40-24			7					
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN2 Calculus	LMN2 Calculus Affected	LMN1 Presence	LMN1 Develop-ment	LMN1 Wear	LMN1 Caries	LMN1 Abscess	LMN1 Calculus
CO-40-25-1			1	9	4			
CO-40-27	0		2		18	1	0	0
CO-40-29A			2	11	4	0	0	0
CO-40-30			2		25	0	0	0
CO-40-31A			2		15	0	0	0
CO-40-31B			1	4	4			
CO-40-31C	0		2		36	0	1	0
CO-40-31-1C	0		5					
CO-40-31D1								
CO-40-31E			5					
CO-40-31F			2		16	1	0	0
CO-40-31G	0		2		15	0	0	0
CO-40-32			2		16	0	0	0.5
CO-40-Prov? Skull		removed PMD @ buccal CEJ	1		27	0	0	
CO-40-68C/7yo			1	PMD	6	0	0	0
CO-40-68C/3yo			1	6				
CO-40-68E/adult								
CO-40-68W/child9yo			2					
CO-40-68W/infant			1	4				
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult	0		2		17	0	0	1
CO-40-77			4					
CO-40-79			2					
CO-40-79B69			4					

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN1 Calculus Affected	LPMN2 Presence	LPMN2 Develop-ment	LPMN2 Wear	LPMN2 Caries	LPMN2 Abscess	LPMN2 Calculus	LPMN2 Calculus Affected
CO-40-1								
CO-40-1A								
CO-40-1AB	but, looks like possibly cleaned off PMD	1		2	0	0	0	
CO-40-1B								
CO-40-1D								
CO-40-1E		4						
CO-40-2								
CO-40-3	lingual @ CEJ	5						
CO-40-3-1		4						
CO-40-4		2		1	0	0	0	
CO-40-5	buccal crown	1	PMD	3	0	0	1	buccal & distal crown
CO-40-6A		2		2	0	0	0	
CO-40-6B	circ at CEJ and mesial crown	5						
CO-40-6C		8	PMD					
CO-40-6D								
CO-40-13		2		7	0	0	1	distal root under CEJ
CO-40-15A								
CO-40-15B		4						
CO-40-15D								
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN1 Calculus Affected	LPMN2 Presence	LPMN2 Develop-ment	LPMN2 Wear	LPMN2 Caries	LPMN2 Abscess	LPMN2 Calculus	LPMN2 Calculus Affected
CO-40-17		4						
CO-40-18A		4						
CO-40-18B		2		7	0	0	0	scrapped off buccal, but probably 2-3 on buccal crown (CEJ and crown)
CO-40-19A		5						
CO-40-19B		8	7					
CO-40-19E		5						
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M		5						
CO-40-19R		5						
CO-40-20A	circ, below CEJ	5						
CO-40-22A								
CO-40-22B juvenile								
CO-40-22C								
CO-40-22D		5						
CO-40-24		2						
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LMN1 Calculus Affected	LPMN2 Presence	LPMN2 Develop-ment	LPMN2 Wear	LPMN2 Caries	LPMN2 Abscess	LPMN2 Calculus	LPMN2 Calculus Affected
CO-40-25-1								
CO-40-27		2		3	0	0	0	
CO-40-29A								
CO-40-30		2		6	0	0	0	
CO-40-31A		2		3	0	0	0	
CO-40-31B								
CO-40-31C		2		5	0	0	1	lingual crown
CO-40-31-1C		5						
CO-40-31D1								
CO-40-31E		5						
CO-40-31F		5						
CO-40-31G		2		3	0	0	1	buccal crown
CO-40-32	buccal crown	2		3	0	0	1	buccal crown
CO-40-Prov? Skull	removed PMD @ buccal CEJ	2	PMD					
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo		1						
CO-40-69/adult	buccal CEJ	2		2	0	0	0	
CO-40-77		4						
CO-40-79		4						
CO-40-79B69		5						

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LPMN1 Presence	LPMN1 Develop-ment	LPMN1 Wear	LPMN1 Caries	LPMN1 Abscess	LPMN1 Calculus	LPMN1 Calculus Affected	LCN Presence
CO-40-1								
CO-40-1A								
CO-40-1AB	1		2	0	0	0	5	
CO-40-1B								
CO-40-1D								
CO-40-1E	4							4
CO-40-2								
CO-40-3	1		3	0	0	1	lingual @ CEJ	5
CO-40-3-1	4							4
CO-40-4	5							5
CO-40-5	1	PMD	3	0	0	1	distal & lingual crown	5
CO-40-6A	2		1	0	0	0		2
CO-40-6B	2		5	0	0	1	circ at CEJ	2
CO-40-6C	8	PME						
CO-40-6D	8	6						8
CO-40-13	2	PMD						2
CO-40-15A								
CO-40-15B	4							4
CO-40-15D								
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LPMN1 Presence	LPMN1 Develop-ment	LPMN1 Wear	LPMN1 Caries	LPMN1 Abscess	LPMN1 Calculus	LPMN1 Calculus Affected	LCN Presence
CO-40-17	2	PMD	4	0	0	3	mesial and buccal crown and root	2
CO-40-18A	4							4
CO-40-18B	2		7	0	0	0		2
CO-40-19A	5				1			1
CO-40-19B								
CO-40-19E	5							5
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M	5							5
CO-40-19R	5							5
CO-40-20A	5							2
CO-40-22A								
CO-40-22B juvenile								2
CO-40-22C								
CO-40-22D	4							4
CO-40-24	2							2
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LPMN1 Presence	LPMN1 Develop-ment	LPMN1 Wear	LPMN1 Caries	LPMN1 Abscess	LPMN1 Calculus	LPMN1 Calculus Affected	LCN Presence
CO-40-25-1								1
CO-40-27	2		3	0	0	0		2
CO-40-29A								
CO-40-30	5							5
CO-40-31A	2		3	0	0	0		2
CO-40-31B	1	4	0					
CO-40-31C	2		5	0	0	1	buccal/lingual crown	2
CO-40-31-1C	5							5
CO-40-31D1								
CO-40-31E	1	14	2	0	0	0		1
CO-40-31F	5							5
CO-40-31G	2		3	0	0	1	buccal crown.	2
CO-40-32	2		3	0	0	1	buccal crown	2
CO-40-Prov? Skull	1	PMD	2	0	0			5
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult								1
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo	2	6						
CO-40-69/adult	2		2	0	0	0		2
CO-40-77	4							4
CO-40-79	4							4
CO-40-79B69	5							5

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LCN Develop-ment	LCN Wear	LCN Caries	LCN Abscess	LCN Calculus	LCN Calculus Affected	LIN2 Presence	LIN2 Develop-ment
CO-40-1								
CO-40-1A								
CO-40-1AB				0			.	
CO-40-1B							5	
CO-40-1D								
CO-40-1E							4	
CO-40-2								
CO-40-3		4	0	0	1	buccal/lingual @ CEJ	5	
CO-40-3-1							4	
CO-40-4								
CO-40-5							5	
CO-40-6A		1	0	0	0		1	
CO-40-6B		7	0	0	0		1	
CO-40-6C								
CO-40-6D	6							
CO-40-13	PMD						5	
CO-40-15A								
CO-40-15B							4	
CO-40-15D							5	
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LCN Develop-ment	LCN Wear	LCN Caries	LCN Abscess	LCN Calculus	LCN Calculus Affected	LIN2 Presence	LIN2 Develop-ment
CO-40-17		7	0	0	3	mesial, buccal, distal crown and root	4	
CO-40-18A							4	
CO-40-18B		6	0	0	0		2	
CO-40-19A	14	2	0	0	1	buccal crown	5	
CO-40-19B								
CO-40-19E							5	
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M							5	
CO-40-19R							5	
CO-40-20A		7	0	0	3	circ	5	
CO-40-22A								
CO-40-22B juvenile							1	
CO-40-22C								
CO-40-22D							4	
CO-40-24							2	
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LCN Develop-ment	LCN Wear	LCN Caries	LCN Abscess	LCN Calculus	LCN Calculus Affected	LIN2 Presence	LIN2 Develop-ment
CO-40-25-1	5							
CO-40-27		4	0	0	1	buccal/mesial at and below CEJ	5	
CO-40-29A								
CO-40-30							5	
CO-40-31A		1	0	0	0		1	
CO-40-31B							8	4
CO-40-31C		5	0	0	1	lingual crown	2	
CO-40-31-1C							5	
CO-40-31D1								
CO-40-31E	14	2	0	0	0		2	
CO-40-31F							5	
CO-40-31G		2	0	0	1	b crown @ CEJ	2	
CO-40-32		2	0	0	1	buccal crown	2	
CO-40-Prov? Skull							5	
CO-40-68C/7yo								
CO-40-68C/3yo								
CO-40-68E/adult		6	0	0	1	circ calc under CEJ	1	
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult		2	0	0	0		2	
CO-40-77							4	
CO-40-79							2	
CO-40-79B69							5	

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LIN2 Wear	LIN2 Caries	LIN2 Abscess	LIN2 Calculus	LIN2 Calculus Affected	LIN1 Presence	LIN1 Develop-ment	LIN1 Wear	LIN1 Caries
CO-40-1									
CO-40-1A									
CO-40-1AB						.			
CO-40-1B						5			
CO-40-1D									
CO-40-1E						4			
CO-40-2									
CO-40-3	3	0	0	1	buccal/lingual @ CEJ and below	1		3	0
CO-40-3-1						4			
CO-40-4									
CO-40-5						5			
CO-40-6A	1	0	0	0		1		1	0
CO-40-6B	5	0	0	2	circ below CEJ	5			
CO-40-6C									
CO-40-6D						1	10	1	0
CO-40-13						2		8	0
CO-40-15A									
CO-40-15B						4			
CO-40-15D						5			
CO-40-16C									
CO-40-16D									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LIN2 Wear	LIN2 Caries	LIN2 Abscess	LIN2 Calculus	LIN2 Calculus Affected	LIN1 Presence	LIN1 Develop- ment	LIN1 Wear	LIN1 Caries
CO-40-17						4			
CO-40-18A						4			
CO-40-18B	PMD					5			
CO-40-19A						1	14	4	0
CO-40-19B									
CO-40-19E						5			
CO-40-19F									
CO-40-19H									
CO-40-19I									
CO-40-19M						5			
CO-40-19R						5			
CO-40-20A						1	14	7	0
CO-40-22A									
CO-40-22B juvenile	1	0	0	0		1		1	0
CO-40-22C									
CO-40-22D						4			
CO-40-24						2			
CO-40-25									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LIN2 Wear	LIN2 Caries	LIN2 Abscess	LIN2 Calculus	LIN2 Calculus Affected	LIN1 Presence	LIN1 Develop-ment	LIN1 Wear	LIN1 Caries
CO-40-25-1									
CO-40-27						5			
CO-40-29A									
CO-40-30						5			
CO-40-31A	1	0	0	0		1		2	0
CO-40-31B	4								
CO-40-31C	5	0	0	1	lingual under CEJ	2		6	0
CO-40-31-1C						5			
CO-40-31D1									
CO-40-31E	2	0	0	0		2		2	0
CO-40-31F						5			
CO-40-31G	2	0	0	1	b crown @ CEJ	5			
CO-40-32	2	0	0	0		2		2	0
CO-40-Prov? Skull						PMD			
CO-40-68C/7yo									
CO-40-68C/3yo									
CO-40-68E/adult	5	0	0	1	b crown				
CO-40-68W/child9yo									
CO-40-68W/infant									
CO-40-69/1yo									
CO-40-69/4yo									
CO-40-69/adult	2	0	0	1	buccal below CEJ	2		2	0
CO-40-77						4			
CO-40-79						2			
CO-40-79B69						5			

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LIN1 Abscess	LIN1 Calculus	LIN1 Calculus Affected	RIN1 Presence	RIN1 Develop-ment	RIN1 Wear	RIN1 Caries	RIN1 Abscess
CO-40-1								
CO-40-1A								
CO-40-1AB				.				
CO-40-1B				5				
CO-40-1D								
CO-40-1E				4				
CO-40-2								
CO-40-3	0	2	buccal/lingual @ CEJ and below	5				
CO-40-3-1				4				
CO-40-4								
CO-40-5				5				
CO-40-6A	0	0		1		1	0	0
CO-40-6B				5				
CO-40-6C								
CO-40-6D	0	0		1	10	1	0	0
CO-40-13	0	0		5				
CO-40-15A								
CO-40-15B				4				
CO-40-15D				5				
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LIN1 Abscess	LIN1 Calculus	LIN1 Calculus Affected	RIN1 Presence	RIN1 Develop-ment	RIN1 Wear	RIN1 Caries	RIN1 Abscess
CO-40-17				4				
CO-40-18A				4				
CO-40-18B				5				
CO-40-19A	0	0						
CO-40-19B								
CO-40-19E				5				
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M				5				
CO-40-19R				5				
CO-40-20A	0	1	under CEJ	5				
CO-40-22A								
CO-40-22B juvenile	0	0		1		1	0	0
CO-40-22C								
CO-40-22D				4/5				
CO-40-24				2				
CO-40-25								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	LIN1 Abscess	LIN1 Calculus	LIN1 Calculus Affected	RIN1 Presence	RIN1 Develop-ment	RIN1 Wear	RIN1 Caries	RIN1 Abscess
CO-40-25-1								
CO-40-27				2		5	0	0
CO-40-29A								
CO-40-30				5				
CO-40-31A	0	1	mesial interprox crown	1		2	0	0
CO-40-31B								
CO-40-31C	0	0		2		6	0	0
CO-40-31-1C				5				
CO-40-31D1								
CO-40-31E	0	0		2		2	0	0
CO-40-31F				5				
CO-40-31G				5				
CO-40-32	0	1	buccal crown	2		2		
CO-40-Prov? Skull				5				
CO-40-68C/7yo				1	9+	1	0	0
CO-40-68C/3yo								
CO-40-68E/adult								
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo				1	6			
CO-40-69/adult	0	0		2		2	0	0
CO-40-77				4				
CO-40-79								
CO-40-79B69				5				

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RIN1 Calculus	RIN1 Calculus Affected	RIN2 Presence	RIN2 Develop-ment	RIN2 Wear	RIN2 Caries	RIN2 Abscess	RIN2 Calculus
CO-40-1								
CO-40-1A								
CO-40-1AB			4					
CO-40-1B			5					
CO-40-1D								
CO-40-1E			5					
CO-40-2								
CO-40-3			5					
CO-40-3-1			4					
CO-40-4								
CO-40-5			1	PMD	2	0	0	2
CO-40-6A	0		5					
CO-40-6B			1		5	0	0	2
CO-40-6C								
CO-40-6D	0							
CO-40-13			5					
CO-40-15A								
CO-40-15B			4					
CO-40-15D			5					
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RIN1 Calculus	RIN1 Calculus Affected	RIN2 Presence	RIN2 Develop-ment	RIN2 Wear	RIN2 Caries	RIN2 Abscess	RIN2 Calculus
CO-40-17			4					
CO-40-18A			5					
CO-40-18B			5					
CO-40-19A								
CO-40-19B								
CO-40-19E			5					
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M			5					
CO-40-19R			5					
CO-40-20A			5					
CO-40-22A								
CO-40-22B juvenile	0		1		1	0	0	0
CO-40-22C								
CO-40-22D								
CO-40-24			1	14	3	0	0	2
CO-40-25			5					

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RIN1 Calculus	RIN1 Calculus Affected	RIN2 Presence	RIN2 Develop-ment	RIN2 Wear	RIN2 Caries	RIN2 Abscess	RIN2 Calculus
CO-40-25-1			1	6				
CO-40-27	1	buccal/lingual at and below CEJ	2		5	0	0	1
CO-40-29A								
CO-40-30			5					
CO-40-31A	1	mesial interprox crown	1		1	0	0	0
CO-40-31B								
CO-40-31C	0	cleaned	2		6	0	0	0
CO-40-31-1C			5					
CO-40-31D1								
CO-40-31E	0		2		1	0	0	0
CO-40-31F			5					
CO-40-31G			5					
CO-40-32	1	buccal crown	1		2	0	0	1
CO-40-Prov? Skull			5					
CO-40-68C/7yo	0		1	9	0	0	0	0
CO-40-68C/3yo								
CO-40-68E/adult			1		5	0	0	1
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo			2	6				
CO-40-69/adult	0		5					
CO-40-77			4					
CO-40-79								
CO-40-79B69			5					

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RIN2 Calculus Affected	RCN Presence	RCN Develop-ment	RCN Wear	RCN Caries	RCN Abscess	RCN Calculus	RCN Calculus Affected
CO-40-1								
CO-40-1A								
CO-40-1AB		5						
CO-40-1B		5						
CO-40-1D								
CO-40-1E		5						
CO-40-2								
CO-40-3		1		4	0	0	1	below buccal CEJ
CO-40-3-1		4						
CO-40-4								
CO-40-5	circ crown	1	PMD	3	0	0	1	buccal crown
CO-40-6A		1		1	0	0	1	buccal crown
CO-40-6B	circ below CEJ							
CO-40-6C		1	7					
CO-40-6D		8	7					
CO-40-13		2		6	0	0	1	buccal under CEJ. Poss more, but PMD + adhesions
CO-40-15A								
CO-40-15B		4						
CO-40-15D		5						
CO-40-16C								
CO-40-16D								

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RIN2 Calculus Affected	RCN Presence	RCN Develop-ment	RCN Wear	RCN Caries	RCN Abscess	RCN Calculus	RCN Calculus Affected
CO-40-17		4						
CO-40-18A		5						
CO-40-18B		5						
CO-40-19A								
CO-40-19B		1	9+	4				
CO-40-19E		5						
CO-40-19F								
CO-40-19H								
CO-40-19I								
CO-40-19M		1	14	2	0	0	1	mesial on buccal aspect of crown
CO-40-19R		5						
CO-40-20A		5						
CO-40-22A								
CO-40-22B juvenile		2						
CO-40-22C								
CO-40-22D								
CO-40-24	buccal and lingual at CEJ	2		2	0	0	1	distal poss (PMD), at CEJ
CO-40-25		5						

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RIN2 Calculus Affected	RCN Presence	RCN Develop-ment	RCN Wear	RCN Caries	RCN Abscess	RCN Calculus	RCN Calculus Affected
CO-40-25-1								
CO-40-27	buccal/lingual at and below CEJ	2		5	0	0	1	buccal/lingual CEJ and below
CO-40-29A								
CO-40-30		5						
CO-40-31A		2		2	0	0	0	
CO-40-31B								
CO-40-31C	cleaned	2		6	0	0	0	
CO-40-31-1C		5						
CO-40-31D1								
CO-40-31E		2		2	0	0	0	
CO-40-31F		5						
CO-40-31G		1		3	0	0	1	b crown
CO-40-32	buccal crown	2		2	0	0	1	buccal crown
CO-40-Prov? Skull		4						
CO-40-68C/7yo								
CO-40-68C/3yo		1	4	0	0	0	0	
CO-40-68E/adult	m crown							
CO-40-68W/child9yo								
CO-40-68W/infant								
CO-40-69/1yo								
CO-40-69/4yo								
CO-40-69/adult		2		3	0	0	1	buccal crown
CO-40-77		4						
CO-40-79								
CO-40-79B69		5						

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPMN1 Presence	RPMN1 Develop-ment	RPMN1 Wear	RPMN1 Caries	RPMN1 Abscess	RPMN1 Calculus	RPMN1 Calculus Affected
CO-40-1							
CO-40-1A							
CO-40-1AB	5						
CO-40-1B	2		2	0	0	0	
CO-40-1D							
CO-40-1E	5						
CO-40-2							
CO-40-3	2		3	0	0	1	lingual below CEJ
CO-40-3-1	4						
CO-40-4	1		1	0	0	0	
CO-40-5	1	PMD	3	0	0	1	distal crown
CO-40-6A	2		1	0	0	0	
CO-40-6B	1		6	0	0	1	circ at CEJ
CO-40-6C	1	7					
CO-40-6D							
CO-40-13	2	PMD					
CO-40-15A							
CO-40-15B	4						
CO-40-15D	5						
CO-40-16C							
CO-40-16D							

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPMN1 Presence	RPMN1 Develop-ment	RPMN1 Wear	RPMN1 Caries	RPMN1 Abscess	RPMN1 Calculus	RPMN1 Calculus Affected
CO-40-17	4						
CO-40-18A	5						
CO-40-18B	2		6	0	0	2	circumferential crown
CO-40-19A	1	14	4	0	0	1	buccal crown
CO-40-19B	8						
CO-40-19E	5						
CO-40-19F							
CO-40-19H							
CO-40-19I							
CO-40-19M	5						
CO-40-19R							
CO-40-20A	5						
CO-40-22A							
CO-40-22B juvenile	2						
CO-40-22C							
CO-40-22D							
CO-40-24	2		2	0	0	1	buccal, lingual @ and below CEJ
CO-40-25	5						

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPMN1 Presence	RPMN1 Develop-ment	RPMN1 Wear	RPMN1 Caries	RPMN1 Abscess	RPMN1 Calculus	RPMN1 Calculus Affected
CO-40-25-1							
CO-40-27	2		5	0	0	0	
CO-40-29A							
CO-40-30	5						
CO-40-31A	2		2	0	0	0	
CO-40-31B	1	4	0				
CO-40-31C	2		6	0	0	1	under lingual CEJ
CO-40-31-1C	5						
CO-40-31D1							
CO-40-31E	5						
CO-40-31F	5						
CO-40-31G	2		3	0	0	1	b crown
CO-40-32	1		2	0	0	1	mesial/lingual crown
CO-40-Prov? Skull	4						
CO-40-68C/7yo							
CO-40-68C/3yo							
CO-40-68E/adult	1		7	0	0	1	d crown to CEJ
CO-40-68W/child9yo							
CO-40-68W/infant							
CO-40-69/1yo							
CO-40-69/4yo							
CO-40-69/adult	2		3	0	0	0	
CO-40-77	4						
CO-40-79							
CO-40-79B69	5						

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPMN2 Presence	RPMN2 Develop-ment	RPMN2 Wear	RPMN2 Caries	RPMN2 Abscess	RPMN2 Calculus	RPMN2 Calculus Affected	RMN1 Presence
CO-40-1								
CO-40-1A								
CO-40-1AB	5							4
CO-40-1B	2		2	0	0	0		1
CO-40-1D								
CO-40-1E	5							5
CO-40-2								2
CO-40-3	2		3	0	0	1	lingual below CEJ	2
CO-40-3-1	4							
CO-40-4	5							2
CO-40-5	1	PMD	3	0	0	1	buccal crown & CEJ	1
CO-40-6A	2		2	0	0	0		2
CO-40-6B	5							1
CO-40-6C	8							1
CO-40-6D								1
CO-40-13	1		6			2	lingual crown to CEJ	1
CO-40-15A								
CO-40-15B	4							4
CO-40-15D	4							4
CO-40-16C								2
CO-40-16D								2

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPMN2 Presence	RPMN2 Develop-ment	RPMN2 Wear	RPMN2 Caries	RPMN2 Abscess	RPMN2 Calculus	RPMN2 Calculus Affected	RMN1 Presence
CO-40-17	4							2
CO-40-18A	4							4
CO-40-18B	4				0			4
CO-40-19A	5							1
CO-40-19B	8	7						1
CO-40-19E	5							5
CO-40-19F								1
CO-40-19H								2
CO-40-19I								1
CO-40-19M	1	14	2	0	0	0		1
CO-40-19R	1	14	3	0	0	0		
CO-40-20A	5							2
CO-40-22A								
CO-40-22B juvenile	1	Ri	0	0	0	0		1
CO-40-22C								1
CO-40-22D								
CO-40-24	1	14	2	0	0	1	buccal, lingual patchy on crown	2
CO-40-25	5				1			5

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RPMN2 Presence	RPMN2 Develop-ment	RPMN2 Wear	RPMN2 Caries	RPMN2 Abscess	RPMN2 Calculus	RPMN2 Calculus Affected	RMN1 Presence
CO-40-25-1								
CO-40-27	2		4	0	0	0		2
CO-40-29A								2
CO-40-30	5							4
CO-40-31A	2		3	0	0	0		2
CO-40-31B								1
CO-40-31C	2		6	0	0	1	at lingual CEJ	2
CO-40-31-1C	5							5
CO-40-31D1								
CO-40-31E	5							2
CO-40-31F	5							2
CO-40-31G	2		3	0	0	1	probably 1 @ b crown, but PMD to area	2
CO-40-32	2		2	0	0	0		2
CO-40-Prov? Skull	4							2
CO-40-68C/7yo								
CO-40-68C/3yo								1
CO-40-68E/adult								
CO-40-68W/child9yo								2
CO-40-68W/infant								
CO-40-69/1yo								1
CO-40-69/4yo								2
CO-40-69/adult	2		2	0	0	0		2
CO-40-77	4							4
CO-40-79								
CO-40-79B69	5							4

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN1 Develop-ment	RMN1 Wear	RMN1 Caries	RMN1 Abscess	RMN1 Calculus	RMN1 Calculus Affected	RMN2 Presence	RMN2 Develop-ment
CO-40-1								
CO-40-1A								
CO-40-1AB							4	
CO-40-1B	14	13	1	0	0		1	14
CO-40-1D								
CO-40-1E							2	7
CO-40-2		4					8	
CO-40-3		19	0	0	1	lingual below CEJ	1	
CO-40-3-1							5	
CO-40-4		18	0	0	0		2	
CO-40-5	PMD	17	0	0	1	lingual CEJ	1	PMD
CO-40-6A		17	0	0	0		2	
CO-40-6B		16	0	0	1	mb crown	5	
CO-40-6C	10	4					8	6
CO-40-6D	11	4	0	0	0			
CO-40-13		37	0	1	1	lingual & buccal on roots	4	
CO-40-15A								
CO-40-15B							4	
CO-40-15D							5	
CO-40-16C		4	0	0	0		2	6+
CO-40-16D	3	4						

