AN OSTEOLOGICAL ANALYSIS OF HUMAN REMAINS FROM CUSIRISNA CAVE, NICARAGUA

by

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This thesis was prepared under the direction of the candidate's thesis advisor, Dr. Clifford T. Brown, Department of Anthropology, and has been approved by the members of her supervisory committee. It was submitted to the faculty of the Dorothy F. Schmidt College of Arts and Letters and was accepted in partial fulfillment of the requirements for the degree of Master of Arts.

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ABSTRACT

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Cusirisna Cave was discovered in the 1870s by Dr. Earl Flint, an explorer for the Harvard Peabody Museum. The human remains and artifacts found in the cave were collected and sent to the museum, where they have remained since, unanalyzed. In December 2011, Dr. Clifford T. Brown and I analyzed the osteological material and artifacts because we thought they might be related to the Preclassic cave complexes of neighboring Honduras, an idea originally suggested by Dr. James Brady. I analyzed the human remains while Dr. Brown studied the artifacts. This thesis presents the results of the analyses and compares the findings to other mortuary complexes in Mesoamerica.

Despite the paucity of material culture, information regarding context, and the small sample size, I propose Cusirisna as a place of exceptional ritual importance. This project adds to our understanding of cave bioarchaeology, mortuary practices in Mesoamerica, and the prehistory of Nicaragua.

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INTRODUCTION

Bioarchaeology opens a window onto past cultures through osteological analysis. In Mesoamerica, caves were exceptionally salient foci of ritual and religious veneration. The same caves often contain human remains connected to their religious function and meaning. This bioarchaeological project examined the human remains recovered from Cusirisna Cave in the Department of Boaco in Nicaragua. The materials are curated at Harvard University's Peabody Museum of Archaeology and Ethnology. Very little was previously known about the collection because the cave site was not excavated systematically and has not been analyzed. I studied the remains to understand the function and meaning of caves in Nicaragua and to examine possible cultural parallels with Mesoamerica.

There is little information regarding the prehistory of central Nicaragua or Boaco, especially in reference to the use of caves. Caves are rare in Nicaragua due to its almost exclusively volcanic geology. In far northeastern Nicaragua, a limestone solution cavern named Cueva La Conga has been discovered in a small area of karst near the border with Honduras (Baker 2011). It is noteworthy for its paintings, the first found in Nicaragua. It is also possible that there are lava tubes around the volcano of Masaya, located south of Managua. Masaya is an active volcano that is growing within a large caldera. I have not been able to find any scholarly reports about the Masaya caves or any associated archaeological remains, but guidebooks say the caves are open to tourists (Wood and Berman 2005:68) and various web pages describe the tours and provide photographs of the caves. Apart from Cusirisna, I have not been able to find any record of human skeletal remains that have been excavated from caves in Nicaragua. The archaeology of the Department of Boaco is known only through one article published by Edgar Espinoza (1999), in which he described the results of test excavations at three sites. Therefore, the research I present below represents a significant contribution to both the archaeology of the region, which is little known, and to the study of ancient Nicaragua cave use, which is poorly documented.

In the 1870s, an expatriate American medical doctor named Earl Flint "excavated" a cave called Cusirisna south of Teustepe in the Department of Boaco (Flint 1882) (Figure 1). Dr. Flint collected a selection of skeletal remains and artifacts from the cave, plus parts of a mummy. We do not know if Flint collected the entirety of the remains from the cave, or whether it was a random selection of larger pieces that may have been easier for transportation. In addition to the skeletal material, a few artifacts were also recovered, including a wooden *duho* (stool), beads of shell and green stone, and gourd bowls. I analyzed these remains and compared them to those of nearby cultural traditions from surrounding regions to determine whether the Cusirisna people exhibit any evidence of affiliation with those cultures or whether these remains represent a purely indigenous population with an autochthonous funerary tradition, or some combination of those alternatives.