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN1 Develop-ment	RMN1 Wear	RMN1 Caries	RMN1 Abscess	RMN1 Calculus	RMN1 Calculus Affected	RMN2 Presence	RMN2 Develop-ment
CO-40-17		15	1	1	0	probably cleaned	4	
CO-40-18A							4	
CO-40-18B				0			4	
CO-40-19A	PMD	17	1	0	0			
CO-40-19B	11	4	0	0	0			
CO-40-19E							1	10
CO-40-19F	6	4						
CO-40-19H							2	3
CO-40-19I	12	4	1	0	0			
CO-40-19M	PMD	18	0	0	0		5	
CO-40-19R							4	
CO-40-20A		22	0	0	1	lingual below CEJ	2	
CO-40-22A								
CO-40-22B juvenile	11	4	0	0	0		1	7
CO-40-22C	4							
CO-40-22D							5	
CO-40-24		15	0	0	1	circ @ and under CEJ	4	
CO-40-25				1			5	

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN1 Develop-ment	RMN1 Wear	RMN1 Caries	RMN1 Abscess	RMN1 Calculus	RMN1 Calculus Affected	RMN2 Presence	RMN2 Develop-ment
CO-40-25-1							1	5
CO-40-27		20	1	1	0		4	
CO-40-29A	11	4	0	0	0			
CO-40-30							2	
CO-40-31A		14	0	0	0		7	
CO-40-31B	7	4					1	4
CO-40-31C		34	0	0	1	mesial crown	2	
CO-40-31-1C				poss healed abscess			2	
CO-40-31D1								
CO-40-31E		12	1	0	0		1	14
CO-40-31F		16	1	0	0		2	PMD
CO-40-31G		15	0	0	0		2	
CO-40-32		16	0	0	0		4	
CO-40-Prov? Skull		16x	1	1	1	circ @ CEJ	1	
CO-40-68C/7yo								
CO-40-68C/3yo	6							
CO-40-68E/adult								
CO-40-68W/child9yo							2	
CO-40-68W/infant								
CO-40-69/1yo	4	0	0	0	0			
CO-40-69/4yo	7							
CO-40-69/adult		17	0	0	0		2	
CO-40-77							4	
CO-40-79								
CO-40-79B69							4	

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN2 Wear	RMN2 Caries	RMN2 Abscess	RMN2 Calculus	RMN2 Calculus Affected	RMN3 Presence	RMN3 Develop-ment	RMN3 Wear	RMN3 Caries
CO-40-1									
CO-40-1A									
CO-40-1AB						3			
CO-40-1B	11	1	0	0		5			
CO-40-1D									
CO-40-1E						6			
CO-40-2									
CO-40-3	16	0	0	1	lingual below CEJ	1		15	0
CO-40-3-1						5			
CO-40-4	12	0	0	1	distal crown	4			
CO-40-5	14		0	0		1	PMD	4	0
CO-40-6A	10	0	0	0		2	7	4	0
CO-40-6B						5			
CO-40-6C									
CO-40-6D									
CO-40-13						4			
CO-40-15A									
CO-40-15B						4			
CO-40-15D						5			
CO-40-16C									
CO-40-16D									

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN2 Wear	RMN2 Caries	RMN2 Abscess	RMN2 Calculus	RMN2 Calculus Affected	RMN3 Presence	RMN3 Develop-ment	RMN3 Wear	RMN3 Caries
CO-40-17						4			
CO-40-18A						4			
CO-40-18B			0			2		17	0
CO-40-19A						4			
CO-40-19B									
CO-40-19E	4	1	0	0		8	3	0	0
CO-40-19F									
CO-40-19H									
CO-40-19I									
CO-40-19M						5			
CO-40-19R						4			
CO-40-20A	21	0	0	1	lingual buccal @ CEJ	1	PMD	16	0
CO-40-22A									
CO-40-22B juvenile	0	0	0	0					
CO-40-22C									
CO-40-22D						5			
CO-40-24						2		11	0
CO-40-25						6			

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN2 Wear	RMN2 Caries	RMN2 Abscess	RMN2 Calculus	RMN2 Calculus Affected	RMN3 Presence	RMN3 Develop-ment	RMN3 Wear	RMN3 Caries
CO-40-25-1									
CO-40-27						6			
CO-40-29A									
CO-40-30	20	0	0	0		4			
CO-40-31A						1	11	11	0
CO-40-31B	0								
CO-40-31C	18		0	0		2		12x	1
CO-40-31-1C	20		0	0		1	PMD	4	0
CO-40-31D1									
CO-40-31E	8	0	0	0		6			
CO-40-31F						5			
CO-40-31G	11	0	0	1	d crown	6			
CO-40-32						2		13	0
CO-40-Prov? Skull	19	0	0	2	circ @ CEJ	1		11	0
CO-40-68C/7yo									
CO-40-68C/3yo									
CO-40-68E/adult									
CO-40-68W/child9yo						2			
CO-40-68W/infant									
CO-40-69/1yo									
CO-40-69/4yo									
CO-40-69/adult	12	0	0	0		2		9	0
CO-40-77						4			
CO-40-79									
CO-40-79B69						4			

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN3 Abscess	RMN3 Calculus	RMN3 Calculus Affected	Estimated Age
CO-40-1				50+
CO-40-1A				20-35
CO-40-1AB				20-35
CO-40-1B				U
CO-40-1D				0-5
CO-40-1E				35-50
CO-40-2				0-5
CO-40-3	0	1	lingual below CEJ	35-50
CO-40-3-1				50+
CO-40-4				20-35
CO-40-5	0	0		20-35
CO-40-6A	0	0		15-20
CO-40-6B				35-50
CO-40-6C				5-10
CO-40-6D				0-5
CO-40-13				35-50
CO-40-15A				20-35
CO-40-15B				35-50
CO-40-15D				U
CO-40-16C				5-10
CO-40-16D				0-5

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN3 Abscess	RMN3 Calculus	RMN3 Calculus Affected	Estimated Age
CO-40-17				35-50
CO-40-18A				20-35
CO-40-18B	0	2	circ crown	35-50
CO-40-19A				20-35
CO-40-19B				5-10
CO-40-19E	0	0		10-15
CO-40-19F				0-5
CO-40-19H				0-5
CO-40-19I				5-10
CO-40-19M				20-35
CO-40-19R				35-50
CO-40-20A	0	1	circ @ CEJ	20-35
CO-40-22A				35-50
CO-40-22B juvenile				5-10
CO-40-22C				0-5
CO-40-22D				50+
CO-40-24	0	1	lingual @ CEJ (poss circ, but cleaned off)	adult
CO-40-25				20-35

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	RMN3 Abscess	RMN3 Calculus	RMN3 Calculus Affected	Estimated Age
CO-40-25-1				0-5
CO-40-27				35-50
CO-40-29A				5-10
CO-40-30				35-50
CO-40-31A	0	0		20-35
CO-40-31B				0-5
CO-40-31C	0	1	mesial crown	35-50
CO-40-31-1C	0	0		20-35
CO-40-31D1				0-5
CO-40-31E				15-20
CO-40-31F				35-50
CO-40-31G				Adult
CO-40-32	0	0		20-35
CO-40-Prov? Skull	0	2	circ @ CEJ	Adult
CO-40-68C/7yo				5-10
CO-40-68C/3yo				3-4 years
CO-40-68E/adult				50+
CO-40-68W/child9yo				9+/-24 mo
CO-40-68W/infant				18 mo
CO-40-69/1yo				
CO-40-69/4yo				0-5
CO-40-69/adult	0	0		20-35
CO-40-77				35-50
CO-40-79				
CO-40-79B69				

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	Comments Max
CO-40-1	
CO-40-1A	Right max only. Can't tell if M1 & M2 resorbing (or just M1), because of of remodeling. PM1 turned perpendicularly. I's completely resorbed.
CO-40-1AB	RNI2 poss ant loss, PMD to bone, but present bone looks resorbed
CO-40-1B	I1 adhesions, so can't tell calc or LEH since buccal and lingual covered. P1 is turned mesial/distally
CO-40-1D	3-4 yr
CO-40-1E	
CO-40-2	3-4+/- 1 year; RM1 unerupted
CO-40-3	L molars: crowns broken PMD, roots in occlusion. RC , RPM1, RI2 have enamel defects (vert lines, shoveling-esqe on lingual). LM3 = accessory "ring of enamel around crown. Non-metric or mullberry?
CO-40-3-1	
CO-40-4	
CO-40-5	LI1: PMD to lingual enamel. Front shoveling, not back. Horizontal bands of discoloration, no LEH. LM1-3 no assoc alveolar due to PMD
CO-40-6A	15+; LM3, RM3 unerupted
CO-40-6B	LPM1 turned mesially.
CO-40-6C	RM2, LC unerupted
CO-40-6D	
CO-40-13	PMD to alveolar bone under LM2-3 means could have been abscess here too, but PMD. Possible abscess at LC, but PMD to alveolar bone. Truncated root suggests possible abscess or developmental disruption
CO-40-15A	
CO-40-15B	
CO-40-15D	
CO-40-16C	Max: L/RM1 erupted; 6 yrs +/-24 mo
CO-40-16D	1 +/- 4mo; RM1 unerupted

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	Comments Max
CO-40-17	
CO-40-18A	Antemortem loss, so hard to tell exactly which teeth lost. Best guess is M2/M1/PM2/PM1/LC - two roots of approximately the same size. Possible I2, but canine seems more likely. Depression behind M2 suggests M3 lost antemortem.
CO-40-18B	LMN1 root turned ML - seems to be ML root, but parallel to jaw, not perpendicular. RMN2 only active resorbing alveolar socket.
CO-40-19A	
CO-40-19B	Max: L/RM1 erupted with wear. RI1 has LEH (prob) at 2.35 and 5 horizontal imperfecta bands. RI2 reassociated from 19H. LC, LM2, RM2 unerupted
CO-40-19E	
CO-40-19F	I = not quite 4, but more than 3, so 3.5 - 4 yo; LI1, LM1 u
CO-40-19H	4yo
CO-40-19I	loose teeth only, LC, RM2 unerupted
CO-40-19M	
CO-40-19R	
CO-40-20A	Max: LPM2 is glued into RC socket (backwards). Something in pencil seems to be written to that effect on mandible.
CO-40-22A	RP1-root broke in socket, leaning into P2. RC has weathering crack length of tooth. LP1 enamel on buccal cusp missing. Prob PMD, but no sharp edges and wear appears to follow curve of missing enamel. Poss secondary dentine below, poss healed abscess.
CO-40-22B juvenile	
CO-40-22C	1 yr +/- 4 mo.
CO-40-22D	
CO-40-24	RM3=PMD to alveolar bone, so PM/ANT loss?, RM2, RPM2, RPM1 - roots only in occlusion (PMD to crown). RI1-LPM2 lost? PMD to alveolar bone
CO-40-25	

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	Comments Max
CO-40-25-1	4+/-12 mo; 5+/-16mo
CO-40-27	
CO-40-29A	RM1 = pit in buccal groove; LM1 = pit in buccal groove + ml accessory cusp
CO-40-30	
CO-40-31A	L/R I1's = double shovel
CO-40-31B	RM1, LC unerupted
CO-40-31C	
CO-40-31-1C	No max bone, M3 found loose.
CO-40-31D1	all unerupted; 9mo +/- 1 yr
CO-40-31E	L1 wear is unusual: mesial aspect of lingual crown worn. Possible occupational wear? Labial winging - non metric
CO-40-31F	LM1 slid laterally. LM2 prob ANT loss (causing dentition shift) w/ M3 PMD 1 root visible & in occlusion. Unsure what missing on anterior L max - either PM2 or LI2 (with major movement out of occlusion), but LI2 based on root hole length present
CO-40-31G	
CO-40-32	
CO-40-Prov? Skull	Max: LM2 has PMD damage to the crown, represented by "X" in Wear.
CO-40-68C/7yo	7-8 yo
CO-40-68C/3yo	
CO-40-68E/adult	2 worn roots (wear = 8), probably incisors. Max RPM has divot in center of crown occlusal surface, buccal aspect. Crown has almost V-shaped wear, possible occupational wear? Possible midline crown pit.
CO-40-68W/child9yo	
CO-40-68W/infant	
CO-40-69/1yo	
CO-40-69/4yo	4.5-6 yrs
CO-40-69/adult	LEH: RC
CO-40-77	
CO-40-79	
CO-40-79B69	

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	Comments Mand
CO-40-1	
CO-40-1A	
CO-40-1AB	
CO-40-1B	RM2-PMD, RM1-PMD=roots broken.
CO-40-1D	
CO-40-1E	RMN2 roots only
CO-40-2	RMN1, LMN1 unerupted
CO-40-3	
CO-40-3-1	RPM2-LM1 almost completely resorbed. RM2 & RM3 not present in inver Alveolar sockets not reactive, but very shallow. Sm all & fragile mandible
CO-40-4	
CO-40-5	LM3 turned perpendicular. Supernumerary (roots only) in LP2-P1. RP2 turned slightly mesiodistally. Most RMs, notes ref. Pitting on RMN2 (occlusal)
CO-40-6A	RMN3, LMN3 unerupted
CO-40-6B	
CO-40-6C	RMN1: erupted, wear really 1 1 0 0; commingled mand M1 CRc - 3 yr; possibly deciduous - crown only so harder to tell, but smaller and pimply looking, indicating enamel imperfecta/incomplete. 1 canine, check with 6D for commingling; Ri, 8.03, 6.45, 10.88
CO-40-6D	
CO-40-13	L/R PM1 PMD, so only root remains. Poss also worn t o root
CO-40-15A	
CO-40-15B	Mandible: all dentition resorbing
CO-40-15D	
CO-40-16C	
CO-40-16D	RMN1 unerupted

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	Comments Mand
CO-40-17	LM3-PM2 = resorbed. Is=resorbed. RM2-3=resorbing. R M1=PMD buccal at interprox.
CO-40-18A	
CO-40-18B	
CO-40-19A	
CO-40-19B	RC (unerupted) has imperfecta on crown near root. L /RMN1 both erupted wear. LMN2 unerupted
CO-40-19E	
CO-40-19F	LMN1, RMN1 unerupted
CO-40-19H	
CO-40-19I	RMN1 erupted with wear.
CO-40-19M	
CO-40-19R	RM3, RM2 resorbing (RM2 is probable resorb based on PMD to a
CO-40-20A	
CO-40-22A	max cont: see drawing. PMD under, but small, c-shap ed area with thicker, rounder margins. Socket below root = wider/hollowed out. However, tooth glued into socket.
CO-40-22B juvenile	LC, RC, RPM1 - in crypts. M1 wear = no wear on ML o r MB cusps. Est age 7 +/-2yrs
CO-40-22C	
CO-40-22D	L = majority lost antemortem. See skeletal notes re garding how determined present/absent dentition; some room for error based on extent of antemortem resorption
CO-40-24	RI1-LPM2 = crown broke PM, roots in occlusion. LM1: socket present, so postmortem loss, but remodeling present in socket. LM2 lost antemortem fully resorbed; LM3 appears to have moved anterior slightly due to antemortem loss
CO-40-25	RM3 isn't present, probable congenitally absent bas ed on age of individual and no active alveolar bone.

Dental Inventory Recording Form: Development, Wear, and Pathology: Permanent Teeth (Attachment 16)

Accession Number	Comments Mand
CO-40-25-1	LMN1 unerupted
CO-40-27	
CO-40-29A	
CO-40-30	LMN3 = turned MB
CO-40-31A	LM3 = PMD to crown, appears to be glued together an d in place.
CO-40-31B	RMN1 unerupted; LNI2, LMN1, LMN2 unerupted
CO-40-31C	LM3 roots in occlusion, crown PMD. LM1 abscess arou nd db root is healed. RMN2 1 pit db cusp (occlusal)
CO-40-31-1C	Mand: RM3 is unworn. Turned DL (barely contacting M 2, so may be too o occlusion to wear. RM2 turned slightly DL. Buccal g roove pit RMN2
CO-40-31D1	
CO-40-31E	
CO-40-31F	LM2 - ramus and bone missing, but immediate distal bone looks active-ish with space. Poss PMD (given R arrange of dent), pos s ANT
CO-40-31G	
CO-40-32	LM2: alveolar bone is receeding, probable antemorte m loss, but check DNA list.
CO-40-Prov? Skull	Mand: LPM1 = peg, RM1 has damage to the enamel on B D cusp
CO-40-68C/7yo	
CO-40-68C/3yo	
CO-40-68E/adult	1 root (wear = 8), probably incisor
CO-40-68W/child9yo	dentition in crypts
CO-40-68W/infant	
CO-40-69/1yo	
CO-40-69/4yo	
CO-40-69/adult	LEH: LCN, RCN
CO-40-77	RC resorbing, rest resorbed completely
CO-40-79	Possible LM1, root remains, crown broken PMD. PMs & C resorbed. LI2, LI1 roots only, crowns PMD
CO-40-79B69	antemortem resorption of all molars, with RM3 still actively resorl

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

Accession Number	Rm2 Presence	Rm2 Development	Rm2 Caries	Rm2 Abscess	Rm2 Calculus	Rm1 Presence	Rm1 Development
CO-40-2	1	11	0	0	0	1	12
CO-40-6C	1		0	0	0	1	
CO-40-6D	1		0	0	0	1	
CO-40-16C	2		0	0	0	2	
CO-40-16D							
CO-40-16E	1						
CO-40-19B	1		0	0	0	2	
CO-40-19F							
CO-40-19H	1		0	0	0		
CO-40-19L							
CO-40-22B juven	2		0	0	0	2	
CO-40-22C							
CO-40-25-1	1					1	
CO-40-29A	2		0	0	0	2	
CO-40-31B	1		0	0	0	1	
CO-40-31B1							
CO-40-31D1							
CO-40-31H							
CO-40-32B							
CO-40-68C/Infant	0	0	0	0	0	1	6
CO-40-68C/3yo	1		0	0	0	1	
CO-40-68C/7yo	1	0	0	0	0	1	0
CO-40-68W/infant	1					1	6
CO-40-68W/child9yo							
CO-40-69/1yo	2	10	0	0	0		
CO-40-69/4yo	1		0	0	0	2	

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

Rm1 Caries	Rm1 Abscess	Rm1 Calculus	Rc Presence	Rc Develop-ment	Rc Caries	Rc Abscess	Rc Calculus	Ri2 Presence	Ri2 Develop-ment
0	0	0							
0	0	0							
0	0	0	1	12	0	0	0		
0	0	0	2		0	0	0		
0	0	0	1	PMD	0		0		
			1	12	0	0	0		
			1	PMD	0	0	0		
0	0	0							
								1	PMD
			1	14					
0	0	0							
0	0	0							
			1	10				1	12
0	0	0							
0	0	0						1	
0	0	0	1					1	
0	0	0	1	6	0	0	0	1	
0	0	0							

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

Ri2 Caries	Ri2 Abscess	Ri2 Calculus	Ri1 Presence	Ri1 Development	Ri1 Caries	Ri1 Abscess	Ri1 Calculus	Li1 Presence	Li1 Development
								1	PMD
								1	11
			1	12	0				
0	0	0							
			1	10					
0	0	0	1		0	0	0	2	
			1						
0	0	0							

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

Li1 Caries	Li1 Abscess	Li1 Calculus	Li2 Presence	Li2 Develop-ment	Li2 Caries	Li2 Abscess	Li2 Calculus	Lc Presence	Lc Develop-ment
0	0	0	1	12	0	0	0		
								1	14
0	0	0							
								1	PMD
			1	10	0	0	0	1	7
								1	14
			1	6				1	4
			1	12					
								1	5
0	0	0							
								5	

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

Lc Caries	Lc Abscess	Lc Calculus	Lm1 Presence	Lm1 Development	Lm1 Caries	Lm1 Abscess	Lm1 Calculus	Lm2 Presence	Lm2 Development
								1	11
0	0	0	1		0	0	0	1	
			1	PMD	0	0	0	1	PMD
			2		0	0	0	2	
			1	PMD	0	0	0	1	14
								1	11
0	0	0	1	12	0	0	0		
			1	PMD	0	0	0		
0	0	0	1	9	0		0		
			1					1	
			2		0	0	0	2	
			1		0	0	0	1	12
			1	9					
0	0	0							
			2		0	0	0	2	
			1					1	
			1	6	0	0	0		
			1		0	0	0	2	

Dental Inventory Recording Form: Development and Pa thology: Deciduous Teeth (Attachment 17)

Lm2 Caries	Lm2 Abscess	Lm2 Calculus	LmN2 Presence	LmN2 Develop-ment	LmN2 Caries	LmN2 Abscess	LmN2 Calculus	LmN1 Presence
0	0	0	2		0	0	0	2
0	0	0	1		0	0	0	1
0	0	0	1	PMD	0	0	0	1
0	0	0	2		0	0	0	PMD
			2	6				2
0	0	0	1	14	0	0	0	1
1 pit mb	0	0	1	11				1
			2		0	0	0	2
			1	7	0		0	1
			2					2
0	0	0	2	0	0	0	0	5
0	0	0	2		0	0	0	1
								1
			1	6				
			1	11				
								2
0	0	0	2		0	0	0	2
			5					5
			1	3	0	0	0	1
			2					2
			2	4	0	0	0	2
0	0	0	2		0	0	0	2

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

LmN1 Develop-ment	LmN1 Caries	LmN1 Abscess	LmN1 Calculus	LNc Presence	LNc Develop-ment	LNc Caries	LNc Abscess	LNc Calculus	LNi2 Presence
	0	0	0	2		0	0	0	5
	0	0	0						
PMD	0	0	0						
				5					5
6				2	9				5
14	0	0	0						
11				1	11				1
	0	0	0	5					5
				1	14	0	0	0	
9	0		0						
									1
				5					5
	0	0	0						
4									
									2
				2	7				2
	0	0	0	2		0	0	0	2
				1					1
6	0	0	0						1
9	0	0	0						2
	0	0	0						

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

LNi2 Development	LNi2 Caries	LNi2 Abscess	LNi2 Calculus	LNi1 Presence	LNi1 Development	LNi1 Caries	LNi1 Abscess	LNi1 Calculus	RNi1 Presence
				5					1
				5					5
				5					2
13									1
				5					1
									1
				5					5
				1	7				1
11									
				2					2
	0	0	0	2		0	0	0	2
				1					1
5	0	0	0						
	0	0	0						
				1					1

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

RNi1 Develop-ment	RNi1 Caries	RNi1 Abscess	RNi1 Calculus	RNi2 Presence	RNi2 Develop-ment	RNi2 Caries	RNi2 Abscess	RNi2 Calculus	RNc Presence
	0	0	0	5					5
				5					5
				2					2
14									1
PMD	0	0	0	1	13	0	0	0	1
11	0	0	0						
				1					
				2		0	0	0	2
									1
7									
				1	11				2
				2					2
	0	0	0	2		0	0	0	2
				1					1
				1	5				

Dental Inventory Recording Form: Development and Pathology: Deciduous Teeth (Attachment 17)

RNc Develop-ment	RNc Caries	RNc Abscess	RNc Calculus	RmN1 Presence	RmN1 Develop-ment	RmN1 Caries	RmN1 Abscess	RmN1 Calculus	RmN2 Presence	RmN2 Develop-ment
				2		0	0	0	2	
									1	
				1	14	0	0	0	2	PMD
				2		0	0	0	5	
9				2	6				5	
									1	14
12				1	11					
12	0	0	0	1	PMD	0	0	0	1	11
				1	14	0		0	1	PMD
				1	9	0		0	1	7
				1					2	
	0	0	0	2		0	0	0	2	
12	0	0	0	1		0	0	0	1	
				1	4					
10				2	10				1	6
				2					1	
7				2					2	
	0	0	0	2		0	0	0	2	
				1	6	0	0	0	1	3
				2					2	
				2	9	0	0	0	2	7
				2					2	

RmN2 Caries	RmN2 Abscess	RmN2 Calculus	Estimated Age
0	0	0	3-4+/-1 year
0	0	0	8
0	0	0	0-5
			6+/- 24 mo
			1+/-4mo
			9mo +/-3mo
0	0	0	7+/- 2yrs
			3-4
0	0	0	2.5-3
			fetal
0		0	7+/-2
0		0	1 yr +/- 4mo
			4-5
0	0	0	7 +/- 2 yrs
0	0	0	4
			6 mo +/- 2 mo
			9mo +/- 1 yr
			4 & 8
			6-9 mo
			6mo - 1 yr
0	0	0	3-4.5 years
0	0	0	6mo-1yr
			9yr +/- 24 mo
0	0	0	0-5
			4.5-6yo

Comments
Max LC has slight resorption of the root (initial). Some commin dentition (see commingled)
Right max canine at least 12+ in development
need to X-ray to see roots. LmN2 (6+), LmN1 (6+), L Nc uneru RNi1 is roots only, PMD, probably erupted. RNi2 roo ts only, PMD, probably erupted. RNc unerupted. RmN1 no wear, uner upted (6+).
frg M1 crown next to Rm2 - CR1/4+; RC frg - crown i n crypt; CR 12 mo. Need to add to Permenant?
RmN2 may be starting to resorb at root apex.
Lm2, LNc, RNm1 = 11+ development
Max Ri1 resorbing
dm1, dm2 crowns - mineralizing - consistent with 11 wks in
RmN1 resorbing
Ri2, Li2, RNi1 erupted (wear), rest not. Lm1, LNm1 9+, but PMD; 11-12 development
Max Rc, Lc has roots resorbing.
RNc 12+
Max Rc unerupted (no wear), development at least 10 +. Max Mand LNi2 erupted (wear), Lm1 unerupted (no wear). LmN2 unerup RNc unerupted. RmN1 unerupted. RmN2 unerupted
LmN2 = 4yo; RmN1, RmN2 = 8yo.Max m1 crown frg found , but er only with wear present. RmN2 resorbing- frg in occl usion.
Note: All in crypts except Li2 which has a small we ar facet. radiograph to get more accuate age.
mand di2: unsided, crown complete. Rm1 has PMD, but at least cr formed.
Max Ri1 resorbing
1.5-2.5 yrs; Rm2 (max) has wear, so erupted. L deci duous all in c (at least 9mo); LmN2 4+

Enamel Defects Recording Form: Permanent Teeth (Attachment 18)

Accession Number	RC Defect 1Type	RC Defect 1 Location	LC Defect 1Type	LC Defect 1 Location	LCN Defect 1Type	LCN Defect 1 Location	RCN Defect 1 Type	RCN Defect 1 Location
CO-40-1	LEH	1.97						
CO-40-13	LEH	2.75						
CO-40-31E			LEH	3.19 (prob)			LEH	2.90
CO-40-69	LEH	4.51			LEH	3.29	LEH	3.35

Cranial and Postcranial Measurement Recording Form: Adult Remains (Attachment 21)

Accession Number	Clavicle Maximum Length	Clavicle: AP diameter	Clavicle: SI diameter	Humerus Maximum Length	Humerus Epicondylar Breadth	Humerus Vertical Diameter	Humerus Maximum Diameter at Midshaft	Humerus Minimum Diameter at Midshaft
CO-40-1				277	PMD	PMD	20.42	17.63
CO-40-1A								
CO-40-1E				309	60.18	43.86	19.46	16.16
CO-40-4								
CO-40-13								
CO-40-18B								
CO-40-19A								
CO-40-19R								
CO-40-20A								
CO-40-26	153.76			301.1	61	47	20.68	17.44
CO-40-27								
CO-40-31A								
CO-40-31G				282.3	50.13	40.17	20.31	15.93
CO-40-32A								
CO-40-77								
CO-40-77b69								

Cranial and Postcranial Measurement Recording Form: Adult Remains (Attachment 21)

Accession Number	Radius Maximum Length	Radius AP Diameter at Midshaft	Radius ML Diameter at Midshaft	Ulna Maximum Length	Ulna AP Diameter	Ulna ML Diameter	Ulna Physiological Length
CO-40-1							
CO-40-1A							
CO-40-1E							
CO-40-4							
CO-40-13							
CO-40-18B	222						
CO-40-19A							
CO-40-19R							
CO-40-20A							
CO-40-26							
CO-40-27							
CO-40-31A							
CO-40-31G	205	10.87	12.65				
CO-40-32A				274.69	18.95	13.36	241.65
CO-40-77	204.5	10.25	11.9		15.82	12.28	
CO-40-77b69							

Cranial and Postcranial Measurement Recording Form: Adult Remains (Attachment 21)

Accession Number	Ulna Minimum Circumference	Sacrum Anterior Length	Sacrum Anterior Superior Breadth	Os Coxae Height	Os Coxae Iliac Breadth	Os Coxae Pubis Length	Os Coxae Ischium Length	Femur Maximum Length
CO-40-1								388
CO-40-1A								
CO-40-1E								430
CO-40-4								
CO-40-13								
CO-40-18B								
CO-40-19A								397.5
CO-40-19R								421
CO-40-20A								441
CO-40-26					154.65			442.5
CO-40-27								
CO-40-31A								474
CO-40-31G								
CO-40-32A								
CO-40-77								
CO-40-77b69								410.3

Cranial and Postcranial Measurement Recording Form: Adult Remains (Attachment 21)

Accession Number	Femur Bicondylar Length	Femur Epicondylar Breadth	Femur Maximum Diameter of Femur Head	Femur AP Subtrochanteric Diameter	Femur ML Subtrochanteric Diameter	Femur AP Midshaft Diameter	Femur ML Midshaft Diameter
CO-40-1	391.9	PMD	PMD	26.07	33.54	25.6	24.51
CO-40-1A	419	69.49	PMD	22.13	30.53	22.57	26.4
CO-40-1E	426			23.86	32.87	26.23	26.71
CO-40-4							
CO-40-13							
CO-40-18B							
CO-40-19A	391			25.37	29.74	26.87	21.29
CO-40-19R				25.81	28.38	27.93	23.83
CO-40-20A	438		44.2	27.66	32.62	31.74	25.64
CO-40-26	436	82.1	47.26	30.88	27.15	27.25	24.54
CO-40-27							
CO-40-31A	471	.	.	29.97	25.84	29.72	24.97
CO-40-31G							
CO-40-32A							
CO-40-77							
CO-40-77b69	404.9	72.3	44.29	27.52	26.62	29.38	22.63

Cranial and Postcranial Measurement Recording Form: Adult Remains (Attachment 21)

Accession Number	Femur Midshaft Circumference	Tibia Length	Tibia Maximum Proximal Epiphyseal Breadth	Tibia Maximum Distal Epiphyseal Breadth	Tibia Maximum Diameter at the Nutrient Foreman	Tibia ML Diameter at the Nutrient Foreman	Tibia Circumference at the Nutrient Foreman
CO-40-1	80						
CO-40-1A	82						
CO-40-1E	85						
CO-40-4		351	62.5	40	42.32	18.52	78
CO-40-13							
CO-40-18B							
CO-40-19A	90						
CO-40-19R	86						
CO-40-20A	90						
CO-40-26		357.8	75.7	53.4	21.81	30.8	91
CO-40-27							
CO-40-31A	90	401	.	53	21.78	33.81	90
CO-40-31G							
CO-40-32A							
CO-40-77							
CO-40-77b69	65						

Accession Number	Fibula Maximum Length	Fibula Maximum Diameter at Midshaft	Calcaneus Maximum Length	Calcaneus Middle Bredth
CO-40-1				
CO-40-1A				
CO-40-1E				
CO-40-4			R: 67.89	R: 33.37
CO-40-13			41.06	74.97
CO-40-18B				
CO-40-19A			67.02	
CO-40-19R			64.69	
CO-40-20A				
CO-40-26				
CO-40-27			81.01	43.58
CO-40-31A				
CO-40-31G				
CO-40-32A				
CO-40-77				
CO-40-77b69				

Cranial and Postcranial Measurement Recording Form: Adult Remains (Attachment 21)

Accession Number	Comments
CO-40-1	
CO-40-1A	Femur=R
CO-40-1E	
CO-40-4	R Tibia: 353/63/41/28.70/19.36/80 mm measurements
CO-40-13	
CO-40-18B	
CO-40-19A	
CO-40-19R	Calcaneus = R
CO-40-20A	R femur: 459/445/77/-/26.46/34.82/27.99/28.34/90
CO-40-26	femur = R
CO-40-27	
CO-40-31A	tibial measurements are R tibia
CO-40-31G	
CO-40-32A	
CO-40-77	Radius =R
CO-40-77b69	

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-1	Cranium		Vault	Very fragile and yellowed. PMD of erosion to areas on bone give lumpy/undulating appearance
CO-40-1	Clavicle	L & R		Very fragile and yellowed. PMD of erosion to areas on bone give lumpy/undulating appearance.
CO-40-1	Scapula	U		Very fragile and yellowed. PMD of erosion to areas on bone give lumpy/undulating appearance.
CO-40-1	Humerus	L		PMD and erosion to shaft
CO-40-1	Ulna	L		L ulna worst affected of all elements of this burial. Cortical bone is very thin in places (not peri/anti; maybe a mm thick). Ulna too eroded to assess if have porosity.
CO-40-1	Radius	L & R		Yellowed with very thin cortical bone, same undulating erosion. Moth eaten appearance on radius tubercles - checked if path, determined not (therefore considered taphonomic)
CO-40-1	Femur	R		Similar PMD – flaking cortical bone exposes spongy bone, causing it to appear porous.
CO-40-1	Femur	U	posterior	Same eroded, undulating thin bone with yellowed color
CO-40-1	Tibia	R	D1/3	Differential coloration - yellowed to lighter brown
CO-40-1A	Femur	R		Some reconstruction to bone from previous researche some plastic deformation of the glue.
CO-40-1A	Femur		fragments	(1) Anterior may appear unincorporated due to rodent gnawing
CO-40-1AB	Occipital			PMD at sutures and erosion to external table
CO-40-1AB	Mandible	R		PMD to R aspect of mental eminence
CO-40-1AB	Ischium	R		Thin white lines, consistent with post mortem trowel mark. Some rodent gnawing at the greater sciatic notch
CO-40-1AB	Acetabulum	R	fragments	Eroded edges of the external area.
CO-40-1AB	Rib fragments	U		One fragment has rodent gnawing present on anterior surface
CO-40-1AB	Humerus	R	PE	Posterior PE linear pressure marking, from head to greater tubercle. Also, originally considered the cross-hatched markings on the PE posterior aspect as possible cut marks, but consulted Heather Worne and DWS, not consistent with antemortem cut marks.
CO-40-1AB	Humerus	L	D1/3 - DE	D1/3 humuers appears to have been removed for analysis - clean break. Some mold/fungus discoloration on posterior DE
CO-40-1AB	phalanx	U	hand	PMD to base
CO-40-1D	Vertebrae	U		2 concretion fused neural arches. Morphology suggests one is thoracic and one is lumbar (not necessarily in anatomical order).
CO-40-1D	Ulna	U		PMD on distal aspect; length is 114mm (with PMD)
CO-40-1D	Radius	L & R		Both radii have extensive PMD. Length of each is approximately 92mm
CO-40-1D	Ulna	L	P1/3-D1/3	Some PMD to distal third; erosion of posterior aspect of shaft (P1/3 - D1/3)
CO-40-1D	Tibia		fragments	Tibia frgs with PMD
CO-40-1E	Scapula	L	glenoid fossa	PMD to rim
CO-40-1E	Ulna	L		Weathered, eroded, cracks and discoloration
CO-40-1E	Humerus	L		Rodent gnaw on P1/3 anterior MSMs
CO-40-1E	Radius	R		Posterior aspect to radial tuberosity has concretions.

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-1E	Femur	R		Lateral aspect, superior to lateral condyle has rodent gnawing
CO-40-1E	Tibia	L		Tibia crest has rodent gnawing
CO-40-2	Ilium	R	crest	PMD to crest
CO-40-2	Tibia		Shaft fragments, D1/3	Possible periostitis on shaft (D1/3 tib). Unsure on dx because child and whole piece is involved (so porosity may be from growth). Pinprick and elongated porosity whole shaft. Some areas vary in coloration, making porosity look patchy, but seems most likely that taphonomy with growth, not path.
CO-40-3	Cranium		Vault	External – weathered with cortical erosion and bleaching.
CO-40-3	Scapula	R	glenoid fossa	Glenoid is eroded past medial edge
CO-40-3	Rib		fragments	Coloration variation (dark brown & red). CO-40-3 seems to be more red, with CO-40-3-1 dark brown. But, ribs overlap in color variations.
CO-40-3	Radius		PE, M1/3-D1/3	Cortical bone eroded with shell adhesions
CO-40-3	Humerus	L	PE, M1/3-D1/3	Cortical bone erosion and PMD fractures
CO-40-3	Humerus	R		Cortical bone eroded on shaft, so MSM is only what can be seen clearly. Erosion appears to have impacted m of the MSM sites, reducing expression. Lots of bone adhesions, particularly on the anterior aspect.
CO-40-3	Femur	L		Eroded cortical bone, can't observe MSM
CO-40-3	Femur	R		Eroded cortical bone on anterior aspect only, so posterior MSM recorded.
CO-40-3-1	Occipital		squamous	Covered in marks consistent with rodent activity – it is possible that the porosity is actually exposed diploe from rodent gnawing
CO-40-3-1	Thoracic vertebrae		fragments	PMD to centrum of vertebra. Some almost look lytic, but white edges show PMD. Superior articular facets for T12 are unusual - L is vertical, R is turned posteriorly. T11 inferior articular facets have same change in morphology, with R curved. Different facets on right side + defect (bone lipping) suggest possible trauma to right side of spine.
CO-40-3-1	Ulna	R		Rodent gnawing at PMD of M1/3.
CO-40-3-1	Femur	L	DE	Rodent gnawing on linea aspera and medial aspect
CO-40-3-1	Femur	R	P1/3	Rodent gnawing on gluteus maximus insertion and anterior aspect of shaft.
CO-40-3-1	Tibia	R	D1/3	Rodent gnawing on posterior and distal aspect
CO-40-4	Ilium	R	Auricular surface	Bone adhesions to superior face
CO-40-4	Ilium	L	Auricular surface	L auricular has too much PMD to score.
CO-40-4	Vertebrae			Overall, superior & inferior centra edges eroded. Hard to tell if schmorl nodes. No expansion of bodies, osteophytes, lipping, etc observed on present facets or present centra.
CO-40-4	Ulna	L		Erosion and warping of shaft
CO-40-5	Cranium		Frontal, Parietal frgs	fragmented and worn/ beveled edges to frgs, erosion and PMD. Did not reconstruct due to damage.

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-5	Mandible	R		Postmortem crushed with bone adhesions near location of RMN3
CO-40-5	Clavicle	L & R		L has cortical erosion, adhesions, with warping and cracking on superior aspect. R has bone adhesions, erosion, PMD of cortical (white bone) probably from handling and chipping.
CO-40-5	Scapula	L		Glenoid fossa has bone adhesions
CO-40-5	Patella	R		Eroded apex and posterior inferior surface.
CO-40-5	Vertebrae		Centrum fragments	10 centrum frgs, 4 whole – all eroded
CO-40-5	Humerus	L	D1/3	PMD to cortical bone of PE
CO-40-5	Humerus	R		Erosion, reconstruction, weathering cracks and warping, with bone adhesions. Looks bowed-ish laterally, but probably just warped and reconstructed poorly. NOTE ulna, R tibia & R humerus all have more taph than L side.
CO-40-5	Ulna	R		Extremely eroded cortical and underlying bone, crack and warping. Reddish coloration and probable mold/fungal discoloration on D1/3 – blackish speckled pattern. Some bone adhesions on M1/3 – slight. No pathology noted, but with PMD/taphonomy, it is almost impossible to see cortical bone. Photos. NOTE: R ulna, R tibia & R humerus all have more taph than L side.
CO-40-5	Radius	L	M1/3	Eroded cortical bone
CO-40-5	Radius	R		Reconstructed. Shaft cortical bone eroded with PMD. Possible canine pitting. Taph obscures possibile path
CO-40-5	Femur	L		P1/3 has erosion of the cortical bone and reconstruction of PMD. Discoloration on lateral near glut max, from shelack, or fungus. M1/3 has cracks from weathering following long axis. D1/3 have cracks from erosion
CO-40-5	Femur	R		P1/3-D1/3 severely eroded cortical bone; features alm obscured.
CO-40-5	Tibia	L	M1/3 - D1/3	Eroded cortical bone and cracks with probable rodent gnawing.
CO-40-5	Tibia	R		Eroded cortical bone and rodent gnawing with possible carnivores – puncture round marks. NOTE: R ulna, R tibia & R humerus all have more taph than L side.
CO-40-5	Fibula		fragments	(1) flatter side has weathering/erosion of cortical bone Erosion of bone impacts margins of lesion.Angular side – PMD and erosion of cortical bone.
CO-40-6A	Long bone fragments			50+ long bone frgs – radius, ulna, tibia, fibula. Erosion of cortical bone.
CO-40-6B	Frontal			Taphonomy – weathering cracks, small cracks, warping around the depression.
CO-40-6B	Vault			25+ frgs with erosion of internal table with shell adhesions.
CO-40-6C	Humerus	U		Cortical bone eroded
CO-40-6C	Femur	L		Erosion of cortical bone, weather cracking, PMD.
CO-40-6C	Femur	R		Erosion and cortical removal, reconstruction, weather cracks. Because of mottled look, not sure if pathology present.
CO-40-13				Weathering cracks and concretions throughout skeleton. Highly fragmented.

Taphonomy Recording Form II: Weathering, discolorat ion, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-13	Parietal	L & R		Weathering cracks and concretions throughout skelet on. Highly fragmented.
	Occipital		fragments	Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	Scapula	L	glenoid fossa	Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	Pubis	L & R		L pubic symphysis: little to no ventral border, pos sibly some on superior aspect, but PMD to area. Tuberosit y is forming possibly forming, but again, PMD to area.
CO-40-13	Acetabulum	U		Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	C2			Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	C3			Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	C4			Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	C5			Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	C6			Weathering cracks and concretions throughout skelet on. Highly fragmented.
CO-40-13	Rib fragments			22 shaft frgs, lots of concretions
CO-40-13	Radius	U		9 frgs, mostly crushed and concreted together with shell adhesions. 1 radius head
CO-40-13	Radius	L		4 frgs, mostly crushed and concreted together with shell adhesions
CO-40-13	Ulna	R	PE - P1/3	Posterior and medial bone have shell adhesions. NOT E: generally, long bone frgs crushed flat, or bone glu ed together/concreted, or both. Very frg
CO-40-13	Radius	U		Unsided radius shaft, fused to about 5 middle ribs
CO-40-13	Ulna	L		L ulna with possible humerus shaft concreted (not s ure if humerus because flattened and broken).
CO-40-13	Radius	U	PE	4 frgs, probable radius, crushed and concreted.
CO-40-13	Humerus	R		Posterior shaft with shell concretions
CO-40-13	Femur	L		Weathering cracking and concretions, with warping a nd bone adhesions/glue
CO-40-13	Femur	R		Shaft is warped, crushed, cracked, with shell adhesions…highly changed by taphonomic processes.
CO-40-13	Tibia	L & R		Warped, crushed, glued, concreted, flatte ned shafts
CO-40-13	Fibula		fragments	9 fibula shaft frgs, shell and crushed. 1 periwinkl e fused whole to shaft.
CO-40-13	Fibula		fragments	Fib shaft frgs fused to sacrum. Too damaged to see much.
CO-40-13	Phalanges	L & R	foot	Proximal concreted to middle, middle concreted to d i distal antemortem fused to middle.
CO-40-15A	Parietal	L & R		Some (+L frontal) eroded cortical bone
CO-40-15A	Occipital	L & R		Cortical bone is eroded
CO-40-15A	Frontal	L		Eroded cortical bone with rodent gnawings
CO-40-15A	Humerus	L		no margins observed on lesion because of PM D to bone.
CO-40-15A	Ulna	L		Medial has rodent gnawing in addition to lesion
CO-40-15B	Ulna	U		PMD at brachalis and coracoid process. Weathering a nd linear cracks with warping.
CO-40-15B	Femur	R	M1/3 - D1/3	Anterior D1/3 has PMD, not pathology

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-15E	Clavicle	L		Shaft very eroded, can't dx.
CO-40-15E	Ulna	R	PE	PMD and erosion of cortical bone at PE
CO-40-15E	Tibia	R		Lateral aspect has and PMD
CO-40-16A	Fibula			Shell adhesions
CO-40-16B	Ilium	L		Anterior crest is eroded from taphonomy
CO-40-16B	Radius	L		Shell adhesions
CO-40-16B	Femur	L & R		L femur marks on P1/3 from rodent gnawing; Both L & R have taphonomy erosion of cortical bone combined with porosity from growth. All present porosity appears to be due to either growth or taphonomy
CO-40-16B	Tibia	L & R		Both have taphonomy erosion of cortical bone combined with porosity from growth. All present porosity appear be due to either growth or taphonomy
CO-40-16C	Rib fragments			Lots of adhesions that looks like periostitis – raised and patchy.
CO-40-16C	Humerus	R	D1/3	Circumferential PMD with cortical delamination and cracks. All long bone shafts = eroded and adhesions then preserved. Most have long weathering cracks, no warping.
CO-40-16C	Ulna	R		All long bone shafts = eroded and adhesions and then preserved. Most have long weathering cracks, no warping.
CO-40-16C	Femur	L		All long bone shafts = eroded and adhesions and then preserved. Most have long weathering cracks, no warping.
CO-40-16C	Femur	R		All long bone shafts = eroded and adhesions and then preserved. Most have long weathering cracks, no warping.
CO-40-16C	Tibia	L		All long bone shafts = eroded and adhesions and then preserved. Most have long weathering cracks, no warping.
CO-40-16C	Tibia	R		All long bone shafts = eroded and adhesions and then preserved. Most have long weathering cracks, no warping.
CO-40-16C	Fibula	R		All long bone shafts = eroded and adhesions and then preserved. Most have long weathering cracks, no warping.
CO-40-16D	Tibia	L		"Cut marks" on lateral aspect D1/3 from excavation (trowel) - very sharp/thin.
CO-40-18A	Occipital			Some weathering cracks near nuchal crest
CO-40-18A	Vertebrae		cervical	2 overlapping sets of vertebrae, both with erosive arthritis, but cannot determine which set belongs to 18A.
CO-40-18A	Vertebrae		cervical	2 overlapping sets of vertebrae, both with erosive arthritis, but cannot determine which set belongs to 18A.
CO-40-18B	Cranium			highly fragmented
CO-40-18B	Ilium	R	Auricular surface	Erosion to face
CO-40-19B	Scapula	L	glenoid fossa	Coracoid unfused, inferior margin PMD, acromion PMD
CO-40-19B	Ulna	R		Eroded cortical with removal of bone
CO-40-19B	Radius	R		Erosion of cortical bone, partially on lateral aspe
CO-40-19E	Scapula	L	glenoid fossa	Acromion and coracoid sheared off PMD
CO-40-19E	Tibia	L & R		PMD to lateral aspect on L & R

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-21	Cranium			Concreted together: R zygomatic, L mand + L zygo + L mastoid
CO-40-21	Os Coxae	R		R os coxae: mainly ilium. Concreted to L4, L5, S1, S2, S3, but other sacral frg = S3-5.
CO-40-21	Sacrum			concretions, but maybe sacralization of L5. Looks like bone bridging from L5 to ala and lumbar morphology on sacrum. Auricular surface has an odd morphology, with less of an "ear" shape and more of a semicircular s Annular rings fusing. L5 or S1 = unfused. S1 or S2 = fusing.
CO-40-21	Ilium	L	Auricular surface	Most of L auricular surface is obscured from concretions
CO-40-21	Pubis	R	Pubic symphysis	Bone adhesions
CO-40-21	Vertebrae			C5-7 (R rib facet). Fused with bone concretions.
CO-40-21	Vertebrae			Shell concretions: 3 thoracic centra + 2 neural arches glued to ribs and some shell
CO-40-21	Vertebrae			Shell concretions: 3 thoracic centra + 3 fused neural arches + 2 neural arches concretion glued + 2 R middle ribs + 3 L rib heads.
CO-40-21	Rib fragments			Ribs fused (concretions) to T8-T12
CO-40-21	Rib fragments			2 ribs posterior and 1 anterior with possible scapula frg concretion glued.
CO-40-21	Rib fragments			3 sternal rib ends, about 40 rib shafts, 6 concreted, 6 rib heads. L 1st, 4 L middle, 2 R middle. 1 unside head. 2 ribs (1 L, 1 R) on articular facet have red staining (ver red v reddish brown of soil).
CO-40-21	Ulna	R	PE	Concretions; possible arthritis in semilunar, but probably concretions.
CO-40-21	Humerus	U	PE	Concretions on tubercle, so can't side.
CO-40-21	Radius	L		Concretions and bone fusion
CO-40-21	Ulna	R		Bone adhesions and concretions PMD. Weathering cracks.
CO-40-21	Radius	R		Bone and shell concretions.
CO-40-21	Ulna	L		Shell and bone concretions with PMD. Probable periostitis on lateral aspect D1/3 of crest (near PMD of shaft) 33.99 x 4.52 w/ elongated linear pores, woven bone, well healed margins with undulating pattern. Covered in concretions.
CO-40-21	Humerus	L		Shell and bone concretions
CO-40-21	Humerus	R		Shell concretions. Lateral epi + near olecranon fossa = reddish stain. Ochre?
CO-40-21	Femur	R		Concretions and PMD – previously cemented in pelvis.
CO-40-21	Femur	L		L DE femur and lat tibial plateau; concretions glued to posterior lateral DE of femur.
CO-40-21	Femur	R	M1/3-D1/3	R femur DE concretion glued to R tibia PE.
CO-40-21	Femur	L		Rodent, PMD, adhesions.
CO-40-22A	Frontal			Erosion with cracks and bone warping (layers). Orbits eroded, can't dx if any CO.
CO-40-22A	parietal		fragments	R: outer layers weathered off from cracks and PMD. Small remaining patches of external table have healed pinprick at midline, no expansion. Extends from suture (open) to bossing. L = healed porosity on midline. Removal of layers and erosion and cracking worse on L.