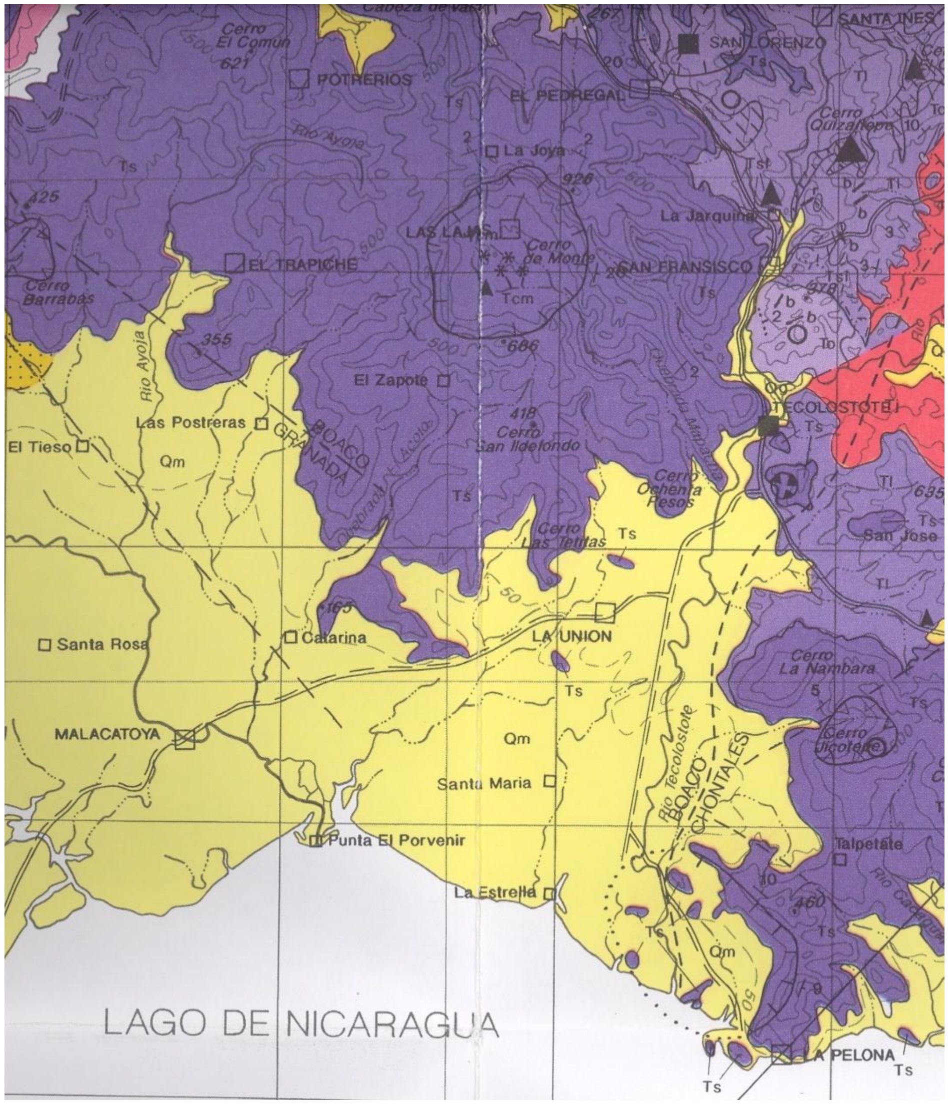

Figure 1.Cusirisna Cave, Department of Boaco (Geologic Map of Western Nicaraguan Highland, Central America. The Geological Society of America, Map and Chart Series MCH084 1999).

The idea of investigating mortuary caves in Nicaragua was originally suggested to Dr. Clifford Brown by Dr. James Brady, who emphasized the importance of determining whether the Formative period mortuary cave practices known from Honduras extended into Nicaragua. In order to address questions of cultural affiliation and cave function, we took a biocultural approach. We analyzed the skeletal material and artifacts, obtained a radiocarbon date, and compared our results to the Honduran materials and those from elsewhere. In order to investigate an extension of mortuary practices from Honduras to Cusirisna Cave in Nicaragua, we measured cultural similarity through cranial modification, dental modification, and artifact style. The Olmec and Tlatilco cultures also share characteristics with the Honduran tradition, so this thesis includes a systematic comparison of their practices.