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-22B adult	Radius	L	D1/3	posterior crest D1/3 has erosion and cortical flaking with nodule erosion.
CO-40-22B adult	Humerus	L & R		Both really eroded – cortical bone basically gone
CO-40-22B adult	Ulna	L		Shaft heavily eroded
CO-40-22B adult	Ulna	R		Even more eroded than L.
CO-40-22B adult	Femur	R		Erosion and nodules obscure possible shaft expansion
CO-40-22B juvenile	Long bone fragments			4 arm/leg shafts: all eroded
CO-40-22B juvenile	Humerus	L & R		eroded cortical bone
CO-40-22B juvenile	Tibia	U	M1/3	eroded cortical bone
CO-40-22B juvenile	Femur	U	M1/3	eroded cortical bone
CO-40-22C	Femur	L		Shaft cortical bone is eroded
CO-40-22D	Cranium			lots of PMD and reconstruction in the past, but now , mostly fragmented. Highly eroded on the external table. Majority of PMD to cranium suggests multiple times of PMD—some edges are eroded, suggesting fractured and eroded in grave, while others are more recent PMD.
CO-40-22D	Frontal	R		Supraorbital ridge obscured by erosion and rodent gnawing. Gives the bone a lumpy/bumpy/uneven morphology with long gouges from the incisors
CO-40-22D	Zygomatics	L & R		Weathered with erosion and PMD breaks
CO-40-22D	Occipital			exterior protuberance and nuchal crest eroded.
CO-40-22D	parietal			Heavily eroded, leaves a series of nodules. Not sure to record the taphonomy – bone not cracking or discolored, just looks like water ran over the parietals, especially continually, leaving higher and lower areas – and perhaps carving out present rodent gnawings.
CO-40-22D	Temporal	L & R		Both mastoids have same erosion pattern as parietal with lumpy erosion nodules. R is more eroded than L .
CO-40-22E	Cranium			Some midline pinprick on L, but hard to tell extent due to PMD and erosion. Highly fragmented, eroded, warped and cracked. Taphonomy & coloration similar to A, but there is element overlap.
CO-40-23A	Frontal	R	orbit	Taphonomic damage to area—trowel marks
CO-40-23A	parietal	L & R		Soil variation has caused the L to look much darker than R frgs.
CO-40-23A	Clavicle	U		Extensive cortical bone erosion
CO-40-23A	Ilium	L	Auricular surface	Apex and GSN PMD
CO-40-23A	Ilium	R	Auricular surface	Overall morphology less clear than L because of shell adhesions.
CO-40-23A	Radius	L		Erosion at tubercle
CO-40-23A	Femur	R	M1/3	M1/3 has small, linear markings consistent with rodent gnawing
CO-40-23A	Tibia	L		Excavation damage on lateral aspect of DE/D1/3. Marks too thin to be cut marks. Most likely excavation damage. Bone weathered with cracks running the long axis of crest of bone.
CO-40-23A	Tibia	R		Tibial crest has a series of marks consistent with rodent gnawing.
CO-40-23B	Patella	R		Anterior surface is eroded and bleach
CO-40-23B	Femur	L		Posterior = trowel marks, anterior = rodent gnaw. Anterior D1/3 has weathering linear cracks from exposure following long axis of bone.

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-23B	Femur	R		Rodent gnaw on medial P1/3, lateral M1/3.
CO-40-23B	Tibia	L		Perpendicular cut mark at M1/3—sampled?
CO-40-23B	Tibia	R		Posterior P1/3 shaft as rodent gnawing
CO-40-25	Acetabulum	L		Some of internal surface seems to have irregular bone growth with a patchy-looking matrix on top of lamellar bone. Edges seem sharp, so probably taphonomic/erosion more than bone formation. So, lipping too may, in fact, may be due to surrounding weathering and not arthritis.
CO-40-25	Ilium	U		Possible sulcus, but looks not only PMD, but possible pathology. Bone has spicule-looking morphology, but with PMD, hard to tell.
CO-40-25	Humerus	L		More superior medial rodent with some marks on D1/3 – deeper, but still looks taph, not cut marks
CO-40-25	Humerus	R		Some rodent gnawing on superior medial muscle attachment
CO-40-25	Ulna	R		Rodent gnawing on D1/3 lat, faint.
CO-40-26	Cranium			Cranium is fragmented. Previously glued, but PMD caused new breaks. Frontal internal table weathered w sections of bone warping and bleaching. Parietal has PMD and bleaching near area of expansion of inner table.
CO-40-26	Scapula	R	glenoid fossa	2/3 sheared off PMD.
CO-40-26	Humerus	R		Some PMD (expansion of trabecular bone) erosion? PE shows some wide and shallow markings, with another series (5) of poss cut marks on posterior aspect of proximal third - all postmortem (thin, sharp_
CO-40-26	Femur	L		PE – lots of PMD to cortical bone. Expansion of fovea capitus (matches observations on L acetabulum). Diaphysis – PMD (flakey, bleaching)
CO-40-26	Tibia	L		Rodent gnawing on P1/3 – M1/3. Looks like piece removed for analysis, but no note present. Medial, posterior with square cut marks with small (~2 mm) hesitation/overshoot cuts? Some cortical reaction/bone formation at fibular articulation, but no ridge as seen in R. Area of raised material on DE, but color and texture suggest not bone (sand glued during shellacking?) previously glued, but broke PMD again.
CO-40-27	Frontal			whole bone is very eroded on superior portion, outer table.
CO-40-27	Clavicle	R		Bone is bleached
CO-40-27	Patella	R		Inferior borders possible PMD, superior aspect is antemortem
CO-40-27	Tibia	R		Bone adhesions on shaft, see pathology notes
CO-40-27	Femur	L	DE	Badly reconstructed (while femur elements complete, plastic deformation of glue males better reconstruction impossible.
CO-40-28	Acetabulum	L & R		Acetabulum have slight erosion and faint porosity on superior posterior rim of acetabulum ~ 20 mm long.
CO-40-28	Pubis	L	Pubic symphysis	Ventral and dorsal rim PMD erosion
CO-40-28	Femur			2 DE, 1 PE femur. 2 DE labeled L, but can't manually articulate. PMD and erosion.

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-29A	Femur	L		Someone glued DE to shaft – it is unfused [and would have been separated in life]
CO-40-30	Cranium			Highly fragmented and eroded. Can identify frontal, parietal, occipital, sphenoid, L/R temporaland mandible. Bone adhesions to internal surface of the table.
CO-40-31A	Acetabulum	L & R		Pressure lesions. L looks like possible path, but superior acetabulum reconstructed. Perhaps the "possible path" is because of morphological variation with PMD to aggrevate? (Dawnie said reminds her of the subchond destruction on tarsals).
CO-40-31A	Fibula	L		possible periostitis, but looks more like erosion.
CO-40-31C	Fibula	R		PMD to lesion means it may have been larger in life
CO-40-31C	Tibia	R		PMD with reconstructed longitude cracks.
CO-40-31-1C	Scapula	R	glenoid fossa	1 rock/rib/shell concretion.
CO-40-31-1C	Humerus	U		Deltoid area, but reconstructed and eroded with PMD.
CO-40-31E	Cranium		Frontal, Parietal frgs	Probable occipital porosity too, but too eroded.
CO-40-31E	Acetabulum	L		1 L acetabulum with femur head concreted in joint
CO-40-31E	Ulna	L		PMD at radial notch with shaft eroded.
CO-40-31E	Femur	L		Weathering cracks following longitudinal axis
CO-40-31F	Tibia	L & R		Both medial aspects have elongated pores with rounded crests. No bone/cortex changes, radiograph indicates taphonomy
CO-40-31G	parietal	L		Posterior L parietal (near lambdoid) eroded external table
CO-40-31G	Ulna	R		PMD at D1/3 – DE. Erosion of cortical bone
CO-40-31G	Ulna	L		Brachialis eroded. Anterior – longitudinal cracking from weathering and erosion inferior to nutrient foramen .
CO-40-31G	Femur	L	P1/3 - D1/3	Reconstructed with erosion to anterior M1/3.
CO-40-31H	Fibula	L		Eroded cortical bone
CO-40-31H	Fibula	R		Some erosion medial and lateral, but subtle.
CO-40-32A	Ulna	L		Eroded at brachialis and cortical bone of shaft
CO-40-32A	Femur	R		No head (PMD). Longitudinal weathering cracks along long axis.
CO-40-32A	Femur	L		Eroded and longitudinal weathering cracks. No obvious shaft expansion or pathology.
CO-40-68C/Infant	Fibula	U		Shell adhesions
CO-40-68C/3yo	Humerus	U	M1/3	Possible periostitis, but too much erosion to cortical bone
CO-40-68C/3yo	Femur	U		Possible periostitis, but too much erosion to cortical bone
CO-40-68E/adult	Ilium	L & R	Auricular surface	L has too much PMD, R has some PMD
CO-40-68E/adult	Vertebrae		Thoracic	There is PMD to rib facet with possible porosity.

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-68E/adult	Humerus	R	PE frg + M1/3-DE	PE frg: lots of PMD. M1/3-P1/3: cracks from weathering, but no bleaching. Only end of deltoid tuberosity present-gracile. DE: no path/arth on condyles or epicondyles. Piece of crab/mollusk bone fused inside olecranon fossa. PMD to groove between trochlea and capitulum - linear arrangement of porosity. Initially thought something, but pore edges are white and sharp. PMD to capitulum, posterior aspect near olecranon fossa hole in cortical bone. Fossa for ulna head on posterior aspect has been depressed more than radius "fossa" and has trabecular bone with irregular structure. R humerus "ulna fossa" also appears to have an accessory fossa lateral and posterior to original area.
CO-40-68E/adult	Ulna	L	P1/3-DE	Lots of PMD to shaft
CO-40-68E/adult	Femur	R	M1/3 - D1/3	rodent gnawing posterior M1/3. Some weathering cracks with slight warping, lamellar bone only.
CO-40-68E/6yo	Humerus	L		PMD has damaged quite a bit of lesion area
CO-40-68W/adult	Cranium			Highly fragmented. Majority of fragments have inner table eroded
CO-40-68W/adult	parietal			Small hole on bottom left of photos, near PH, is PMD. Inner table very weathered (bleached and eroded). Seems to be a probably pacchion body eroded to outer table.
CO-40-77	Occipital		basilar portion	Shell adhesions
CO-40-77	Frontal			Shell adhesions
CO-40-77	Clavicle	L		Bone coloration similar to rest of burial, but few shell adhesions.
CO-40-77	Clavicle	R		Lots of shell adhesions
CO-40-77	Sternum			Lots of shell adhesions.
CO-40-77	Ilium			Shell adhesions
CO-40-77	Pubis	L		Shell adhesions
CO-40-77	Patella	L		PMD to medial surface
CO-40-77	Vertebrae	U	U	1 centrum frg (unsequenced): compression fx (poss) anterior portion of midline centrum compressed compared to lateral aspect. Inferior aspect has some white, indicating PMD to bone. Inferior centrum, has shell embedded. Erosion may have given shape.
CO-40-77	C2			Body of C2 has impression on superior left portion. Inferior aspect shows PMD, superior area of 7.78x8.37 has depression. Probable compression fx PMD
CO-40-77	Vertebrae		Thoracic	1 shell adhesion: Appears to be all thoracic, T2-6i sh Fused with ribs and 1 R scapula spine. Can clearly thoracic spinous processes and at least 5 centrum. Approx 7 rib shafts fused.
CO-40-77	Ulna	L	PE - D1/3	Lots of shell adhesion
CO-40-77	Ulna	R	PE - M1/3	Lots of shell adhesions on P1/3
CO-40-77	Femur			Probably 1 femur DE, but in 6 frgs: cannot rearticulate due to shell adhesions
CO-40-77	Femur	L	M1/3	Rodent gnawing on medial aspect
CO-40-77	Tibia	R	D1/3	Rodent gnawing on D 1/3 lateral shaft.
CO-40-77	Talus	R		R talus adhered to calcaneus
CO-40-79b69	Tibia	L		Prox shaft, on crest has series of faint rodent gnawing.

Taphonomy Recording Form II: Weathering, discoloration, polish, cutmarks, gnawing, and other cultural modifications (Attachment 24)

Accession number	Skeletal element	Side	location	Taphonomy
CO-40-79b69	Tibia	R		Same faint possible rodent gnawing, but very faint
CO-40-79	Mandible			Mental eminence partially covered with shell adhesions
CO-40-79	Scapula	U		Posterior has shell adhesions.
CO-40-79	Ilium	R		Does have marks, but unsure as to “cut mark” claim. Do not appear to be paired, but shallow and wide (a fe wide, but less than 2 mm deep). Possible V pattern in some cases, but fairly random looking. Not convince cut marks, but unsure of how taphanomic. Doesn’t look deep enough to be rodents, but possible excavation damage

Maxillary dental metrics

Accession Number	Sex	Age	RM3 Mesio-distal	RM3 Bucco-lingual	RM3 Crown Height	RM2 Mesio-distal	RM2 Bucco-lingual	RM2 Crown Height	RM1 Mesio-distal	RM1 Bucco-lingual	RM1 Crown Height
CO-40-1	F	50+									
CO-40-1B	F?	U									
CO-40-1D	U	0-5							10.55	11.29	7.33
CO-40-1E	M	35-50							10.69	11.22	3.97
CO-40-2	U	0-5							11.02	10.84	6.86
CO-40-3	M	35-50				8.68	11.20	6.41	11.16	10.93	6.11
CO-40-4	F	20-35							12.12	11.86	5.34
CO-40-5	M?	20-35	11.39	12.12	6.29				11.81	12.61	6.21
CO-40-6A	F	15-20	11.46	10.00	6.06	9.45	10.85	6.11	10.03	11.11	6.02
CO-40-6B	M	35-50							10.66	11.52	4.42
CO-40-6C	U	5-10				9.76	10.06	7.81			
CO-40-6D	U	0-5							10.60	11.48	6.78
CO-40-13	M	35-50				10.30	11.92	4.71			
CO-40-15A	F?	20-35							9.77	10.55	6.46
CO-40-16C	U	5-10							10.24	10.60	6.52
CO-40-18B	F	35-50	8.70	11.08	5.93	10.07	11.87	5.65	0.00	0.00	0.00
CO-40-19B	U	5-10				9.42	10.23	7.29	10.28	9.75	7.03
CO-40-19E	U	10-15							10.03	9.70	6.03
CO-40-19F	U	0-5									
CO-40-19H	U	0-5							11.16	11.07	7.66
CO-40-19I	U	5-10				9.44	10.34	6.71			
CO-40-19M	F	20-35				8.40	9.77	7.14			
CO-40-20A	F?	20-35	8.84	10.83	5.45				10.03	10.87	6.24
CO-40-22A	M	35-50				9.79	11.18	6.05	11.39	11.94	5.03
CO-40-24	M	adult							11.20	11.65	6.37
CO-40-25-1	U	0-5									
CO-40-27	M?	35-50				10.47	12.46	5.87	13.14	11.95	5.73
CO-40-29A	U	5-10							12.40	11.40	6.87
CO-40-30	M?	35-50				10.81	11.82	5.52	11.17	11.84	5.14
CO-40-31A	M	20-35	10.21	11.37	7.28	10.61	12.35	7.17	10.71	12.81	6.03
CO-40-31B	U	0-5							11.67	11.18	7.68
CO-40-31C	M	35-50	9.81	12.59	7.01	9.73	11.06	3.16	10.35	11.71	3.95
CO-40-31-1C	M?	20-35	8.05	9.53	6.92						
CO-40-31E	M?	15-20				9.45	10.27	6.41	10.36	10.57	6.05
CO-40-31G	?	Adult	10.79	10.02	6.63				10.48	12.10	5.65
CO-40-31H	U	5-10							10.65	11.45	7.49
CO-40-Prov? Skull	M	adult	7.58	9.88	5.80	10.30	10.57	6.18	11.18	11.13	6.62
CO-40-68C/7yo	U	5-10							11.41	10.84	6.56
CO-40-68E/adult	F?	50+									
CO-40-69	M	20-35							11.57	11.52	6.23

Maxillary dental metrics

Accession Number	RP2 Mesio-distal	RP2 Bucco-lingual	RP2 Crown Height	RP1 Mesio-distal	RP1 Bucco-lingual	RP1 Crown Height	RC Mesio-distal	RC Bucco-lingual	RC Crown Height	RI2 Mesio-distal
CO-40-1	6.19	8.04	2.93				8.30	6.68	9.49	
CO-40-1B										
CO-40-1D										
CO-40-1E										
CO-40-2										
CO-40-3	6.88	9.33	5.35	8.11	10.09	4.99	8.56	6.65	9.13	0.00
CO-40-4	8.36	9.46	4.93	8.57	9.21	7.21	7.36	6.61	8.40	
CO-40-5	7.14	9.83	6.67	7.57	9.81	7.09	7.71	5.11	9.98	8.10
CO-40-6A	7.43	8.92	6.76				6.60	4.81	10.64	7.10
CO-40-6B										
CO-40-6C										6.60
CO-40-6D	7.37	9.54	6.36	7.71	9.28	6.85				
CO-40-13										
CO-40-15A	7.25	9.34	6.85	9.53	7.49	6.53				
CO-40-16C										
CO-40-18B	6.67	10.00	9.93	5.94	9.95	3.86				
CO-40-19B							7.48	5.07	10.86	5.95
CO-40-19E							6.52	5.83	10.22	
CO-40-19F										6.43
CO-40-19H										
CO-40-19I										5.99
CO-40-19M										
CO-40-20A	6.61	9.31	6.17	7.49	8.13	6.83	7.95	7.67	6.45	
CO-40-22A	6.40	9.22	5.13	6.98	9.18	5.06	7.79	7.96	5.12	
CO-40-24							7.98	6.88	9.56	8.16
CO-40-25-1										
CO-40-27	7.61	9.76	6.31	7.78	9.45	6.91	9.55	7.42	8.88	8.41
CO-40-29A										
CO-40-30										
CO-40-31A	7.77	10.33	7.85	7.52	10.10	8.77	9.96	6.46	11.53	8.82
CO-40-31B										
CO-40-31C	6.77	9.64	3.63	7.84	10.29	3.75	3.86	6.77	8.55	7.71
CO-40-31-1C										
CO-40-31E	7.13	9.04	5.80	6.67	9.01	6.56				
CO-40-31G				7.51	9.18	7.40				
CO-40-31H				7.73	9.41	8.90				
CO-40-Prov? Skull	6.19	8.90	6.24	7.39	8.53	5.75	8.91	8.40	7.77	
CO-40-68C/7yo										
CO-40-68E/adult				7.51	9.56	5.73				
CO-40-69				7.23	8.39	6.23	8.21	6.73	7.96	

Maxillary dental metrics

Accession Number	RI2 Bucco-lingual	RI2 Crown Height	RI1 Mesio-distal	RI1 Bucco-lingual	RI1 Crown Height	LI1 Mesio-distal	LI1 Bucco-lingual	LI1 Crown Height	LI2 Mesio-distal	LI2 Bucco-lingual
CO-40-1										
CO-40-1B										
CO-40-1D										
CO-40-1E										
CO-40-2										
CO-40-3	0.00	0.00	9.04	6.24	7.93					
CO-40-4			9.21	6.06	7.64	8.94	5.20	8.32	7.32	5.04
CO-40-5	5.27	9.95				10.07	4.93	10.93		
CO-40-6A	4.25	8.84	8.22	3.87	9.59	8.11	4.00	9.57	7.00	4.01
CO-40-6B										
CO-40-6C	3.12	10.12								
CO-40-6D									9.58	4.36
CO-40-13										
CO-40-15A										
CO-40-16C										
CO-40-18B										
CO-40-19B	2.26	9.58	7.90	4.49	12.44					
CO-40-19E										
CO-40-19F	3.37	7.84				8.68	3.75	9.28		
CO-40-19H			8.57	2.80	9.48					
CO-40-19I	4.53	8.61								
CO-40-19M										
CO-40-20A									5.74	5.99
CO-40-22A			6.98	4.74	4.26					
CO-40-24	5.03	8.36								
CO-40-25-1			8.57	4.76	8.95	7.98	5.19	9.06	6.45	3.75
CO-40-27	5.30	6.88		5.68	6.12				7.56	4.46
CO-40-29A										
CO-40-30										
CO-40-31A	5.04	9.80	8.22	4.78	10.63	8.19	4.62	11.45	7.49	4.57
CO-40-31B										
CO-40-31C	4.75	7.33	7.88	4.70	4.84				6.20	5.08
CO-40-31-1C										
CO-40-31E						7.98	4.16	7.94	7.44	4.34
CO-40-31G										
CO-40-31H										
CO-40-Prov? Skull										
CO-40-68C/7yo										
CO-40-68E/adult										
CO-40-69										

Maxillary dental metrics

Accession Number	LI2 Crown Height	LC Mesio-distal	LC Bucco-lingual	LC Crown Height	LP1 Mesio-distal	LP1 Bucco-lingual	LP1 Crown Height	LP2 Mesio-distal	LP2 Bucco-lingual	LP2 Crown Height
CO-40-1										
CO-40-1B		8.57	6.81	8.27	8.20	8.82	6.49			
CO-40-1D										
CO-40-1E										
CO-40-2		6.54	7.36	5.05						
CO-40-3					8.03	10.36	6.56	6.98	9.28	6.11
CO-40-4	7.51				7.12	9.00	6.53	8.35	9.35	7.09
CO-40-5		8.65	8.46	10.43	8.41	8.39	6.25	7.58	10.07	7.50
CO-40-6A	9.12	6.49	4.68	10.33	7.50	9.35	7.43	7.19	8.83	6.93
CO-40-6B		7.63	6.87	6.83	7.48	8.99	3.50	6.73	8.33	3.20
CO-40-6C		8.16	5.34	12.00						
CO-40-6D	9.65				7.61	9.55	6.84			
CO-40-13										
CO-40-15A										
CO-40-16C		8.19	5.52	10.44	6.98	8.25	8.40			
CO-40-18B										
CO-40-19B		7.58	5.63	10.89						
CO-40-19E										
CO-40-19F										
CO-40-19H										
CO-40-19I		7.08	3.51	11.25						
CO-40-19M								6.24	8.64	6.17
CO-40-20A	5.52	6.93	6.46	6.13	5.85	8.99	6.73	6.21	8.84	6.00
CO-40-22A		7.97	6.19	6.12	6.82			7.04	9.25	4.28
CO-40-24										
CO-40-25-1	8.91									
CO-40-27	7.39	10.42	7.59	8.62	8.03	8.90	7.27	7.85	9.35	7.00
CO-40-29A										
CO-40-30										
CO-40-31A	10.39	8.29	5.90	11.79	7.40	10.29	8.88	7.52	9.90	8.20
CO-40-31B										
CO-40-31C		8.71	7.79	6.27	8.06	8.58	5.57	6.92	9.68	5.25
CO-40-31-1C										
CO-40-31E	8.28	6.75	5.28	9.30						
CO-40-31G					7.30	8.80	6.56	7.16	9.68	5.89
CO-40-31H		8.36	7.10	11.63	7.33	9.44	7.60			
CO-40-Prov? Skull					7.11	8.28	5.69	7.08	8.87	5.32
CO-40-68C/7yo										
CO-40-68E/adult		7.44	7.54	8.04				6.65	9.39	4.64
CO-40-69								6.40	7.95	5.88

Maxillary dental metrics

Accession Number	LM1 Mesio-distal	LM1 Bucco-lingual	LM1 Crown Height	LM2 Mesio-distal	LM2 Bucco-lingual	LM2 Crown Height	LM3 Mesio-distal	LM3 Bucco-lingual	LM3 Crown Height
CO-40-1									
CO-40-1B	11.27	10.79	5.33	10.18	10.99	4.65			
CO-40-1D	10.24	11.02	6.31						
CO-40-1E									
CO-40-2									
CO-40-3	10.49	11.20	6.37	9.02	11.08	6.36	10.32	8.95	5.95
CO-40-4	12.39	11.64	6.82	11.22	11.71	6.76			
CO-40-5									
CO-40-6A	10.01	10.81	6.42	9.43	10.15	6.41	11.13	9.63	6.12
CO-40-6B	10.05	11.58	5.62	9.22	10.66	5.90			
CO-40-6C									
CO-40-6D	10.58	10.90	6.40						
CO-40-13				11.01	11.79	6.77	8.40	11.79	6.01
CO-40-15A	10.84	11.59	7.26	10.37	9.75	5.55	8.82	10.11	6.48
CO-40-16C	10.19	10.72	6.87						
CO-40-18B	10.58	11.78	5.03	9.49	11.70	6.06	8.92	11.14	5.64
CO-40-19B	10.02	9.99	7.08	9.52	10.24	7.11			
CO-40-19E									
CO-40-19F	11.67	11.19	7.59						
CO-40-19H	10.64	10.63	7.93						
CO-40-19I									
CO-40-19M	10.54	11.11	6.18	10.19	9.70	6.58			
CO-40-20A	10.08	10.86	6.31	9.11	10.85	6.62			
CO-40-22A	11.25	11.86	4.46	8.87	11.46	5.80			
CO-40-24	11.05	11.69	8.17	11.14	12.47	7.90	10.41	9.89	8.16
CO-40-25-1									
CO-40-27	12.05	11.79	6.62	11.50	11.84	6.15			
CO-40-29A	11.20	11.27	6.67						
CO-40-30									
CO-40-31A	10.60	11.52	7.46	10.32	12.14	8.20	10.33	11.69	6.44
CO-40-31B									
CO-40-31C	10.52	11.74	6.09	9.83	11.93	7.31	9.34	11.42	7.01
CO-40-31-1C									
CO-40-31E									
CO-40-31G	10.18	11.34	5.88	9.38	10.98	6.04	8.09	10.16	6.43
CO-40-31H	10.79	11.64	7.72						
CO-40-Prov? Skull	10.81	11.28	5.73				8.33	9.30	5.20
CO-40-68C/7yo	11.97	10.67	6.50						
CO-40-68E/adult									
CO-40-69	11.81	11.88	6.06						

Maxillary dental metrics

Accession Number	Comments
CO-40-1	
CO-40-1B	
CO-40-1D	
CO-40-1E	
CO-40-2	
CO-40-3	
CO-40-4	
CO-40-5	
CO-40-6A	
CO-40-6B	
CO-40-6C	
CO-40-6D	
CO-40-13	
CO-40-15A	RM1 noticably smaller, but M1
CO-40-16C	
CO-40-18B	
CO-40-19B	
CO-40-19E	
CO-40-19F	
CO-40-19H	
CO-40-19I	
CO-40-19M	
CO-40-20A	
CO-40-22A	
CO-40-24	
CO-40-25-1	
CO-40-27	
CO-40-29A	
CO-40-30	
CO-40-31A	
CO-40-31B	
CO-40-31C	
CO-40-31-1C	
CO-40-31E	
CO-40-31G	
CO-40-31H	
CO-40-Prov? Skull	
CO-40-68C/7yo	
CO-40-68E/adult	
CO-40-69	

Mandibular dental metrics

Accession Number	Sex	Age	RM3 Mesio-distal	RM3 Bucco-lingual	RM3 Crown Height	RM2 Mesio-distal	RM2 Bucco-lingual	RM2 Crown Height	RM1 Mesio-distal	RM1 Bucco-lingual
CO-40-1AB	M	20-35								
CO-40-1B	F?	U				12.03	10.27	6.28	12.24	10.28
CO-40-1D	U	0-5							10.55	11.29
CO-40-2	U	0-5								
CO-40-3	M	35-50	10.80	10.68	5.30	10.14	10.04	5.02	11.61	10.30
CO-40-4	F	20-35				13.10	10.62	6.67	13.14	11.21
CO-40-5	M?-M	16-20	13.77	11.92	5.83	12.30	10.76	6.08	12.58	11.83
CO-40-6A	F	15-20	10.65	10.54	5.65	11.02	10.01	6.81	11.69	10.10
CO-40-6B	M	35-50							11.33	9.90
CO-40-6C	U	5-10				12.42	10.58	8.18		
CO-40-6D	U	5-10							11.44	9.82
CO-40-13	M	35-50								
CO-40-16C	U	5-10							10.35	9.42
CO-40-17	M	35-50							11.44	10.88
CO-40-18B	F	35-50	11.57	10.33	4.60					
CO-40-19E	U	10-15				10.67	9.57	5.96		
CO-40-19F	U	0-5							11.82	9.51
CO-40-19I	U	5-10							11.61	9.97
CO-40-19M	F	20-35							11.65	10.78
CO-40-19R	M	35-50								
CO-40-20A	F	20-35	11.34	9.90	4.52	10.23	10.22	5.12	11.09	10.40
CO-40-22B juven	U	5-10				10.08	12.04	6.03	12.50	10.31
CO-40-24	M	Adult	12.21	10.68	6.94				12.44	11.06
CO-40-25-1	U	0-5								
CO-40-27	M?	35-50							13.39	11.26
CO-40-29A	U	5-10							11.65	10.57
CO-40-30	M	35-50				11.12	10.62	4.92		
CO-40-31A	M	20-35	12.02	11.71	7.50				11.84	10.49
CO-40-31B	U	0-5							11.92	10.12
CO-40-31C	M	35-50	11.59	10.60	3.89	10.86	9.92	4.45	11.55	10.45
CO-40-31-1C	M?	20-35	9.81	8.69	4.46	11.06	10.81	4.18		
CO-40-31E	M?	15-20				10.56	9.63	6.58	10.93	9.31
CO-40-31G	?	Adult				10.92	9.91	6.44	11.45	10.88
CO-40-31H	U	5-10							12.33	10.33
CO-40-32	M	20-35	12.16	10.46	5.53				11.99	10.47
CO-40-Prov? Skull	M	Adult	11.06	9.71	5.37	11.60	10.11	4.78		
CO-40-68C/7yo	U	5-10								
CO-40-68E/adult	F?	50+								
CO-40-69	M	20-35	8.94	9.55	5.16	9.44	9.46	6.16	12.58	11.55
CO-40-69/4yo	U	0-5							11.93	10.60

Mandibular dental metrics

Accession Number	RM1 Crown Height	RP2 Mesio-distal	RP2 Bucco-lingual	RP2 Crown Height	RP1 Mesio-distal	RP1 Bucco-lingual	RP1 Crown Height	RC Mesio-distal	RC Bucco-lingual	RC Crown Height
CO-40-1AB										
CO-40-1B	4.70	7.24	7.42	5.17	7.70	7.17	6.10			
CO-40-1D	7.33									
CO-40-2										
CO-40-3	5.15	7.18	7.49	5.72	8.19	8.33	6.91	7.77	6.62	9.09
CO-40-4	5.29				7.02	7.15	8.11			
CO-40-5	5.97	7.56	8.16	7.53	8.84	8.34	6.44	8.55	8.65	9.76
CO-40-6A	6.08	7.11	7.46	6.65	6.40	6.62	7.64			
CO-40-6B	5.09				6.38	7.49	3.44			
CO-40-6C		6.45	6.68	7.37				7.21	4.90	11.56
CO-40-6D	7.79									
CO-40-13		7.49	8.98	4.45				7.14	8.10	6.03
CO-40-16C	7.73									
CO-40-17	6.42									
CO-40-18B					6.72	8.28				
CO-40-19E										
CO-40-19F	8.22									
CO-40-19I	6.72									
CO-40-19M	6.39	6.83	6.64	6.45				7.97	5.52	9.83
CO-40-19R		6.93	6.86	7.06						
CO-40-20A	5.25									
CO-40-22B juven	8.28	7.79	7.82	7.22						
CO-40-24	6.94	7.91	8.65	8.27	8.50	8.27	9.59	7.53	6.29	11.16
CO-40-25-1										
CO-40-27	5.93	8.52	8.27	5.44	8.50	7.66	5.59	8.42	7.19	8.20
CO-40-29A	7.86									
CO-40-30										
CO-40-31A	7.45	7.54	8.67	7.45	6.74	7.74	7.82	7.26	7.19	11.36
CO-40-31B	7.52									
CO-40-31C	4.17	7.22	8.37	3.76	7.20	8.54	4.33	6.94	7.22	5.67
CO-40-31-1C										
CO-40-31E	6.40							6.68	4.81	9.20
CO-40-31G	6.73	8.16	8.78	6.98	7.66	8.11	8.10	8.23	8.73	9.07
CO-40-31H	6.75	7.48	7.77	6.33	7.36	7.37	7.77			
CO-40-32	5.52	6.55	7.67	5.93	6.27	7.15	7.58	7.10	6.19	8.61
CO-40-Prov? Skull										
CO-40-68C/7yo										
CO-40-68E/adult					6.75	7.69	5.23			
CO-40-69	5.71	6.22	7.29	5.81	6.70	6.92	7.10	7.43	5.57	9.46
CO-40-69/4yo	7.74									

Mandibular dental metrics

Accession Number	RI2 Mesio-distal	RI2 Bucco-lingual	RI2 Crown Height	RI1 Mesio-distal	RI1 Bucco-lingual	RI1 Crown Height	LI1 Mesio-distal	LI1 Bucco-lingual	LI1 Crown Height	LI2 Mesio-distal
CO-40-1AB										
CO-40-1B										
CO-40-1D										
CO-40-2										
CO-40-3							5.44	4.65	5.37	6.90
CO-40-4										
CO-40-5	6.96	5.18	9.56	7.11	4.75	8.59				
CO-40-6A	5.81	4.55	8.09				5.92	3.29	8.15	5.84
CO-40-6B	5.31	4.37	4.94							4.99
CO-40-6C										
CO-40-6D				5.15	2.82	8.66	5.35	3.96	8.87	
CO-40-13										
CO-40-16C										
CO-40-17										
CO-40-18B										
CO-40-19E										
CO-40-19F										
CO-40-19I										
CO-40-19M										
CO-40-19R										
CO-40-20A							5.68	4.45	4.95	
CO-40-22B juven	6.38	3.05	10.35	6.07	3.23	9.87	9.52	2.90	9.60	6.75
CO-40-24	6.51	5.42	4.09							
CO-40-25-1										
CO-40-27	6.22	5.04		5.82	5.15	6.72				
CO-40-29A										
CO-40-30										
CO-40-31A	6.38	3.07	10.39	5.52	3.02	7.65	6.54	3.46	9.58	6.20
CO-40-31B										
CO-40-31C	5.57	5.57	4.81	4.73	5.03	5.93	4.46	5.37	5.25	6.13
CO-40-31-1C										
CO-40-31E	6.32	3.22	7.71	5.43	3.16	6.72	5.56	2.98	6.83	6.19
CO-40-31G	6.65	4.19	8.43							6.54
CO-40-31H										
CO-40-32	6.04	3.92	7.66	5.36	3.50	6.65	5.27	3.63	7.03	6.46
CO-40-Prov? Skull										
CO-40-68C/7yo	6.39	4.44	8.49	5.70	3.06	8.37				
CO-40-68E/adult	5.62	5.46	5.03							5.82
CO-40-69				5.13	3.67	6.75	5.17	3.82	6.45	6.10
CO-40-69/4yo										

Mandibular dental metrics

Accession Number	LI2 Bucco-lingual	LI2 Crown Height	LC Mesio-distal	LC Bucco-lingual	LC Crown Height	LP1 Mesio-distal	LP1 Bucco-lingual	LP1 Crown Height	LP2 Mesio-distal	LP2 Bucco-lingual
CO-40-1AB						8.07	7.61	7.44	7.15	7.29
CO-40-1B										
CO-40-1D										
CO-40-2										
CO-40-3	5.50	6.81	7.74	6.90	8.65				7.54	8.06
CO-40-4								0.00	8.26	7.60
CO-40-5						8.41	8.39	6.25	7.71	8.12
CO-40-6A	4.27	6.84	7.93	5.79	9.14	6.86	7.26	8.64	7.04	7.38
CO-40-6B	3.91	4.30	6.47	8.47	0.00	6.42	7.18	4.39		
CO-40-6C										
CO-40-6D										
CO-40-13										
CO-40-16C										
CO-40-17										
CO-40-18B			6.99	7.30	6.28	6.65	7.25	4.54		8.58
CO-40-19E										
CO-40-19F										
CO-40-19I										
CO-40-19M										
CO-40-19R										
CO-40-20A			6.88	6.47						
CO-40-22B juven	4.66	9.28								
CO-40-24										
CO-40-25-1										
CO-40-27			8.39	6.94	8.91	7.66	7.71	7.32	8.47	8.21
CO-40-29A										
CO-40-30									7.75	8.35
CO-40-31A	3.05	9.58	7.08	5.19	10.90	7.36	8.19	7.93	7.76	8.96
CO-40-31B										
CO-40-31C	4.46	5.50	7.20	6.86	8.04	7.93	8.27	6.18	7.77	8.39
CO-40-31-1C										
CO-40-31E	3.82	8.02	7.65	8.34	8.73	7.23	7.30	7.61		
CO-40-31G	6.23	8.67	7.01	6.80	8.58	7.56	8.30	7.95	7.83	8.64
CO-40-31H										
CO-40-32	3.47	7.41	7.18	5.04	8.52	7.39	6.52	7.01	7.63	7.81
CO-40-Prov? Skull						6.08	6.37	4.70		
CO-40-68C/7yo										
CO-40-68E/adult	5.87	5.27	6.62	7.07	6.15					
CO-40-69	3.62	8.12	8.34	5.49	8.34	7.01	6.46	7.12	7.11	7.17
CO-40-69/4yo										

Mandibular dental metrics

Accession Number	LP2 Crown Height	LM1 Mesio-distal	LM1 Bucco-lingual	LM1 Crown Height	LM2 Mesio-distal	LM2 Bucco-lingual	LM2 Crown Height	LM3 Mesio-distal	LM3 Bucco-lingual	LM3 Crown Height
CO-40-1AB	5.57	12.17	9.55	4.87	11.61	9.47	5.57			
CO-40-1B										
CO-40-1D		10.24	11.02	6.31						
CO-40-2		11.91	9.70	6.78						
CO-40-3	6.81	11.45	10.91	4.68	10.71	10.31	5.33	10.71	10.44	4.45
CO-40-4	6.85	13.25	10.83	4.77						
CO-40-5	7.15	12.23	11.47	6.96	12.81	11.26	6.98	12.60	11.40	6.56
CO-40-6A	7.22	11.49	10.41	5.36	11.59	9.23	6.51	10.38	9.87	6.86
CO-40-6B		10.94	10.23	5.31	9.76	9.44	5.05			
CO-40-6C					11.04	9.93	7.50			
CO-40-6D		11.58	9.67	7.62						
CO-40-13										
CO-40-16C		11.24	9.77	6.89						
CO-40-17										
CO-40-18B	1.65					0.00	0.00	12.10	10.59	4.33
CO-40-19E										
CO-40-19F		11.52	10.38	8.22						
CO-40-19I										
CO-40-19M										
CO-40-19R										
CO-40-20A		10.63	10.48	4.97				10.74	11.48	5.14
CO-40-22B juven										
CO-40-24								11.65	10.61	6.87
CO-40-25-1		13.55	10.57	7.59	0.00	0.00	0.00	0.00	0.00	0.00
CO-40-27	6.45	12.98	11.34	6.19	12.01	11.24	6.44			
CO-40-29A		11.70	11.16	7.68	0.00	0.00	0.00	0.00	0.00	0.00
CO-40-30	5.49	11.70	11.42	5.58	0.00	0.00	0.00	0.00	0.00	0.00
CO-40-31A	9.23	11.15	10.45	7.62				12.18	11.96	7.63
CO-40-31B		11.98	10.27	7.61	0.00					
CO-40-31C	4.95	11.21	10.32	3.19	10.91	10.21	6.85	12.92	11.50	6.23
CO-40-31-1C					10.50	10.66	5.63			
CO-40-31E										
CO-40-31G	6.59	11.73	10.87	6.89	10.89	10.15	5.87			
CO-40-31H		12.22	10.15	7.98						
CO-40-32	6.04	11.94	10.98	5.73						
CO-40-Prov? Skull		11.43	11.09	3.57	11.14	10.22	4.97	10.33	9.06	5.01
CO-40-68C/7yo		11.42	10.40	6.78						
CO-40-68E/adult										
CO-40-69	6.88	12.77	11.06	6.00	9.47	9.35	6.24	9.89	9.26	5.87
CO-40-69/4yo										

Mandibular dental metrics

Accession Number	Comments
CO-40-1AB	
CO-40-1B	
CO-40-1D	
CO-40-2	
CO-40-3	LI1, LI2 have extensive calculus, crown height esti mated as (obscured.
CO-40-4	
CO-40-5	
CO-40-6A	
CO-40-6B	
CO-40-6C	
CO-40-6D	
CO-40-13	
CO-40-16C	
CO-40-17	
CO-40-18B	RP1 crown = too much calc to measure; LP2 = MD unev en poss leave out LP2 crown height due to wear
CO-40-19E	
CO-40-19F	
CO-40-19I	
CO-40-19M	
CO-40-19R	
CO-40-20A	
CO-40-22B juven	
CO-40-24	
CO-40-25-1	
CO-40-27	RI2 crown has too much calc, can't measure height (can' CEJ)
CO-40-29A	
CO-40-30	
CO-40-31A	
CO-40-31B	
CO-40-31C	
CO-40-31-1C	
CO-40-31E	
CO-40-31G	
CO-40-31H	
CO-40-32	
CO-40-Prov? Skull	commingled max and mand, sex based on mand
CO-40-68C/7yo	
CO-40-68E/adult	
CO-40-69	
CO-40-69/4yo	

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-1	Cranium		Vault	
CO-40-1	Clavicle	L & R		
CO-40-1	Scapula	U		
CO-40-1	Fibula	L	D1/3-DE	
CO-40-1	Femur	U	posterior	
CO-40-1	Tibia	L		
CO-40-1	Tibia	R	D1/3	
CO-40-1A	Cranium			
CO-40-1A	Humerus		PE	
CO-40-1A	Fibula		fragments	1 frg: 52.18 max length; Frg 2: 67.70 max length
CO-40-1A	Femur		fragments	1: 90.51 max length, Lesion: 42.56 x 17.57 at widest (superior aspect); (2) 62.62 max length; (3) 52.20 max length, Lesion: 24.73 x 6.49
CO-40-1AB	Occipital			
CO-40-1AB	Parietals	L & R		
CO-40-1AB	Mandible	R		
CO-40-1AB	Scapula	L	glenoid fossa	
CO-40-1AB	Scapula	L	acromion process	
CO-40-1AB	Acetabulum	R	2 fragments	
CO-40-1AB	Lumbar vertebrae	U	centra and neural arch fragments	
CO-40-1AB	Cervical vertebrae		Centra with neural arch fragments.	
CO-40-1AB	C2			
CO-40-1AB	Thoracic vertebrae		T11	
CO-40-1AB	Rib fragments	U		
CO-40-1AB	Scaphoid	L & R	articular surfaces	

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-1AB	phalanx	U	hand	
CO-40-1AB	MT5	L		
CO-40-1B	Cranium		Occipital, parietals	
CO-40-1B	Frontal	L	orbit	
CO-40-1D	Frontal	R	orbit	
CO-40-1D	Rib	U		fragment - 12mm
CO-40-1D	Radius	L	P1/3-D1/3	Fragment - 81.24mm
CO-40-1D	Ulna	L	P1/3-D1/3	119.64mm
CO-40-1D	Ulna	R	P1/3-D1/3	
CO-40-1D	Radius	R	P1/3	
CO-40-1D	Tibia	L	2 shaft fragments	
CO-40-1D	Tibia	R	M1/3	27x7mm
CO-40-1D	Long bone fragments			
CO-40-1D	Fibula		Shaft fragments	(1) 67mm, (2) 58mm, (3) 43mm.
CO-40-1E	Parietals	L & R	fragments	
CO-40-1E	Occipital	L & R		
CO-40-1E	Palatines	L & R		
CO-40-1E	Scapula	R	glenoid fossa	
CO-40-1E	Lumbar vertebrae	U	Centrum fragments	
CO-40-1E	Radius	L	D1/3-DE	
CO-40-1E	Calcaneus	R		
CO-40-2	Frontal		fragments	
CO-40-2	Parietal	L		
CO-40-2	Clavicle	L		
CO-40-2	Ulna	L		
CO-40-2	Ulna	R		
CO-40-2	Radius	R		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-2	Fibula		fragments	(1) Fib frg labeled L: 85.21 max length frg (raised bone lesion: 17.64 x 4.91); (2) Fib frg labeled R. 126.27 max length (Superior lesion: 37.68 x 5.38 Inferior lesion: 31.61 x 8.98)
CO-40-2	Femur	L	D1/3	lesion: 35.86 x 7.01.
CO-40-2	Femur	R	PE & DE	37.82 x 10.88 on anterior lesion.
CO-40-3	Cranium	R	Occipital, parietal	
CO-40-3	Cranium		Vault	
CO-40-3	Scapula	R	glenoid fossa	
CO-40-3	Vertebrae		C1, C2	
CO-40-3	Vertebrae	L	Lumbar	
CO-40-3	Sacrum			
CO-40-3	Rib		fragments	
CO-40-3	Tibia	L & R	fragments	
CO-40-3	Calcaneus	L & R		
CO-40-3-1	Occipital		squamous	
CO-40-3-1	Temporal	R		
CO-40-3-1	Ilium	L		
CO-40-3-1	Ischium	L		
CO-40-3-1	Sacrum			
CO-40-3-1	Rib fragments			
CO-40-3-1	Ulna	R		
CO-40-3-1	Femur	L	DE	
CO-40-3-1	Talus	R		
CO-40-4	Frontal	L & R		max 64.15 x 83.06
CO-40-4	Frontal	L & R		R active: 6.74 x 4.39; Inactive: 10.69 x 8.58, but edges fragmented PMD; L 9.64 x 5.29
CO-40-4	Parietals	L & R		
CO-40-4	Occipital		squamous	
CO-40-4	Temporal	L & R		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-4	Sphenoid	L & R		
CO-40-4	Palatines	L & R		
CO-40-4	Acetabulum	L & R		
CO-40-4	Humerus	R		
CO-40-4	MT3	R		
CO-40-5	Cranium		Frontal, Parietal frgs	
CO-40-5	Scapula	L		
CO-40-5	Patella	R		
CO-40-5	Humerus	L	D1/3	
CO-40-5	Ulna	L	M1/3	Lesion: 19.31 x 8.81
CO-40-5	Tibia	L	M1/3 - D1/3	
CO-40-5	Tibia	R		
CO-40-5	Fibula		fragments	
CO-40-5	Phalanges			
CO-40-6A	Occipital		squamous	
CO-40-6A	Parietal			
CO-40-6A	Phalanx		proximal	
CO-40-6B	Frontal			
CO-40-6B	Occipital	R		
CO-40-6B	Occipital			
CO-40-6B	Parietal		Midline	
CO-40-6B	Femur	R	P1/3-D1/3	
CO-40-6B	Femur	L	P1/3-D1/3	
CO-40-6C	Parietal	R	Midline	

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-6C	Femur	L		
CO-40-6C	Tibia	R	fragments	
CO-40-6C	Tibia	L		
CO-40-13	Parietal	L & R		
	Occipital		fragments	
CO-40-13	Scapula	L	glenoid fossa	
CO-40-13	Pubis	L & R		
CO-40-13	Acetabulum	U		
CO-40-13	C2			
CO-40-13	C3			
CO-40-13	C4			
CO-40-13	C5			
CO-40-13	C6			
CO-40-13	Radius	R	D1/3 - DE	
CO-40-13	Ulna	R	PE - P1/3	
CO-40-13	Radius	U	PE	
CO-40-13	metacarpals	L & R		
CO-40-13	phalanges	L & R	hand	
CO-40-13	phalanges	R	foot	
CO-40-13	Phalanges	L & R	foot	
CO-40-15A	Parietal	L & R		
CO-40-15A	Humerus	L		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-15A	Ulna	L		
CO-40-15B	Ulna	U		
CO-40-15B	Femur	L	M1/3	Medial = 63 x 10.5; Lateral = 93.5 x 19
CO-40-15B	Femur	R	M1/3 - D1/3	medial lesion: 50 x 17mm
CO-40-15B	Tibia	R		
CO-40-15B	Tibia	L	P1/3	Medial lesion 33 x 20.5
CO-40-15D	Cranium	U	Frontal, Parietal frgs	
CO-40-15D	Ulna	L		lesion: 17x3mm
CO-40-15D	Radius	L	M1/3	Lesion: 42 x 7.5 mm
CO-40-15E	Clavicle	R		
CO-40-15E	Patella			
CO-40-15E	Ulna	R	PE	
CO-40-15E	Tibia	R		
CO-40-15E	Long bone fragments	U		(1) 48 x 21 max length; (2) 54 x 17.15 max length; (3) 45 x 36 max length
CO-40-16A	Ulna	L		
CO-40-16A	Ulna	R		
CO-40-16C	Frontal	L & R	orbit	
CO-40-16C	Cranium			
CO-40-16C	Humerus	R	D1/3	
CO-40-16C	Ulna	R		
CO-40-16C	Femur	L		
CO-40-16C	Femur	R		
CO-40-16C	Tibia	L		
CO-40-16C	Tibia	R		
CO-40-16C	Fibula	R		
CO-40-16D	Frontal	L & R	squamous	Lesion: ~20 x 12mm
CO-40-16E	Fibula	L		
CO-40-16E	Fibula	R		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-17	Cranium		fragments	
CO-40-18A	Parietal		fragments	
CO-40-18A	Occipital			
CO-40-18A	Scapula	U	glenoid fossa	
CO-40-18A	Patella	R		
CO-40-18A	Vertebrae		cervical	
CO-40-18A	Vertebrae		cervical	
CO-40-18A	Vertebrae		Lumbar	
CO-40-18A	Rib fragments			
CO-40-18A	Humerus	L	D1/3	67 x 19mm
CO-40-18A	Humerus	R	D1/3	
CO-40-18A	Ulna	L & R		
CO-40-18A	Fibula	R		51mm at anterior porosity
CO-40-18B	Cranium			
CO-40-18B	Scapula	L & R	glenoid fossa	
CO-40-18B	Clavicle	L		37 x 13 mm
CO-40-18B	C2			
CO-40-18B	Rib fragments			
CO-40-18B	Radius	L	D1/3	34 x 13.09mm (posterior woven lesion)
CO-40-18B	Radius	R	D1/3	
CO-40-18B	Femur	L	P1/3	35.58 x 11.80mm (medial aspect lesion
CO-40-18B	Femur	R	M1/3	12 x 5 mm on M1/3
CO-40-18B	Calcaneus			
CO-40-19A	Occipital			
CO-40-19A	Rib fragments			
CO-40-19A	Humerus	L		
CO-40-19A	Radius	L	P1/3	
CO-40-19B	Frontal	L	orbit	
CO-40-19B	Fibula	U		
CO-40-19E	Tibia	L & R		
CO-40-19H	Frontal	L	orbit	
CO-40-19I	Frontal	L & R	orbit	

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-20A	Frontal	L & R	squamous	
CO-40-20A	Frontal	L & R	orbit	
CO-40-20A	Parietal	R		
CO-40-20A	Parietal	L		
CO-40-20A	Temporal	L & R		
CO-40-20A	Occipital	L	squamous	
CO-40-20A	Clavicle	L		
CO-40-20A	Scapula	R	glenoid fossa	
CO-40-20A	Patella	L & R		
CO-40-20A	Ilium	R	Auricular surface	
CO-40-20A	Ulna	R		periostitis lesion: 63 x 10mm
CO-40-20A	Ulna	L		8.5 x 18.16mm
CO-40-20A	Radius	R		
CO-40-20A	Femur	R		
CO-40-20A	Femur	L		
CO-40-20A	Tibia	U	DE	
CO-40-20A	MC1	R		
CO-40-21	Frontal	R	orbit	
CO-40-21	Patella	L & R		
CO-40-21	Scapula	U		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-21	Scapula	U		
CO-40-21	Ulna	L		
CO-40-21	Femur	R	M1/3-D1/3	Lesion: 38.72 x 8 mm
CO-40-21	Femur	L		
CO-40-22A	Scapula	L		
CO-40-22A	Scapula	R		
CO-40-22A	Ischium	R		
CO-40-22A	Ilium		fragments	
CO-40-22A	C2			
CO-40-22A	Humerus	L		
CO-40-22A	Radius	R		
CO-40-22A	Ulna	L		
CO-40-22A	Tibia	L & R		
CO-40-22A	Fibula	L		
CO-40-22A	Talus	L & R		
CO-40-22A	MT4	R		
CO-40-22B adult	Radius	U	DE	
CO-40-22B adult	Radius	L	D1/3	
CO-40-22B adult	Ulna	L		Lesion ~25 x 15mm
CO-40-22B adult	Ulna	R		
CO-40-22B adult	Femur	R		
CO-40-22B adult	Tibia	U		
CO-40-22B adult	Fibula	L		
CO-40-22C	Frontal		squamous	
CO-40-22C	parietal			
CO-40-22D	Acetabulum	L		
CO-40-22D	Acetabulum	R		
CO-40-22D	L5			