"By focusing on the social construction of the human experience, the study of archaeological skeletal remains can make unique contributions to our understanding of social life in the past as well as those issues that plague the world today" (Knudson and Stojanowski 2008:399). Bioarchaeological studies such as this one enable reconstruction of social identities and past cultural experiences. This particular study uses skeletal remains to understand ritual practice in a Nicaraguan cave.

Cusirisna Cave itself is interesting for several reasons. Nicaragua is overwhelmingly volcanic and possesses few caves. Cusirisna Cave is the only apparent mortuary cave known in the country, the largest nation in Central America. Nicaragua has had less archaeological exploration and research than any other country in the region, and the Department of Boaco is poorly known even by the standards of Nicaraguan archaeology. An analysis of the unusual remains—uniquely well-preserved—from the only funerary cave in this little known area will inevitably be of interest and significance to archaeologists and prehistorians. This research will, more broadly, add to the current database concerning the functions of caves in Mesoamerica.

This study contributes to questions regarding the function of caves, and the relationships among individuals who used caves for a variety of purposes. One of the larger burdens in cave archaeology today is uncovering the association between skeletal remains and the artifacts they are affiliated with and then what this means in a larger context. “Despite 100 years of study, the most noteworthy features of the investigation of human osteological remains in caves are the paucity of explanations for the material, the lack of consensus over its meaning, and the near absence of research questions dealing with skeletal material” (Scott and Brady 2005:266). This has been, and still is, a serious issue within archaeology and I believe that it is our generation’s job to attack the problem head-on. Applying a biocultural approach, I have attempted to place the material in its proper cultural and chronological context and have attempted to answer research questions relating to the purpose of the cave and the nature of the population buried in it. In the following thesis, I will discuss the little known about Cusirisna Cave, and describe the methods utilized to interpret and understand the human remains, present the results in detail, and conclude with a discussion and interpretation of them.

This research also provides osteological data for future comparisons in Mesoamerica and lower Central America (e.g., biodistance studies). The metric data allow for comparisons of stature, the dental observations aid in understanding diet, and the pathological assessment contribute to knowledge of prehistoric health.

Beyond these issues, I have addressed a set of specific hypotheses about the relationship between the Cusirisna people and ancient people in Honduras who may exhibit a similar funerary complex. The original scope of the project was to examine three groups of funerary caves that are known from Honduras that all exhibit an unusual mortuary complex clearly related to the Formative cultures of distant central Mexico, and then compare those caves to Cusirisna. However, they do not have a temporal relationship and an extensive discussion has been excluded. The following section on historical background will provide summarized information on cave sites that pre-date Cusirisna Cave. In addition to the skeletal material, a few artifacts were recovered, including a wooden *duho* (stool), beads of shell and green stone, and gourd bowls. I analyzed these remains and compared them to those of nearby cultural traditions from surrounding regions to determine whether the Cusirisna people exhibit any evidence of affiliation with those cultures or whether these remains represent a purely indigenous population with an autochthonous funerary tradition, or some combination of those alternatives.

HISTORICAL BACKGROUND

In the 1870s, an expatriate American physician named Earl Flint "excavated" a cave called Cusirisna south of Teustepe in the Department of Boaco in Nicaragua. He reported that,

> [o]ne *natural* cave in the neighborhood of Teustepe is worthy of note, as it contains a numerous collection of human bones, assorted, and from a few sent to the [Peabody] museum, I think there are two kinds. Skulls placed by themselves were found in the outer cave, or mouth. The inner cave was so ingeniously concealed that I did not see it—filled up with a cartload of ribs—and so narrow as to preclude an idea it was a passage. Afterwards, the guide (thinking that I was in search of treasures) visited it and crawled in, found more skulls, and *each* one was enclosed in a calabash, and a mummified entire skeleton was found, on the bed of the cave. He brought me the skull, and one tibia and humerus of the mummy, and also a wooden seat, used at the time of the conquest for a seat and a pillow. On the last skulls pieces of brown hair were found. From these circumstances, I think the cave was re-occupied. What called my attention to the antiquity of the skulls found at the mouth was a piece of wrought fossil shell ornament. The outer cave was protected from moisture. The rock is quartz, and no moisture can penetrate the cave [Flint 1882: 297, emphasis in original].