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-22D	L4			
CO-40-22D	Vertebrae			
CO-40-22D	Vertebrae		cervical	
CO-40-23A	Frontal	R	orbit	
CO-40-23A	parietal	L & R		
CO-40-23A	Temporal	L & R		
CO-40-23A	Radius	L		
CO-40-23A	MT1	L		
CO-40-23B	Femur	L		
CO-40-23B	Femur	R		
CO-40-24	parietal	L & R		
CO-40-24	Occipital	U	squamous	
CO-40-25	Acetabulum	L		
CO-40-25	Rib fragments	L		
CO-40-25	Humerus	R		
CO-40-26	Cranium			Parietal measurement 36.53 x 26.93 mm
CO-40-26	Scapula	R	glenoid fossa	
CO-40-26	Scapula	L	glenoid fossa	
CO-40-26	Acetabulum	L		
CO-40-26	Ilium	U		
CO-40-26	Acetabulum	R		
CO-40-26	Ischium	L		
CO-40-26	Vertebrae		Lumbar	

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-26	Sacrum			
CO-40-26	Rib fragments			
CO-40-26	Humerus	R		
CO-40-26	Ulna	R		
CO-40-26	Ulna	L		
CO-40-26	Radius	R		
CO-40-26	Radius	L		
CO-40-26	Tibia	R		
CO-40-26	Fibula	R		
CO-40-26	Tarsals	R		
CO-40-27	Frontal			
CO-40-27	Clavicle	R		
CO-40-27	Patella	R		17 x 10mm
CO-40-27	Acetabulum	L		
CO-40-27	Vertebrae		C1/C2	
CO-40-27	Vertebrae		C3/C5	
CO-40-27	Tibia	R		
CO-40-27	Fibula	L		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-27	Tibia	L		
CO-40-27	Femur	L		
CO-40-27	Fibula	R	P1/3	
CO-40-28	Scapula	R	glenoid fossa	
CO-40-28	Ilium	R		
CO-40-28	Humerus	L		
CO-40-28	Radius	R		
CO-40-28	Ulna	L		
CO-40-28	Ulna	R		
CO-40-28	Fibula	R		
CO-40-29A	Frontal	L & R	orbit	
CO-40-29A	Sphenoid			
CO-40-31A	Cranium		Parietal, occipital	
CO-40-31A	L5			
CO-40-31A	Fibula	R		R lesion: 122.5 x 17mm
CO-40-31C	Cranium	R	Frontal, Parietal frgs	
CO-40-31C	Clavicle	L & R		
CO-40-31C	C1			
CO-40-31C	Rib fragments			
CO-40-31C	Radius	R		~86.5, both anterior and posterior
CO-40-31C	Ulna	R		lesion: 54mm
CO-40-31C	Radius	L		
CO-40-31C	Fibula	R		Lesion: 110 x 4.5
CO-40-31C	Fibula	L		
CO-40-31C	Tibia	R		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-31C	Femur	L		
CO-40-31C	Femur	R		
CO-40-31C	Tibia	L	P1/3	77 x 15mm
CO-40-31C	Scaphoid	R		
CO-40-31C	Lunate	R		
CO-40-31C	MC1	L & R		
CO-40-31C	Calcaneus	L & R		
CO-40-31-1C	Cranium			
CO-40-31-1C	Scapula	R	glenoid fossa	
CO-40-31D1	Humerus		M1/3	
CO-40-31E	Cranium		Frontal, Parietal frgs	
CO-40-31E	L5			
CO-40-31E	Ulna	L		
CO-40-31E	Tibia	L		
CO-40-31F	Frontal	L	orbit	
CO-40-31F	Frontal	L & R		
CO-40-31F	Fibula	R		
CO-40-31G	Frontal	L & R		
CO-40-31G	Parietal	L		
CO-40-31G	parietal	R		
CO-40-31G	Patella	L		
CO-40-31G	Ulna	R		
CO-40-31G	Radius	R		
CO-40-31G	Femur	R		
CO-40-31G	Femur	L	P1/3 - D1/3	lesion: 104.63 x 25.72 mm
CO-40-31H	parietal	L & R		
CO-40-31H	Fibula	L		
CO-40-31H	Fibula	R		
CO-40-31I	Patella	R		
CO-40-32A	parietal	L & R		
CO-40-32A	Vertebrae		Thoracic	

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-32A	Femur	R		
CO-40-32B	Tibia	L		
CO-40-32B	Tibia	R		
CO-40-68C/3yo	Humerus	U	M1/3	
CO-40-68C/3yo	Femur	U		
CO-40-68E/adult	Ilium	L & R	Auricular surface	
CO-40-68E/adult	Vertebrae		Thoracic	
CO-40-68E/adult	Rib fragments			
CO-40-68E/adult	Rib fragments			
CO-40-68E/adult	Rib fragments			
CO-40-68E/adult	Ulna	L	P1/3-DE	
CO-40-68E/adult	Ulna	R	PE-M1/3	
CO-40-68E/adult	Radius	R	M1/3 - DE	
CO-40-68E/adult	Radius	L	P1/3-DE	
CO-40-68E/adult	Femur	L	PE - DE	
CO-40-68E/adult	Femur	R	M1/3 - D1/3	
CO-40-68E/adult	Tibia	R	PE - M1/3; DE frg	
CO-40-68E/adult	Tibia	L	P1/3 - DE	
CO-40-68E/adult	Phalanges	U		
CO-40-68E/adult	Calcaneus	L		
CO-40-68E/adult	MT2	R		
CO-40-68E/adult	Phalanx	U		
CO-40-68E/6yo	Humerus	R		Lesion: 24.09 x 6.45 mm
CO-40-68E/6yo	Ulna	R		lesion 36.12 x 8.56 mm on medial ulna
CO-40-68E/6yo	Humerus	L		
CO-40-68E/6yo	Femur	U		Lesion=23.97 x 6.34 mm
CO-40-68E/6yo	Femur	L	P1/3-D1/3	lesions: 28.85 x 6mm, 10.05 x 4.10mm
CO-40-68E/6yo	Tibia	R		

Paleopathology descriptions

Accession number	Skeletal element	Side	location	Measurements
CO-40-68E/6yo	Tibia	L		
CO-40-68E/6yo	Fibula			Shaft 1: 92mm, Circ lesion (51.21, 17.83, 13.13 in length x 9.84 width); Shaft 2: 46x8.5, Lesion 46x4.76 on edge of bone.
CO-40-68W/adult	Frontal	U	orbit	
CO-40-68W/adult	Occipital			
CO-40-68W/adult	parietal			
CO-40-69/4yo	Frontal	L	orbit	
CO-40-69/4yo	Femur	L	D1/3	
CO-40-77	parietal	R		
CO-40-77	Clavicle	U		
CO-40-77	Clavicle	L		
CO-40-77	Patella	R		3.94 x 4.64mm
CO-40-77	Vertebrae	U	U	
CO-40-77	C2			
CO-40-77	Humerus	L & R		
CO-40-77	Femur			(1) 31x30mm; (2) 52x31mm
CO-40-77	Phalanx	U	hand	
CO-40-77	MC2	R		
CO-40-77	Phalanx	U	Foot	
CO-40-79b69	Occipital			
CO-40-79b69	Sternum		Body	
CO-40-79b69	Patella	L & R		
CO-40-79b69	Tibia	L		Lesion at nutrient foramen (most complete portion of lesion): AP: 37.22 ML: 26.40
CO-40-79b69	Tibia	R		Lesion: 20.40x13.04 (posterior distal).
CO-40-79b69	Calcaneus	L & R		
CO-40-82b	Fibula			

Paleopathology descriptions

Accession number	Description
CO-40-1	Diffuse periositis throughout all cranial bones
CO-40-1	Diffuse periositis throughout (sm, patchy).
CO-40-1	Diffuse periositis throughout (sm, patchy).
CO-40-1	Healed periostitis on medial aspect near nutrient foramen. Only minor undulating bone remains. Well healed.
CO-40-1	Some of the changes to the cortical bone is PMD, but the posterior aspect has sclerotic, well healed undulating bone on whole posterior. No margins, elongated pores.
CO-40-1	Possible shaft atrophy/remodeling, however, only two fragments pres
CO-40-1	Cortical bone normal on posterior aspect, but medial and lateral are thin, with woven bone and undulating morphology
CO-40-1A	Possibly healed crobra orbitalia, but most of orbit mis
CO-40-1A	2 humerus fragments with lipping on the superior he
CO-40-1A	Path on 2 of 6 fragments: (1) Was previously glued to frg (glue deformed) and obscures some of the remaining path. Frg has 13 written on it in red. Shaft appears swollen from bone expansion. Side with “13” and non-marked side have woven bone incorporated into underlying matrix, but undulating pattern remains. Majority of 2 surfaces covered with elongated pores and some woven bone. Side “13” has line from vein etched into surface. Remaining side “1A” has pinprick porosity and does not appear to have same shaft expansion (no undulating bone deposits). (2) Unlike frg 1, frg 2 has shaft expansion of whole area. While the lateral, rounded portion of the bone is well incorporated with some areas of undulating bone, the areas near and on the crests of the fibula frg are sclerotic, with clear edges, with both elongated and pinprick porosity.
CO-40-1A	3 fragments. (1) Medial anterior aspect has area of bone growth with irregular matrix inferior and more incorporated/sclerotic superior. Elongated pores with bone spicule-like formation of sclerotic on superior to inferior = incorporated margins as move anterior and medially with elongated pores. Anterior has areas of unincorporated bone growth. (2) Entire frg covered in woven bone with elongated pores. Undulating pattern to bone matrix. Margins well incorporated. (3) Majority of cortical bone well incorporated with no porosity. Small area of PMD to cortical bone shows probable periostitis with margins not incorporated to underlying cortical area of porosity and slightly woven bone.
CO-40-1AB	Occipital has pinprick and diffuse porosity near suture li
CO-40-1AB	L/R parietals: pinprick porosity, healed, along sutures. Midline depression of parietals = plastic deformation. No change in internal structure.
CO-40-1AB	Mandible – porosity (diffuse + pinprick @ mental eminence) broken near R aspect of mental eminence
CO-40-1AB	Osteophytes at superior border, posterior and inferior lipping. Posterior bone formation on articular surface with a ring of unincorporated porosity.
CO-40-1AB	Expanded MSM at process tip, with facet. (Note, matching L clavicle has too much PM match easily at articulation point).
CO-40-1AB	Focal bone deposition with unincorporated margins and macroporosity. Grainy texture with discoloration from surrounding bone.
CO-40-1AB	3 lumbar centra: 1 centrum has slight osteophyte growth on anterior annular ring. 5 lu neural arches, with lipping on all the articular facets. L5 has porosity and anterior bone formation on right aspect. Sacrum not present, but based on dense bone of auricular surface and bone formation on L5, possible remodeling of R sacrum
CO-40-1AB	Expanded left inferior articulation with extensive remodel. Anterior aspect of centrum has no porosity, but well incorporated osteophytes. Some porosity on superior neural arch.
CO-40-1AB	Dens has an osteophyte
CO-40-1AB	Centrum with osteophytes around the annular ring, porosity and expansion of the right neural arch
CO-40-1AB	Lipping on most of the costal groove of fragments
CO-40-1AB	osteophytes with lipping

Paleopathology descriptions

Accession number	Description
CO-40-1AB	1 unsided proximal hand phalanx with expansion of b ase and osteophyte formation. Unsequenced, but not first.
CO-40-1AB	Lipping at base
CO-40-1B	Healed porosity on midline occipital. and L/R parie tals following suture lir
CO-40-1B	Healed cribra orbitalia
CO-40-1D	Cribra orbitalia active and healed (fragment of orb it (
CO-40-1D	1 rib frg: sclerotic bone and shaft expansion. Poro sity present but majority of the middle of the lesion lost to PMD.
CO-40-1D	Circumfirential periostitis lesion. Posterior well incorporated, but rest unincorporated and sclerotic with elongated pores. D1/3 = posterior ra ised woven lesion, but PMD. P1/3 = PMD, so anterior may be better incorporated, but da maged. Posterior D1/3 = pinprick porosity.
CO-40-1D	Circ periostitis with diffuse porosity. Sclerotic a t radial articulation (P1/3 medial, ~31x11mm). With sheet-like and porosity (diffuse pi nprick). Some sclerotic bone on D1/3 posterior, but PMD.
CO-40-1D	Shaft expansion and periostitis circumferential wov en and sclerotic. Circumferential diffu porosity and bone growth.
CO-40-1D	Circumferential periostitis. Medial and lateral are remodeled with well incorporated margins. Anterior is mostly remodeled with 1 active , woven area with porosity (~25x12mm). lateral and medial margins are well inc orporated, anterior margin is not. Posterior lesion is approx 96 mm, unincorporated wi th some PMD, sclerotic bone and diffuse porosity, elongated pores on P1/3.
CO-40-1D	Circunfirential woven periostitis with shaft expan sion. Posterior has areas remodeled (smoother) with porosity (both pinprick and elongat ed), but patchy lesions. No incorporation, just layers of periostitis
CO-40-1D	Posterior is smoother with porosity, but M1/3 has a raised lesion. Circumferential perio with woven bone and shaft expansion. Margins of rai sed posterior portion of lesion are not incorporated
CO-40-1D	4 frgs (probably R tibia): woven bone periostitis w ith remodeling in medullary cavity. Fl looking sheet like bone.
CO-40-1D	3 fibula shafts (sorted with 1D based on periostiti s lesions and morphology): all 3 have circumferential woven periostitis (67mm, 58mm (w/ d istal epip), 43mm). Largest fragem (67mm) has patch of remodel (~38x11mm) with pinpric k porosity.
CO-40-1E	Healed porotic hyporostosis with faint, healing por osity present over majority of parietal frgs
CO-40-1E	Diffuse porosity throughout
CO-40-1E	Remodeling at anterior suture and incisive foramen. Porosity and woven bone/spicules present
CO-40-1E	Slight lipping/rim around glenoid fossa, with poros ity around
CO-40-1E	2 lumbar centrum (1 = L5). Lumbars have slight lipp ing with initial bone formation on midline centrum on annular ring, but very slight.
CO-40-1E	Healed periostitis. Note – DE does not articulate w ith D1/3 frg due to PMD. Area of bone formation is anterior and superior to grooves, with raised "bump" with incorporated margins, faint pinprick porosity and slight discolo ration. The medial aspect of the lesion is more active with woven bone present.
CO-40-1E	Lipping at talus articulations
CO-40-2	Pacchion bodies on internal table.
CO-40-2	One fragment with diffuse porosity. No other frgs w ith poro
CO-40-2	Fine grained pinprick porosity on superior aspect o
CO-40-2	Possible shaft expansion. Seems to be sheet of scle rotic bone on both frgs with pinprick and elongated porosity. Few areas of PMD suggest co rtex with bone formation on top, but because of influences of growth, unsure.
CO-40-2	Shaft expansion on medial aspect of bone. Sclerotic with pinprick and elongated porosity. PMD cross-section shows circumferential sclerotic b one and porosity
CO-40-2	Sclerotic on tubercle (MSM). No shaft expansion, bu t circumferential sclerotic on M1/3 – D1/3 with fine pinprick porosity. Postierior has el ongated porosity with incorporated margins. Proximal margins are unincorporated

Paleopathology descriptions

Accession number	Description
CO-40-2	(1) Generalized porosity, particularly on M1/3. pin prick + healed. Most could be growth, there is area of raised bone growth that is definit e periostitis. Margins distinct and unincorporated. Opposite to this lesion, can see di stinct, uninforporated margins running the long axis of the bone, with area of porosity ra ised lightly above underlying, not porous bone. (2) 2 periostits lesions (superior & inferior). Superior: margins unincorporated, with sclerotic bone, pinprick + elongated porosity. No c lear shaft expansion. Inferior: Margins unincorporated, cortical bone appears depressed wit h sclerotic bone. Shaft expansion w pinprick and elongated porosity.
CO-40-2	Anterior only; slightly darker with pinprick and el ongated porosity. Possible shaft expansion? No clear margins.
CO-40-2	Similar to L, diffuse pinprick over whole bone with patches of more sclerotic looking bone at D1/3. PMD suggests cortex with bone growth
CO-40-3	Porosity across occipital (superior to nuchal) to R parietal. Pinprick and larger. Healing on R parietal, doesn't appear to be healing on occipit al. Less concentrated on L occipital.
CO-40-3	Pacchion bodies on internal table. No external poro sity or def
CO-40-3	Some possible lipping
CO-40-3	C1 & C2: possible eburnation (definite facet) at C1 /C2 dens/articul
CO-40-3	L4: osteophytes off L centrum lateral border
CO-40-3	Fusion of L5-S1 at neural arches. Centrum and infer ior articular facets unfused, but transverse fused bilaterally to L/R ala. Posterior R still has spicules between S1 and L5, Left = complete fusion of bone. Incomplete fusion o f S5-S4 of posterior neural arch. Coccyx 1 fused to S5.
CO-40-3	Lipping at costal groove
CO-40-3	L/R crests, L/R popletiel line, 1 DE frg, 22 frgs - some frgs have elongated/long pores following long axis, but not enough present to dete rmine pathological or not.
CO-40-3	Bilateral extension of articular facet with head of f
CO-40-3-1	Pinprick and coalesced porosity on internal surface
CO-40-3-1	Temporal porosity – lytic like on petrous portion. Possible PMD, but edges rour
CO-40-3-1	Porous and light - osteoporosis?
CO-40-3-1	Porous and light - osteoporosis?
CO-40-3-1	Lumbardization of S1 or fusion of L5. Have 4 forame n and no extra L5 transverse processes. Sacral canal isn't opened – bony bridge across ala in line with L5/S1. fusion lines of inferior articular processes still visible (particularly on L). Spinous = lumbar morphology. Appears to be fused anteriorly, but PMD at center, but edges fused. S5 curved like for coccyx, so, I think lumbardization of S1.
CO-40-3-1	All associated rib fragments are porous and light - osteopor
CO-40-3-1	Lipping on coracoid process. Lipping and eburnation on posterior radial no
CO-40-3-1	Lipping of patellar surface
CO-40-3-1	Accessory facet on superior surface.
CO-40-4	Posterior L/R frontal starting at approximately mid point on squamous to suture line (lost PMD) has diffuse, healing pinprick porosity. Porosi ty more dense at midpoint and midlin with pinprick and coalescing areas, but diffuse pin prick porosity covers to L/R frontal lines.
CO-40-4	L orbit cribra orbitalia has more porosity and it a ppears a larger area (but there is less healing than R, so that may attribute to larger les ion appearance), larger pores, but no raised bone. On present portion of lateral orbit, p orosity becomes more diffuse, consistent with healing. Maybe if more present, could see more healing. R has mostly healed cribra orbitalia with the active portion more midline. Act ive area has about 12 pores, mostly pinprick but a few are larger. Inactive area has we ll remodeled borders, but raised bone with diffuse porosity is still present.
CO-40-4	Diffuse porosity, with more concentrated at saggita l suture, that runs the length of both sides (110 mm), and approximately 30 mm on each sid e of the saggital suture. Pinprick and healing near frontal, laterally. Larger porosit y found on L/R sagittal suture, no healing (A-P). mid and posterior portions of parietal have pinprick with little healed.
CO-40-4	Diffuse pinprick porosity with no healing evident o n superior aspect, above nuchal crest (PMD) to lambdoid suture.
CO-40-4	Posterior porosity to mastoids, pinprick —Variation ? Scurvy? Diseas

Paleopathology descriptions

Accession number	Description
CO-40-4	3 frgs – 1 internal (but not sure what side—eroded) . 2 are L/R lesser wings (with greater wing frgs PMD at sella turcica). Pinprick porosity on inferior portion of greater wings and lesser wings anterior and on external surface. Poro sity on R is more concentrated, no healing evident.
CO-40-4	Diffuse pinprick porosity (particularly anteriorly) with the present midline portions appeari white (PMD). Maybe from preservation material?
CO-40-4	Slight lipping on rim
CO-40-4	Healed trauma. Antemortem break on D1/3. Well heale d bony callus with remodeling. No edges distinguishable. Shaft shows significant thic kening from P1/3-M1/3. Displaced laterally, causing bone to have bent/bowed appearan ce.
CO-40-4	RMT3 = subchondral pit. No cuneiform to compare to, but I/Dawnie have seen this type of focal bone loss on a lot of Native Americans.
CO-40-5	Present parietal frgs (about 12) have pinprick poro sity, diffuse but no expansion. Frontal has posterior pinprick near bregma.
CO-40-5	Spine with possible periostitis. 2 patches (1: infe rior medial, near PMD, 2: midline on lateral aspect) of flakey, dark bone. However, the majority of the area has cortical bone eroded. Probable porosity following shape of spine. Pinprick and larger. No healing but well rounded edges of pores.
CO-40-5	Anterior superior has small spicules consisten with enthesophy
CO-40-5	Posterior D1/3 has very diffuse pinprick porosity, some PMD at the MSMs, so look more aggravated. Elongaged pores on posterior medullary cavity.
CO-40-5	Previous reconstruction. Medial M1/3 with patchy pe riostitis. Sclerotic bone, darker, with distinct edges and pinprick porosity. Edges irregul ar, not incorporatedinto underlying cortical bone. PMD to margins and white underlying cortical bone suggests patch is actually larger
CO-40-5	M1/3 – D1/3 looks swollen. Possible shaft expansion
CO-40-5	Possible swollen shaft, but it's a small frg, with tapho
CO-40-5	2 shaft frgs almost identical in size. Distinquised based on wood (probably a pencil) in medullary cavity of one (1): flatter side has heale d periostitis (88.43 x 9.76). Erosion of bone impacts margins of lesion. (may have extended further in life/whole bone) 33.06 mm of lesion = raised area with long, linear sclerotic pores. Margins on angular side of fibula well incorporated (other margins – PMD/erosion). Re maining 50+ mm of lesion are combo of woven bone and diffuse pinprick porosity. (2) fl atter side: healed/ing periostits = 149.13 x 13.32. 2 main areas of elevation (bumps). Elongat ed pores nearer to bump with change to ovoid shape as move away from center. Angular si de has more pinprick. Vein etching, very slight at one end. Right before PMD, no pathol ogy. Both 1 & 2 bumps have some elongated pores, and no woven on either. Margins we ll incorporated. 2 is more angular looking, but may be illusion since 1 has erosion PM D to bump (white spots)
CO-40-5	Distal phalanges have lipping at DIP and heads tuft ed from arthritis. Middle and distal lipping at lat edges.
CO-40-6A	diffuse pinprick and coalescing porosity
CO-40-6A	Erosion of inner table on most frgs, porosity with pinprick and healing porosity on external table
CO-40-6A	1 prox phalanx with bone growth inferior to head – a
CO-40-6B	Midline – healed trauma. Circular depression (11 mm in diameter) superior to glabella (PMD), R of frontal crest. Pinprick posterior to in bending area.
CO-40-6B	Pinprick diffuse following lambdoid suture. Concent ration of porosity on superior aspect.
CO-40-6B	Diffuse porosity on some fragments
CO-40-6B	Diffuse pinprick porosity, concentrated at suture
CO-40-6B	Shaft expansion at P1/3, particularly anterior to g lut max. well healed with only porosity on anterior aspect with more woven looking bone. Mostl y lateral-posterior and lateral-anterior affected. Small patch sclerotic on medial aspect (3 0 x 10).
CO-40-6B	Less expansion than R with well remodeled margins. Limited to medial-posterior with diffuse porosity. Some medial vein etching M1/3
CO-40-6C	Coalesced porosity

Paleopathology descriptions

Accession number	Description
CO-40-6C	Probable shaft expansion on lateral aspect, but PMD makes dx questionable. Definitely shaft expansion on medial – well remodeled and undulating form of bone. More M1/3, but since well healed, maybe more. Faint pinprick porosity with most healed areas.
CO-40-6C	(1) only 1 area of remodeling with expansion, (2) Healed woven on center with sclerotic edges. Large, elongated pores. Undulating morphology throughout.
CO-40-6C	Major shaft expansion with vein etching laterally, undulating on lateral and almost rounded medially. Porosity varies across bone with elongated porosity at medial to large, to pin, back to large (traveling superior to inferior).
CO-40-13	Diffuse and healed porosity on L/R parietals at sutures. Lambdiod is closing, sagittal is obliterated.
	Larger pores at lambda and occipital.
CO-40-13	Inferior border only. Lipping and bone formation and depression of face, indicating arthritis.
CO-40-13	Superior portion of R pubis – seems to be bone growth at tubercle with sclerotic and porosity, but with concretions, can't dx exactly what is taphonomic and what may be pathological.
CO-40-13	Superior acetabulum with lipping and slight porosity – arth
CO-40-13	inferior articular facet expanded (bone formation) with porosity and lipping. Corresponds to expansion of C3 superior articular facet. Possible formation on inferior centrum. Area inferior and anterior on centrum border seems to have expanded slightly. Some PMD to area, so may have been symmetrical with L side of centrum.
CO-40-13	lipping and expansion of posterior superior border with lipping at center and cupping-like bone growth at L/R aspects of centrum. L superior articular facet has macroporosity, lipping and expansion of area – corresponding to C2. The inferior articular facet has major bone expansion with macroporosity. Facet appears flattened and expands posterior onto neural arch. Area inferior to spinous process appears flattened as well with macroporosity and spicule osteophyte formation on posterior, inferior aspect.
CO-40-13	L neural arch frg includes superior and inferior articular facets. Corresponding bone formation, macroporosity and flattened appearance. C4 L inferior articular facet has ring of osteophytes surrounding facet and some expansion, but much less than superior facet. Centrum = PMD to R and superior centrum. Inferior shows curvature (suggesting bone formation and removal to create cupping-like shape) with macro- and microporosity along central inferior border. Some expansion of C4 inferior anterior centrum border, causing extend past superior border.
CO-40-13	L articular facets and centrum (whole). L superior articular facet: expanded and curving posterior to connect to inferior articular facet. No porosity. Lipping present inferiorly. Inferior facet proken PMD. Centrum has macroporosity on L with some L/central. Superior anterior border eroded and expansion of inferior aspect with lipping at both anteriorly. Inferior centrum has macroporosity both L and R with erosion of L border, creating cuplick form of centrum.
CO-40-13	L articular facet more vertical with expanded articular facet, corresponding to C5 (superior). Inferior has no path/arth. L centrum superior = eroded and macroporosity with lipping anteriorly. Inferior has 2 macro-pores (possible PMD) on L, some lipping anteriorly.
CO-40-13	lipping around DE
CO-40-13	Coracoid damaged PMD, but olecranon process and semilunar notch have lipping. Medial osteophytes on olecranon.
CO-40-13	1 unsided radius head with circumferential lipping
CO-40-13	All heads and bases have lipping
CO-40-13	Lipping on heads and bases
CO-40-13	Middle phalanx with flat head. Heads of distal have lipping. 1st distal has a malformed base on medial aspect from osteophytes.
CO-40-13	Proximal concreted to middle, middle concreted to distal, distal antemortem fused to middle.
CO-40-15A	Diffuse pinprick porosity
CO-40-15A	Healed woven on medial aspect with diffuse porosity

Paleopathology descriptions

Accession number	Description
CO-40-15A	Shaft expansion at brachalis. Swollen looking with well healed lesions. Anterior at brachialis least organized, most concentration of p orosity. Medial has well incorporated margins. Posterior has diffuse porosity and well in corporated margins (except most lateral portion of posterior). Lateral aspect has clear mar gin on posterior/lateral aspect (lesion 43.50 in length). Faint sheet like qualities.
CO-40-15B	Possible shaft expansion
CO-40-15B	Rugged linea aspera. M1/3 medial and lateral both h ave undulating bone with diffuse porosity. Meidial has vein etching
CO-40-15B	Linea aspera is rugged looking. Posterior D1/3 has periostitis with well incorporated margins, diffuse porosity and discoloration of lesi on. M1/3 medial aspect has palpable bump with no margins/well incorporated margins, dif fuse pinprick porosity, and slight discoloration of lesion
CO-40-15B	Lateral/medial aspects have active lesion (almost c ircumferential) on the whole fragment, with elongated pores and woven bone. Posterior is w ell healed with diffuse porosity and lumpy areas.
CO-40-15B	Active woven with concentrated pinprick porosity. M edial superior remodeled with margins into sclerotic area and diffuse porosity
CO-40-15D	Diffuse pinprick porosity on frontal and parietal
CO-40-15D	Possible healed periostitis on medial. Slight woven and diffuse porc
CO-40-15D	Healed posterior periositis with sheetlike lesion a nd diffuse pinprick porosity. No margins observed/well incorporated
CO-40-15E	Superior anterior acromial end has pinprick porosit y with probable healed woven bone. Some PMD in area, but possible shaft expansion.
CO-40-15E	Enthesophytes on midline anterior patella
CO-40-15E	Shaft expansion. Whole PE looks swollen with diffus e porosity on medial under radial notch
CO-40-15E	Shaft expansion. Can't even see the crest, shaft is so expanded. Lateral aspect has diffuse porosity. Posterior has undulating bone.
CO-40-15E	(1) woven, elongated without margins and undulating morphology. Some diffuse porosity; (2) elongated pores without undulating bone, but pr obable shaft expansion, without margins; (3) diffuse along one margin only. Shaft e xpansion with undulating morphology.
CO-40-16A	Medial and posterior periostits. Raised, sclerotic and slight pinprick porosity. Approximately 25 mm length, but not a solid lesion – patchy on both sides
CO-40-16A	Posterior periostitis. Raised and sclerotic. Faint porosity. Patchy, but this time concentrated to small, thin line on posterior 19 x 1.5mm
CO-40-16C	Active cribra orbitalia with large pores and bone f orma
CO-40-16C	Most skull with no porosity. 1 frg (L parietal near lambdoid) and temporal frg with large pores. Parietal frgs with healed porosity
CO-40-16C	faint pinprick porosity
CO-40-16C	Posterior has probable periostitis with scaly and p inprick porosity. No margins visible.
CO-40-16C	Probable on lateral aspect. Well incorporated with diffuse pinprick. Faintly scaly looking, but diffuse porosity from PE-D1/3 on lateral – grow th?
CO-40-16C	Has same lateral PE – M1/3 pinprick porosity. Well incorporated with diffuse pinprick. Faintly scaly looking, but diffuse porosity from PE -D1/3 on lateral – growth?
CO-40-16C	Medial shaft expansion. L = bump (49 x 16). All but anterior well incorporated (anterior = flakey + spicules). Diffuse pinprick and elongated. Areas of raised bone
CO-40-16C	Extensive medial expansion with PMD. Need xray. Sta rts P1/3 to DE, crest affected. Medial distal (near PMD) wraps to lateral aspect wi th unincorporated margins and spicules. Can't tell porosity extent with PMD/shlac k, but probable pinprick throughout.
CO-40-16C	Healed lesion proximal portion.
CO-40-16D	Slight porosity on frontal (midline, just above nas al sutures) concentrated pinprick and diffuse larger pores.
CO-40-16E	Bone growth on shaft. Can see original shaft (not r econstructed) with new bone laid o PMD at PE, circumfirential growth. Diffuse pinprick porosity. 3 raised patches of periostits, near PMD break. Sclerotic, faint porosity.
CO-40-16E	Margins better incorporated with shaft still visibl e in largest lesion. Diffuse pinprick porosity. PMD.

Paleopathology descriptions

Accession number	Description
CO-40-17	Parietal frgs – left shows no porotic hyporostosis, but R does, with healed/faint pinprick porosity at midline.
CO-40-18A	Expanded diploe. External/internal table eroded, bu t 1 frg has slight bit of unweathered external table with concentrated pinprick and coale sced porosity. Parietal near sagittal, unsided.
CO-40-18A	Active diffuse pinprick on occipital superior to nu chal c
CO-40-18A	Posterior lipping, but too much PMD to side.
CO-40-18A	Enthesophyte on anterior of ligament. Mesial condyl e = posterior lipping (severe) and subchondral destruction of articular surface.
CO-40-18A	C4-C7. Erosive arthritis with spicule formation and bone “strutting”. Inferior and lateral more affected. Erosive pathology on centrum with bo ne formation on centrum (laterally and inferiorly) giving “squished” appearance. Osteo phytes are mainly on L side.
CO-40-18A	C6, C7 – erosive arthritis, but no lateral bone for mation on superior C6. Minimal on superior C7 with some porosity on L. no strutting.
CO-40-18A	Lumbar centrum with curved osteophyte at annular ri
CO-40-18A	Lipping at costal groove.
CO-40-18A	Shaft expansion on posterior surface with well inco rporated edges. Anterior is undulating, but appeared better incorporated.
CO-40-18A	Has small pinprick porosity, well healed on posteri or asp
CO-40-18A	Severe lipping at coracoid and lateral articulation areas. L – osteophyte at olecranon condyle, lateral aspect (R = PMD)
CO-40-18A	Shaft expansion with well healed shaft expansion. S ome undulating bone, but mostly just rounded. Anterior crest – circumferential elongated porosity. No margins.
CO-40-18B	Porosity on petrous temporals, occipital (lambdoid to nuchal), L/R parietals (+ area of raised, healed bone), L sphenoid = pinprick and act ive.
CO-40-18B	Slight lipping of posterior.
CO-40-18B	Shaft expansion posterior with undulating bumpy bon e depression (37 x 13 mm) near w appears to be trapezius origin. Diffuse pinprick ac ross, concentrated on superior aspect.
CO-40-18B	Enthesophyte on dens
CO-40-18B	Slight osteophytes on costal groove
CO-40-18B	Medial D1/3 healing periostitis. Woven bone with di ffuse porosity on posterior. superior borders still clear and distinct from cortex. Infer ior lost to PMD.
CO-40-18B	Medial aspect adds secondary ridge on D1/3 (12.50 m m long and 25 mm from DE). Healed anterior porosity at ridge
CO-40-18B	Raised bump of well remodeled bone on medial aspect . Area shows margins well remodeled with only a faint undulating bone remaini ng in center. Posterior edge of “bump” has faint, healed porosity. Probably healed periost its.
CO-40-18B	R femur has focal bone formation on medial aspect. can palpitate and see raised area on medial shaft. Possible healed periostitis.
CO-40-18B	Calcaneus and talus = elongation on facet on head o f talus and side of calcaneus (sustenculum tali)
CO-40-19A	Diffuse occipital porosity
CO-40-19A	1 fragment has callus = healed fx with diffuse pinp rick poı
CO-40-19A	Shaft expanded. Posterior with no margins, diffuse porosity and undulating bone. Anterior = undulating bone, partially onto medial aspect
CO-40-19A	Anterior shaft expansion with elongated bores and w oven without margins
CO-40-19B	Cribra orbitalia pinprick and larger. Active, no he al
CO-40-19B	4 shaft frgs, all have periostitis. Woven with pinp rick, no margins. 3 manually articulate, reconstructed.
CO-40-19E	Sheet like lesions with elongated and pinprick poro sity, healing/no margins. healed mesial L and mesial R.
CO-40-19H	faint prinprick in orbit – possibly cribra orbitali a, but PMD to
CO-40-19I	Active cribra orbitalia. large pores with raised bo ne formation in R and slight depression in L.

Paleopathology descriptions

Accession number	Description
CO-40-20A	Frontal: pinprick and dense at midline from bregma to glabella. Bone formation, no margins, only bump from bregma to middle (near numbers). Healed porosity and pinprick from numbers to orbits and glabella. Possible bone formation. Particularly R orbit seen have “swollen” area medially, near nasal, superior to notch with larger porosity. 94.18 x 32.95. L seems more healed. Porosity from frontomaxillary suture to opposite suture and to nasals.
CO-40-20A	Healed cribra orbitalia, with only trace porosity and pinprick remair
CO-40-20A	Porosity from sagittal sutures (anterior-posterior) and medial-lateral to parietal lines. Diffuse and healed posterior and lateral to parietal lines. Most dense at suture with lessening as move laterally. Bone formation at bregma, continued from frontal bone formation. Well remodeled – only location on sagittal with no porosity. Broken (PMD) a of parietal show clear expansion (particularly on L). internal – no sulcus for sagittal, but depressions near bregma on internal moving medial-lateral and anterior (1 L, 1 R). Diffuse porosity throughout (+ frontal and occipital)
CO-40-20A	More healed, but same pattern of densest porosity nearest sagittal suture and frontal and more diffuse moving lateral/inferior/posterior. None inferior to parietal lines. Mirrored bone growth at bregma
CO-40-20A	Diffuse porosity on mastoid and superior to external auditory meatus. R – larger pores and less healed than L.
CO-40-20A	Large pores at/near sutures. Moving inferiorly at midline is more healed, but more dense porosity. Can’t score nucal. Porosity does not extend past external protuberance.
CO-40-20A	Porosity at midshaft. Pin+coalesced porosity with no margins, both superior and inferior aspect. Bone has undulating morphology, but with MSM expansion, hard to determine extent.
CO-40-20A	Slight inferior posterior lipping of glenoid fossa. Some porosity laterally and ingeriorly. Slight pinprick at rim.
CO-40-20A	Enthesophytes on anterior, superior aspect. L is more pronounced. Both lipping and medial posterior facet. L = either bone loss from accessory facet on lateral or bone formation of lateral facet.
CO-40-20A	Possible retroauricular activity, but looks more pathological. R sacral ala = Pl
CO-40-20A	Healed periostits with bone formation. Elongated pores and small bump medially. No margins. Very slight undulation pattern of cortical bone. Also, some lipping around semi-lunar, particularly medial olecranon.
CO-40-20A	Bone growth lateral to brachalis insert. Darker coloration with pinprick/coalescing porosity. Small remodeled bone spur.
CO-40-20A	Periostits with bone formation interior to radial tuberosity. Sclerotic, darker, pinprick + larger porosity. Posterior = incorporated with undulateing morphology. Medial = sclerotic patch, clear margins with minimal incorporation. Posterior D1/3 = incorporated and undulating with pinprick, larger, and coalescing porosity. Well healed margins.
CO-40-20A	Shaft expansion and depression of bone. Large porosity at glut max insert with fine porosity across area. Bone remodeling on posterior aspect, inferior to lesser trochanter, medial to glut max. 72 x 17.80. Some of linea aspera remodeled (P1/3). No margins, undulating cortex. Some bone depression medial D1/3 linea aspera. Measures 31.5 x 4
CO-40-20A	Irregular matrix along length of linea aspera. Xray equiv
CO-40-20A	Lipping around articular facet.
CO-40-20A	Healed break. Bone growth and remodeling.
CO-40-21	Probable cribra orbitalia. Healed with pinprick, but only have small part of orbit, so can’t be completely sure on dx.
CO-40-21	Little to no medial articular surface on posterior surface. Lateral and crest, but crest ro over to edge, with no clear surface on R and slight on edge of L. L has anterior superior enthesophyte (1) and lipping (anterior and medial). Both have depression medial and inferior, near apex.
CO-40-21	The majority of the spinous processes look blunted. Possible ossification of ligament/tendon? Some spicules on lower aspect, making spinous process appear flared on inferior aspect.

Paleopathology descriptions

Accession number	Description
CO-40-21	1 spinous process with same morphology as described above – possible ossification of ligmnet/tendon.
CO-40-21	Lipping of semilunar at medial olecranon border.
CO-40-21	Healed periostits medial M1/3-D1/3 near linea aspera. No margins (well healed). No porosity, undulated bone matrix.
CO-40-21	Possible periostits healed on inferior border. Posterior near linea aspera, but well healed. Only undulating bone and irregular cortex remains. Can see 2 vein etching on medial aspect. Medial patch: 40.78 x 12.03. Lateral patch: 24.03 x 8.29. D1/3 where linea aspera changes to DE area has periostits. Bone formation with well healed margins and porosity present. Medial, posterior. 12.28 x 15.71. Healed lesion on medial. Palpable bump with vein etching. No margins, faint porosity on medial/anterior aspect. 41.57 x 26.04
CO-40-22A	Secondary ring of bone growth on posterior and inferior border from artl
CO-40-22A	Secondary ring of bone growth on posterior and inferior border from artl
CO-40-22A	Slight bone ridge on rim or acetabulum – arthritis
CO-40-22A	Woven bone periositis. Only small frg (lesion 21.5 x 7), probable ilium between ilium and pubis, with woven boen raised off underlying matrix. Large pores.
CO-40-22A	inferior L articular facet – expansion and osteophyte growth, indicating arthritis. Variation on L transverse foramen – smaller and higher than standard, creating asymmetry.
CO-40-22A	Lipping around inferior posterior head.
CO-40-22A	Lipping at DE
CO-40-22A	Lipping at coracoid
CO-40-22A	Diffuse porosity posterior M1/3 midshaft
CO-40-22A	2 frgs, Lateral shaft has periostitis on M1/3. inferior margins well remodeled, superior lesion indicated by increased porosity and discoloration. ~75 x 8.5. superior, anterior margin cleanest (least incorporated). Sheet-like lesion.
CO-40-22A	Slight lipping on articular surface
CO-40-22A	Healed periostitis. Lat on shaft (30.74 x 6.36). Margins well incorporated, center of lesion has diffuse porosity, pinprick and elongated. Palpable bump remains. L = no path. RMT none.
CO-40-22B adult	Lipping on articular surface
CO-40-22B adult	posterior crest D1/3 = possible lesion. Pinprick with sclerotic bone formation. Erosion and cortical flaking with nodule erosion.
CO-40-22B adult	Patch of probable periostitis. Lateral aspect, inferior to radial notch. Woben with porosity (diffuse pinprick). Posterior aspect suggestions margins well incorporated, but with PMD, hard to tell.
CO-40-22B adult	Apperas to have porosity and periosits in similar location, but extent is difficult to tell as there is a pressure lesion throughout the lesion.
CO-40-22B adult	Possible shaft expansion. Present cortical bone on D1/3 = pinprick and healed sclerotic with undulating morphology.
CO-40-22B adult	Shaft expansion. Very rounded. Because M1/3 and rounded, hard to side, but possibly R. lateral aspect = sclerotic bone with woven and remodeled edges. Anterior lateral aspect is more active, and the posterior aspect is well remodeled. Diffuse porosity throughout shaft, but clearest on lateral side. Posterior has some PMD, anterior crest seems remodeled PMD, medial is mostly PMD, but some diffuse porosity is evident.
CO-40-22B adult	Shaft expansion. Medial aspect has active remodel with woven bone, elongated and pinprick porosity and erosion. Rest of shaft is rounded, with posterior aspect having clearest undulating morphology.
CO-40-22C	Near nasals, appears to be bump with diffuse pinprick and larger porosity. Well healed, no margins, only palpable bump at midline.
CO-40-22C	Inner table is eroded. 1 frg (L parietal near lambdoid/sagittal midline) measuring ~43 x 28 has active porosity with large pores and raised bone lesion (28 x 18.5).
CO-40-22D	Bone formation around rim. Superior has subchondral destruction with slight bone formation on lateral aspect
CO-40-22D	Subchondral destruction on superior face, but not to extent
CO-40-22D	Superior ring osteophytes on centrum. R inferior centrum has curved osteophy

Paleopathology descriptions

Accession number	Description
CO-40-22D	Superior centrum has ring osteophytes, inferior has anterior osteophytes. Anterior centr = bone strutting. Center appears to have been compression fx with remodeling. No corresponding fx on L5, possibly L4 – L3? (L3 not present).
CO-40-22D	1 unID cent frg, probably lumbar due to ring osteophytes on annula
CO-40-22D	Erosive arthritis on superior/inferior centrum with anterior pinced and lats built
CO-40-23A	Cribra orbitalia: large pores on anterior aspect. Some healing, with pinprick in posterior.
CO-40-23A	Midline pieces both have diffuse pinprick porosity and diploe expansion. Left near saggital and lambdoid has pinprick porosity.
CO-40-23A	Porosity and fossa superior and posterior to external auditory meatus—possible non metric? Bilateral.
CO-40-23A	Tubercle is expanded. Possible from growth? Doesn't look like necrosing, but has increased porosity and irregular margins.
CO-40-23A	Slight depression in base (plantar, medial). Does not penetrate bone, no poros
CO-40-23B	bone formation/lipping of linea aspera.
CO-40-23B	bone formation/lipping of linea aspera.
CO-40-24	Porotic hyperostosis with diploe expansion. Pinprick + larger. Some coalescing. Mostly posterior and midline. More on R.
CO-40-24	2 occ frg – 1 midline with porosity – large and pinprick
CO-40-25	Some lipping present.
CO-40-25	1 possible rib shaft – floating rib shaft - accessory facet/fossa lateral to head. Doesn't appear to be path, possible arth.
CO-40-25	Slight lipping of medial trochlea
CO-40-26	Posterior parietal, near foramena shows areas of activity. Bone formation, healed in ce with pinprick porosity. Pinprick porosity on and above nuchal crest. Superior aspect coalescing, diffuse, and more healed. Parietal bone formation from inflammation. Rasied area of bone formation from healed PH lat to bone formation. Internal table – raised area with formation (22 x 17.5) on L parietal.
CO-40-26	Present portion of glenoid (posterior 1/3) has bone formation on more anterior of posterior rim. Looks like bone loss, but aspects near the face (moving towards midline of scapula body show areas of porosity and less well incorporated bone matrix (inferior/anterior to glenoid fossa).
CO-40-26	Area of pinprick porosity in center of glenoid fossa. Superior aspect shows possible site of dislocation, but unclear (partially because I can't check bilaterally). Some porosity and unusual bone morphology, but PMD in same area.
CO-40-26	PMD, but area around where ligament from fovea capitus attaches has areas of increased porosity, bone loss, minimal bone formation. Some lipping.
CO-40-26	Bone formation inferior to anterior inferior iliac crest. Well incorporated with some macroporosity.
CO-40-26	Focal bone loss on anterior superior aspect. Surrounded by area of porosity and abnormal trabecular bone formation. Some lipping.
CO-40-26	Fragment has some acetabulum. Portion of acetabulum as similar abnormal trabecular bone formation as well as macro-porosity.
CO-40-26	Lipping on superior/inferior articular processes (particularly L4-L5). L3 has L inferior articular process with odd morphology. Pinched looking and tipping towards the midline with accessory facet superior to articular facet. Also has erosion of superior annular ring. Possible path, but some taphomonic damage on anterior portion of ring. L4 – possible periostitis on anterior midline centrum. Bone growth in focal area 18.88 x 12.70 mm, but bone growth (candle wax in appearance with possible taphonomy on top? Bone has almost a candle wax appearance on superior/inferior, spicule like bone depression on midline. Edges questioned because they are very sharp, but with the bone glue/PMD, difficult to assess). Erosion of midline superior and inferior annular rings with bone loss and nodules present on centrum border. Inferior centrum looks "pinched" with body center higher than lateral aspects, but no bony reaction. L5 cent only – osteophytes on R lateral centrum, causing slight lipping.

Paleopathology descriptions

Accession number	Description
CO-40-26	Possible lumbardization of S1 – PMD, but present superior articulation and neural arch looks lumbar more than sacral. S2 was fused, but PMD. L superior articular process has bone growth on posterior aspect and possible accessory facet on posterior. Anterior aspect of left superior has porosity (pinprick) with erosive bone loss. No neural arch on L5, so can't check that. Both L/R superior have possible accessory facets on midline near fossa for articular facets, with bone growth and possible eburnation (slight).
CO-40-26	All present heads and articular facets have lipping around facets. Lipping and osteophytes at costal groove.
CO-40-26	Distal third and DE: Anterior aspect has remodeling (bone formation) around fossa. Formation in and around both fossa. Posterior: bone formation in olecranon fossa. Looks almost like piece of another bone incorporated into humerus. Medial aspect healed with remodeling. Some/slight remodel in olecranon fossa.
CO-40-26	Hole in prox epip on olecranon process. Present on L as well. PMD? Non metric? Possible expansion of radicular notch, but PMD. Corresponding radius has a wide head and deep (~9mm). Lipping at all PE margins and expansion of coranoid process - arthritis
CO-40-26	Slight lipping of coracoid
CO-40-26	Expansion of radial tuberosity and head (~10 mm)
CO-40-26	Expansion of radial tuberosity. Head less expanded (~8
CO-40-26	Medial malleolus has subchondral destruction (posterior) ~ 10.9 x 5.3 mm. Deep pit, remodeled boarders.
CO-40-26	D1/3 – periostitis (healing) near MSM. MSM near DE, but present periostits extends 50 mm superiorly. Lateral malleolus fossa seems expanded with irregular trabecular patterns.
CO-40-26	Lipping on all facets
CO-40-27	Present patches of lamellar bone have diffuse porosity (mostly pinprick, with larger pores on midline near coronal suture. Diffuse porosity on L temporal line/frontal line. Active concentrated porosity on L supraorbital margin to glabella (but eroded). Extent hard to assess due to erosion of bone.
CO-40-27	Inferior half has woven bone present. Posterior edges well remodeled. Anterior edges more active/less incorporated in bone matrix. Anterior portion, near trapezoid, has porosity with most lateral area with pinprick changing to more elongated pores as move medially.
CO-40-27	large posterior subchondral defect
CO-40-27	Pinprick porosity near the attachment of the ligament from the femur, not on articular surface, but superior to attachment. Most of acetabulum is PMD at edge, but present e of articular surface shows lipping and some bone erosion consistent with arthritis. Perhaps porosity is also related to arthritis?
CO-40-27	Slight eburnation on dens and fossa
CO-40-27	Centrum and neural arch fragment with erosion superior and inferior to cen
CO-40-27	Taphonomy is confusing the diagnosis of the lesions. There appears to be diffuse porosity on the P1/3-M1/3 tibial crest, but erosion and bone adhesions on the M1/3 suggest maybe taphonomic and not pathological. Possible patches of periostitis on the remaining tibial shaft, but due to the bone adhesions, all questioned: Medial midshaft has area of possible active periostits with raised flaky looking bone with faint porosity (23.09x10.08). however, PMD = pitting and some erosion of cortical bone (in some cases, to medullary cavity) and PMD break (reconstructed) at midshaft. Surrounding area has long pores of cortical bone following long axis. Photos. Posterior midshaft – diffuse porosity superior and inferior to PMD break. Eroded cortical bone and cracks from weathering following long axis and l adhesions on posterior lateral aspect. Photos. Lateral midshaft: bone erosion is minimal, but can't tell if have bone adhesions inferior to PMD break or raised periostitis. Also small (11.22 x 6.51) area of concentrated porosity (pinprick and coalesced) and possible bone loss (or erosion).
CO-40-27	2 shaft frgs. Anterior portion appears to have shaft expansion. Majority of bone is severly weathered with cortical bone flaking off. Maybe more shaft expansion, indicated by diffuse porosity on mesial aspect. Anterior crest of fibula has woven bone and diffuse pinprick porosity.

Paleopathology descriptions

Accession number	Description
CO-40-27	Possible shaft expansion; crest has diffuse pinprick porosity along length. Lateral aspect has woven bone P1/3-M1/3, well healed, edges well incorporated with one area depressed from surrounding bone (33 x 13). Pinprick porosity on lateral face to D1/3 (210mm), with highest concentration near crest, PM break at midshaft and depressed area.
CO-40-27	Possible shaft expansion. P1/3 – M1/3 has long cracks from weathering, so hard to diagnose. However, undulating pattern of lamellar bone and diffuse pinprick porosity suggest woven bone that is healed. Also posterior lateral has an active periostitis patch (11 x 5.5) – raised and pinprick.
CO-40-27	Patch of healed periostitis – has long pores with raised bone. Lateral edges well incorporated.
CO-40-28	Posterior and superior aspect = erosive + macropores (erosive arthritis?) lipping of ant side, with depression and hiatus of rim on anterior superior aspect.
CO-40-28	R aur surface: has a strange morphology, probably pathological (with PMD), with bony growth behind apex (anterior) of auricular surface. Can you dislocate your sacrum? Mos the face eroded, but present bone shows erosion and pitting of superior face.
CO-40-28	Extensive trabecular remodel of anterior DE – spicule formation and lip
CO-40-28	Slight lipping on radial head.
CO-40-28	Possible undulating bone on medial P1/3 (superior PMD restored). Most matrix well incorporated, only faint traces of woven on posterior border/edge.
CO-40-28	Remodeling inferior to radicular notch with porosity and woven bo
CO-40-28	Cortical bone morphology is undulating, but no clear area of infection could be discerned
CO-40-29A	cribra orbitalia has pinprick, active lesions in or
CO-40-29A	Diffuse pinprick on exterior sphenoid greater wing.
CO-40-31A	Have pinprick porosity. Occipital has larger pores. R parietal has less healing and more active porosity, with clearer pinprick than L (which is more faint and less defined).
CO-40-31A	L5 spondylolosis. Neural arch only present
CO-40-31A	R – healed lateral periostitis M1/3 – D1/3. healed woven with shaft expansion. No pores, no margins. More buildup on anterior aspect
CO-40-31C	Diffuse faint pinprick.
CO-40-31C	Diffuse pinprick on acromial end – superior only.
CO-40-31C	Osteophyte on inferior articular facet with dens
CO-40-31C	Some slight lipping at costal groove
CO-40-31C	Healed periostits. Anterior = remodeled M1/3 – DE with D1/3 = porosity and bump. Posterior M1/3 – D1/3 undulating bone with elongated pores. No margins
CO-40-31C	P1/3 shaft expanded to look round highly remodeled with pinprick only remaining on medial. Rest is undulating morphology only
CO-40-31C	Anterior near crest P1/3 – healed woven with elongated pores. No margins (47 mm). posterior = remodeled with undulating (36mm). shaft expansion.
CO-40-31C	Lateral – raised, sclerotic lesion with healed margins. Active in middle, incorporated at edges. Faint pinprick on posterior only.
CO-40-31C	Medial = healing with active, unincorporated edges (anterior). Sclerotic (active overlaps healed – chronic). Healed pinprick and elongated porosity with undulating morphology mm. P1/3 – M1/3. Active (54mm) wraps with unincorporated margins, from onto anterior crest to lateral. Second lesion (75mm) from lateral to posterior. Both unincorporated sclerotic bone growth, no pores, but rugged outlines/margins D1/3 anterior crest = elongated and scaly lesion ~34.5mm.
CO-40-31C	Extensive remodel M1/3 – D1/3, some on P1/3. Posterior = undulating only, no clear margins on any aspect. Medial – largest/highest bone growth, partially on D1/3. Vein etching. Middle = well remodeled and no pores. D1/3 = anterior portion unincorporated spicules into cortex with some porosity. Superior M1/3 has patches of well incorporated with irrecular margins. Anterior crest almost rounded away – M1/3. lateral – M1/3 least incorporated with spicules into cortex. Some pores, but inferior D1/3 well remodeled. Inferior D1/3 appears unincorporated, but PMD. Photos.

Paleopathology descriptions

Accession number	Description
CO-40-31C	With exception of L aspera, shaft expansion complet ely remodeled/incorporated with minimal – diffuse pinprick. Majority of pinprick po rosity superior P1/3 and medial. Vein etching. Linea aspera = rugged/sclerotic looking.
CO-40-31C	Seems to have 2 lesions: (1) P1/3 – M1/3, expansion on medial with minimum growth. Some porosity. (2): M1/3 – D1/3 with overlap. major expansion with irregular patches with margins. Like L, linea aspera = rugged.
CO-40-31C	major bone expansion. Margins in with popletial lin e. Posterior superior = unincorporated, but rest of margins are incorporated. Elongated por osity. Inferior is well remodeled.
CO-40-31C	slight lipping on articular facet
CO-40-31C	lipping on meidal and lateral of facets
CO-40-31C	lipping on heads
CO-40-31C	slight lipping on sustentaculum tali articular face
CO-40-31-1C	Depression following sagittal suture to midline occ ipital, above external occipital protuberance. Widens near parietal foamina to occip ital. Pairetals have faint, healed porosity with larger pores near sutures (3 or 4 L/R postierior to foramina). Occipital – l pores. Reconstructed parietals and occipitals.
CO-40-31-1C	Ring lipping. Medial is most pronounced. Both media l and lateral have areas of focal porosity associated with lipping.
CO-40-31D1	circumferential periostitis, well healed
CO-40-31E	Diffuse pinprick porosity faint throughout
CO-40-31E	Anterior, midline portion of frg incorporated with centrum (but for most part, unsure if adhesions or fused).
CO-40-31E	Some shaft expansion
CO-40-31E	Some increased porosity medial, but no lesion or bu mp; may just be varia
CO-40-31F	L orbit healed porosity; no path in R.
CO-40-31F	Frontal: general diffuse pinprick porosity. Healing at bregma. Some healing at glabella.
CO-40-31F	Possible healed periostitis. Irregular cortical bon e with slight undulating morphology
CO-40-31G	Cribra orbitalia. R = 8 large pores at midline with more diffuse porosity (healed) lateral. L PMD, but can see diffuse porosity medially with lar ger, healed pores laterally.
CO-40-31G	Faint diffuse pinprick near lambda on L parietal he
CO-40-31G	3 frgs with cortical bone external flaked off/erode d, but 1 spot near sagittal suture (2) has faint diffuse pinprick porosity.
CO-40-31G	Subchondral destruction on medial facet
CO-40-31G	Posterior aspect has diffuse, elongated pores runni ng from about radial notch to PMD at D1/3 – DE. Erosion.
CO-40-31G	Healed lesion P1/3 anterior (37 x 12). Inferior asp ect with sclerotic undulating bone with faint diffuse porosity. Superior = undulating only with trace diffuse porosity some porosity on posterior P1/3, but erosion to cortical bone, so not sure if lesion or just porosity.
CO-40-31G	Medial shaft expansion. Lesion well remodeled with no margins. Faint, healed porosity, palpable bump (66.3 x 19.8). distal 1/3 frg shows s heetlike bone formation in medullary cavity on medial aspect.
CO-40-31G	medial M1/3 – shaft expiation. Similar to R, well h ealed, no margins, well healed porosity (faint, diffuse only). Linea aspera remodeled M1/3, almost completely incorporated in rest of shaft.
CO-40-31H	Some parietal frgs with very faint diffuse porosity
CO-40-31H	Possible small healed periositis lesion on medial a spect. No margins, diffuse porosity o
CO-40-31H	Lateral aspect has diffuse pinprick. Crest shows ar eas of undulating bone. Possible he lesions – no margins.
CO-40-31I	Diffuse pinprick on posterior articular surface. Su rface seems irregular morphology. Surfaces are bumpy-looking, rather than 2 distinct facets. Growth? Variation?
CO-40-32A	More large pinprick on L parietal than R. bone on f rontal under pinprick = raised slightly.
CO-40-32A	7-9ish. 7 = inferior schmoral's node, 8 – superior/ inferior schmoral's node, 9 – superior/PMD to inferior

Paleopathology descriptions

Accession number	Description
CO-40-32A	Shaft looks no path, but vein etching, so may indic ate previous shaft expan
CO-40-32B	Appears to have possible lesion on posterior metaph ysis D1/3 – but, it's the metaphysis. Scaly with pinprick porosity.
CO-40-32B	3 frgs. Sm frg has lesion on medial/anterior aspect (but, near metaphysis. Pinprick and scaly-looking. Growth?
CO-40-68C/3yo	Possible periostitis, but too much erosion
CO-40-68C/3yo	Possible periostitis, but too much erosion
CO-40-68E/adult	Ilium frgs have portions (inferior demiface only) o f aur surfaces. L has too much PMD, R has some PMD, but clearer areas of dense bone and g ranularity. Poss older adult?
CO-40-68E/adult	Centrum has an expanded L rib facet (enlarged artic ulation area, poss from dislocation). Size of centrum suggests superior thoracic vert
CO-40-68E/adult	Irregular bone growth on anterior aspect of a rib f rg. Probable periostitis. Bone deposits well remodeled (no porosity), but margins still cle ar, particularly on frg with periostitis in costal groove
CO-40-68E/adult	Possible healed fx. Area of thinner bone with proba ble callus surrounding.
CO-40-68E/adult	Possible break near articular tubercle. Groove runn ing from posterior to anterior, superior to inferior. Inferior aspect of this additional gro ove terminates in 2 patches of probable periostitis. Thinner cortical bone surrounded by pr obable callus.
CO-40-68E/adult	Some bone growth on extensor groove, but not active and well remodeled. More active bone growth on inferior aspect of interosseous cres t.
CO-40-68E/adult	Lipping at coracoid. Minimal activity on olecranon process, but barely discernable enthesophyte. Radial notch has accessory facet with some bone remodeling.
CO-40-68E/adult	Some lipping of DE. Complete rim on superior aspect of DE articular surface, some lip inferior and medial of DE articulation.
CO-40-68E/adult	Irregular growth on interosseous crest. Lipping of superior DE articular surfa
CO-40-68E/adult	Posterior aspect, inferior to trochanters, on linea aspera—area of bone deposition and removal. Probably stress lesion of glut max. overal l morphology of linea aspera is very rugged with bone growth, probably from muscle attac hment/expansion. At least 6 "vein etching"—3 medial, 3 lateral in spiral-like pattern , suggests shaft expansion
CO-40-68E/adult	DE frgs-slight lipping on condyle border; 1 faint " vein etching" at midshaft, w/ possible second crossing it - suggests shaft expansion
CO-40-68E/adult	DE: small area of bone growth. Middle = pinprick po rosity. Margins well incorporated. D1/3-M1/3: Some activity on popletial line (MSM). Latera l aspect of M1/3 = four vein etching - suggests shaft expansion
CO-40-68E/adult	Remodel/bone activity on/near popletial line. 2 vei n etching on M1/3 lat aspect - suggests shaft expansion
CO-40-68E/adult	All proximal phalanges have lipping on shaft, both sides. Thickening the length of the shaft, then thining right before head. Causes head to look "pinched in."
CO-40-68E/adult	Lipping at facets, with bony extension at achilles (enthesoph
CO-40-68E/adult	subchondral pit + accessory facet. No matching dest ruction on cuneiform. Accessory fa on ventral aspect of base, with some lipping on fac et
CO-40-68E/adult	Distal toe phalanx, distal tufting is resorbed, wit h dorsal more affected than ventral aspect. Moth-eaten appearance, with most of bone destroyed.
CO-40-68E/6yo	Well healed periostitis with coalesced porosity in middle, posterior D
CO-40-68E/6yo	Corticle bone layers appear to be separating from s haft. Also has periostitis on shaft, with PMD causing lesion to flake off. Proximal end of le sion is broken. On distal end is well healed and unincorporated. Pinprick porosity throug hout.
CO-40-68E/6yo	Largest patch of periostitis (28.32x8.91) on medial D1/3 and lateral D1/3 (13.92x8.96).
CO-40-68E/6yo	Periostitis lesion raised with edges well healed an d coalescing poros
CO-40-68E/6yo	Possible periostitis on 2 fragments, but too much P MD to tell if path or adhesions (note, tibias have extensive periostitis).
CO-40-68E/6yo	Lesions on medial and lateral surfaces. Medial is m ore active on distal portion (32.43x9.74), more healed on the proximal (23 cm le ngth, circ). Lateral: 70.26x8.64 in thickest place.

Paleopathology descriptions

Accession number	Description
CO-40-68E/6yo	L tibia: Too much PMD to lesions and bone to make c oherent measurements. Medial (at widest): 52.11x12.7
CO-40-68E/6yo	2 shafts: Cortical bone layers appear to be separat ing from shaft. Also has periostitis on shaft, with PMD causing lesion to flake off.
CO-40-68W/adult	Cribra orbitalia. edges show healing, but large, co alescing pores. One portion (left in photos) is slightly raised.
CO-40-68W/adult	Some pacchion bodies
CO-40-68W/adult	1 fragment (of 10) has trace, well healed PH.
CO-40-69/4yo	Pinprick porosity consistent with cribra orbitalia
CO-40-69/4yo	Periostitis: medial D1/3 pinprick porosity with scl erotic bo
CO-40-77	Pacchions following saggital suture
CO-40-77	3 clavicle frgs. One with focal bone loss present o n articular
CO-40-77	Very thin cortical bone in comparison to other piec es, osteopor
CO-40-77	Subchondral destruction (bone loss, focal on medial articular surfa
CO-40-77	1 centrum frg (unsequenced): compression fx (poss) anterior portion of midline centrum compressed compared to lateral aspect. Inferior asp ect has some white, indicating PMD bone. Inferior centrum, has shell embedded. Erosion may have given shape.
CO-40-77	Osteophyte on dens.
CO-40-77	Porosity along crest between trochlea and capitulum
CO-40-77	(1) appears to be proximal portion of condyle (near patellar articular surface) with possible subchondral destruction (arthritis related?); (2) i s more distal portion of a condyle, with small, well healed patch of periostitis/bone growth on posterior portion of condyle
CO-40-77	Distal hand phalanx: osteophytes ringing the proxim al articular surfa
CO-40-77	Base is expanded. Possible healed fx.
CO-40-77	Prox phalanx with expansion of prox articulation su r
CO-40-79b69	Pars basilar not fused (hypo or spheno occ), looks like outside fused and inside did not. Congenital defect? L broken PMD, so can't compare.
CO-40-79b69	Unfused at both epiphyses, poss congenital defect?
CO-40-79b69	Medial accessory facets (nothing on femurs DE, tibi a PE (in piec
CO-40-79b69	Matrix well incorporated. Pores long and linear – n o pinprick or undulating bone on medial aspect, but also has linear vein etching.
CO-40-79b69	Same undulating bone deposits, but only on distal e nd D1/3. Well incorporated margin remodeling with linear pores. Similar vein etching, but very faint.
CO-40-79b69	Achilles enthesophyte
CO-40-82b	Very small, raised patches of bone with fine, pinpr ick poı

APPENDIX 7: MITOCHONDRIAL DNA PILOT STUDY

This report details the proposed pilot study to assess the feasibility of sequencing mitochondrial DNA (mtDNA) from the teeth of five individuals from Cerro Mangote. This pilot study provides sufficient evidence to expand the sample to include another 15-20 individuals from the skeletal sample, pending funding. This increased sample will be used to answer questions regarding relationships between Paleoindian groups and the individuals from Cerro Mangote. This report includes the methods, results, and future plans and uses of the data. The methods sections details the specific procedures used in the pilot study, expanding on the generalized methods of the proposal. The results section reports the success of the pilot study, specific to each individual sequenced. The further studies section outlines how the mtDNA will be used to answer questions regarding population structure and past migration patterns.

Methods

Five samples were chosen from Cerro Mangote from the assemblage curated at the University of Arkansas, Museum Studies.

Accession #	Sample 1	Sample 2
CO-40-20A	Right Maxillary molar 3	Right Maxillary molar 2
CO-40-31A	Left Mandibular molar 2	Right Mandibular molar 2
CO-40-32	Right Maxillary molar 2	Left Maxillary molar 2
CO-40-4	Left Mandibular molar 2	Right Mandibular molar 2
CO-40-31F	Left Mandibular molar 2	Right Mandibular molar 2

Mitochondrial DNA analysis was preferred for this aDNA project due to the number of copies. There are, on average 750 mitochondria per cell, with each mitochondrion containing an average of 2.5 mtDNA (Merriwether 1999: 122). The increased number of copies greatly enhances the probability of successful recovery. Samples from teeth are ideal, since the enamel provides protection of the sterile interior bone material (O'Rourke 2000). Teeth are preferred as they can be directly associated with a particular individual *in situ* and are easily transported. Two teeth from each individual were labeled using accession numbering for the collection.

All extraction and PCR methods were performed under the strident sterile positive pressure conditions of D.A. Merriwether's ancient DNA laboratory at Binghamton University to ensure the validity of aDNA results. Before DNA extraction, the bone was immersed in a 20% bleach solution for approximately five minutes and then placed in a strata linker in order to minimize the effects of handling and site contamination. The pulp of one tooth from each individual was extracted using a dremel drill bit within a sterile hood. Minimal damage was done to the exterior of the teeth and three out of the five roots can be easily attached back to the crown. The other two teeth, while no longer having an intact root still maintained the integrity of the crown. The DNA of each sample was then extracted from the bone dust using a modified version of the Yang *et al.* (1998) protocol. Approximately 1 gram of bone dust was placed in a 15 mL conical tube with 2 mL of 0.5M EDTA buffer. After sealing each tube with parafilm the samples were then rotated at room temperature (25° C) for 96 hours. Then 1.5 mL of H_2O and 0.5 mL of the enzyme Proteinase K (20mg/mL) was added to the tubes, which were then incubated while rotating at 55° C for 24 hours. After incubation the samples were centrifuged at 2,000 x g for five minutes and then placed in centricons (size exclusion filters) to reduce the volume to ~30 µL by centrifuging at 4,300 x g for 30 minutes. The flow through was kept in reserve at -80° C in case the initial extraction failed.

A column-based Qiagen extraction kit (Qiagen, Valencia, CA) was used to finish the DNA extraction. The reduced volume of 30 µL was mixed with 5 volumes of Qiagen PB buffer and loaded 750 µL at a time into the Qiagen column. This was then centrifuged at 12,800 x g for 1 minute. The samples were then washed with 750 µL of Qiagen PE buffer and centrifuged at 12,800 x g for 1 minute. Finally the samples were eluted from the Qaigen columns with100 mL of irradiated TE buffer with pH 8.0. The samples were then stored at –80° C.

The completed extracts were then amplified by PCR (Saiki *et al.* 1988) with Platinum Taq Polymerase (Invitrogen) under strict sterile conditions to avoid contamination. Each reaction cocktail contained the following reagents and their concentrations, differing only in the primers used in each reaction: 1X standard PCR buffer, 1.5 mM of $MgSO_4$, .2 mM dNTP, .2 µM forward primer, .2 µM reverse primer, and 0.5% of total reaction volume Platinum Taq. A touchdown PCR (-0.1) was completed with the conditions at 94ºC denaturing temperature for 20 sec. followed by the associated annealing temperature for 30 sec. and an elongation temperature of 72ºC for 45 sec. The 3 primer sets used consisted of the following:

Primer Set 1: annealing at 58º C

16106F, 5'-GCCAGCCACCATGAATATTGTA-3'

16251R, 5'-GGAGTTGCAGTTGATGTGTGAT-3';

Primer Set 2: annealing at 55º C

16190F, 5'-CCCCATGCTTACAAGCCAGT-3'

16355R, 5'-GGGATTTGACTGTAATGTGCT-3';

Primer Set 3: annealing at 51º C

16327F, 5'-CGTACATAGCACATTACAGT-3'

16429R, 5'-GCGGGATATTGATTTCACGG-3'.

This amplification was verified by electrophoresis using 1% ethidium bromide stained agarose gels. Samples were prepared for sequencing by filtration with a Millipore plate (Millipore, Billerica MA) to remove contaminates. One µL of this product was then sequenced using Applied Biosystems 377XL automated sequencer under the sequencing protocol described in Merriwether *et al.*, 1999.

Hypervariable region I of the mitochondrial D-loop was specifically targeted for amplification with the appropriate associated primers. Sequencing Hypervariable region I of the D-loop presents a high number of human polymorphisms, thereby providing the greatest amount of information and making it an economic use of resources. The samples were prepared and sequenced in the Merriwether lab under the standard lab protocols described in Merriwether *et al.* (1999) thereby creating the raw data for the production of individual genetic profiles.

Contig assemblage and sequence alignment was accomplished with SEQUENCHER (Forensic Version, GeneCodes, Ann Arbor, MI), CLUSTAL X (Thompson *et al*, 1994), and McClade (Maddison and Maddison, 1989). A polymorphic sites table was constructed in order to further format the sequence data for refined analysis and easier differentiation between sequence data (see Figure 1, in Results section).

Results

Initial results of the pilot study are preliminary and do not represent the final analysis. Still, it is possible to ascertain the feasibility of further tests on the population in question. Figure 1 represents the polymorphic sites that appear in the HVI region of the mitochondrial genome of experimental samples that were sequenced. The first line, highlighted in dark gray is the standard Cambridge reference sequence called the Anderson sequence, referred to in the chart as Anderson (Anderson *et al.* 1981). The mtDNA base pair differences between a particular sample and that of the reference sequence are shown, while the period denotes no change from the reference. The question mark stands for currently un-sequenced regions of a sample.

Figure 1:

Sample	16188	16190	16204	16207	16221	16225	16262	16302	16309	16325
*Anderson	T	C	A	T	C	A	C	T	T	C
CO-40-4	.	.	.	.	.	G	T	.	C	?
CO-40-20A	.	.	C	C	.	.	.	.	.	.
CO-40-31A	.	.	.	.	.	.	?	?	?	?
CO-40-31F	C	T	.	.	T	.	?	?	?	?
CO-40-32	.	.	.	.	T	.	.	.	C	T
AHuard	.	.	.	.	.	.	.	C	.	.
JLuedtke	.	.	.	.	.	G	.	.	.	.
ABaker	.	.	.	.	.	.	.	.	.	?

The pilot study demonstrates that there was minimal to no contamination as the experimental samples have differences from the three control samples obtained from the participating investigators. These appear as the last three sequences in the chart. Only one sample is the exception that of CO-40-31A, which has no discernable differences from that of the reference or ABaker. This could be contamination from the individual who extracted the teeth initially for the testing; however, it may be due to an absence of variation in the sample over the obtained sequence data. Further sequencing with different primers should elucidate these results to determine whether it is contamination or not. Another alternative is to extract the sample again from a different tooth from the same individual.

Sample CO-40-4 appears to have three transitions (changes that are more likely to occur within the genome due to molecular structural similarities among bases) at mtDNA positions 16225 (A G), 16262 (C T), and 16309 (T C). CO-40-20A shows two changes, one transition at 16207 (T C) and one transversion (a more unusual mutation, again due to molecular structure of DNA bases) at 16204 (A C). Sample CO-40-31A appears to have no differences from the reference sequence within the mtDNA Hypervariable region 1. CO-40-31F has three transitions at 16188 (T C), 16190 (C T), and 16221 (C T). The only sample that appears to share changes with other samples is that of CO-40-32 with transitions at 16221 (C T) like that of sample CO-40-31F and at 16309 (T C). This sample also shows a transition at position 16325 (C T).

Even with the data described above, individual haplotypes were not obtained in this initial study. As detailed above, the samples appear to have unique changes within the HVI region, indicating viable sequences. Further sequencing of HVII and more time spent generating sequence data from HVI should show discernable differences such that haplotypes may be determined.

Further Study

To complete the recommendations above, as well as add additional samples to the study, monies have been requested from the Wenner Gren Foundation. One main critique against ancient DNA analysis stems from the consistently smaller sample sizes, which limit the resolution and robusticity of conclusions asserted (Kolman and Tuross 2000; Malhi *et al.* 2002; Eshleman *et al.* 2003). As with so many other ancient DNA studies, the sample size is limited by the preservation of the individuals at Cerro Mangote. While still not a sample size comparable with modern population studies, by increasing the sample to 20-25 individuals (including the five individuals from the pilot study), this study will have a similar, if not greater sample size to other published ancient DNA studies (Gilbert *et al.* 2005).

Cerro Mangote affords the opportunity to examine ancient DNA haplotypes frequencies within the larger context of both archaeological and bioarchaeolgical data. For example, by comparing individual genetic haplotypes with existing stable isotope data (Norr 1991), possible immigrants can be more easily identified. The comparison of modern variation to ancient demography and movement is an underutilized tool in the study of ancient cultures and the origins of contemporary peoples. Genetic studies have focused on extrapolating modern sequences to infer ancient population movements for an overall mtDNA characterization of the region. The documentation of prehistoric mtDNA haplotypes at Cerro Mangote allows for the testing of past population characteristics, as well as a direct link to migration and demography in Panama.

To address these questions, each sample will have both the HV1 and HV2 regions sequenced in the same manner described in the methods section, creating a mtDNA profile for each individual. These profiles, when completed and confirmed, will be placed with the Pubmed BLAST database to search for the closest matching sequences among the current published data (including, but not limited to, over 40 modern and ancient South American native groups). Both algorithmic and criterion based methods of tree creation will be utilized with the alignments described earlier to create a "best estimate" of an evolutionary history based upon the genomic data generated among grouped burials (Swofford *et al.* 1996: 408; Hall 2004; Swofford 2000; Bandelt 1995). Other analytical methods to be used are criteria based or discrete methods, such as Maximum Parsimony, Maximum Likelihood, and Bayesian Analysis. These construct multiple trees from which a best set of evolutionary trees may be chosen (Hall 2004). These trees are used to determine those individuals that share a particular characteristic (i.e. change in base pair etc.) inherited from a common ancestor, therefore determining those more closely related to each other among the burials (Li 1997). This estimation of likelihood was first proposed by Cavalli-Sforza and Edwards (1967) and later used by

Felsenstein (1993) to infer phylogenetic histories of nucleotide data sets.

The computer program Arlequin will be used to analyze data both among and between the burial populations through various statistical methods (Excoffier and Schneider 2005). AMOVA (Analyses of Molecular Variance) will be used to measure the variance of gene frequencies while taking into account the number of mutations between molecular haplotypes (Excoffier *et al.* 1992). A hierarchical analysis of covariance will be created and dissected into intra-individual difference, inter-individual differences, and inter-population differences. Various statistical equations will employ setting parameters to focus on intra-population and inter-population tests (Excoffier and Schneider 2005). Neutrality tests will also be used to examine whether or not this population is under selectively neutral conditions.

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