Clifford Brown (personal communication, 2012) visited Cusirisna in August 2010 and shared the following description with me.

> Cusirisna is not a commonplace cave, and Flint's description of it is not very accurate. It is not one cave but several small adjacent horizontal shafts that extend into a vertical cliff face. It is not clear to me which Flint

meant by “inner” and “outer” caves. The caves are neither limestone solution caverns nor are they in quartz, as Flint asserted. The entire region is volcanic, lying only 2 to 3 km northwest of the giant Las Lajas caldera, a well-preserved erosional remnant of a Miocene age stratoshield volcano (Buriánek and Hradecký 2011; Ehrenborg 1996). The parent rock surrounding the small shafts is a conglomerate composed of angular, blocky fragments of volcanic rock weakly cemented together. It is probably part of one of the lahar deposits surrounding the Las Lajas edifice (Buriánek and Hradecký 2011:39), which rises to almost 1000 m a few kilometers to the southeast. Cusirisna Cave is located at latitude 12.343457° N, longitude 85.772534° W (WGS 1984 datum) at an elevation of approximately 62 m amsl. Today, the caves are empty, although we observed small splinters of bone in some of the dry crevices (Figures 2, 3, and 4) and we found two arrowheads on the ground surface in front of the caves. Although the interior of the caves was mostly dry when we visited, the microenvironment is extremely humid. A fine veil of water constantly cascades down the cliff face right in front of the cave mouths [Brown 2012].

Figure 2. Cusirisna Cave. The largest chamber is slightly right of the machete-wielding archaeologist. The smaller shafts are to the left and slightly higher in elevation.

Figure 3. The smaller shafts of Cusirisna Cave, where small fragments of bone, perhaps human, were seen.

Figure 4. Inside one of the smaller shafts at Cusirisna Cave. The surface appears quite dry, suggesting that organic preservation is a definite possibility.

The Early to Middle Formative, or Preclassic, period in Mesoamerica (ca. 1800-400 B.C.) is best known for the elaborate and complex Olmec culture, but the Olmec was only one of several interrelated and contemporaneous cultures. At this time in the central Mexican highlands the Tlatilco culture appeared. Although they were in contact with the Olmec, the Tlatilqueños had their own highly distinctive and unusual culture that has captivated archaeologists for almost a century. These two cultural groups created a foundation for later Mesoamerican cultures, and the following discussion will briefly introduce the cultures and their relation to Nicaraguan research.

The Olmec civilization emerged during the Early Formative (ca. 1800 – 900 B.C.) within the Gulf Coast lowlands of Veracruz and Tabasco, Mexico. This archaeological tradition was originally defined by its art style, often recognizable through its unique iconography, realistic sculptures, and three dimensional carved stonework (Coe and Koontz 2008). There are two Olmec caves that are famous for the paintings within them. Both are located in Guerrero: Oxtotitlan and Juxtlahuaca. A few of the notable Olmec habitation sites are San Lorenzo Tenochtitlán, Veracruz; La Venta, Tabasco; and Chalcatzingo, Morelos. While extensive archaeological work has been done to understand Olmec culture, we lack information about the physical biology of Olmec individuals. Little osteological analysis has been performed on Olmec human remains. Part of this is explained by the lack of preservation in the Olmec heartland because the soils and climate are not conducive to preservation. One reference to skeletal remains at La Venta was noted by Philip Drucker. “Just over the paving of the floor was a layer of heavy olive-brown clay or swamp muck 5.0 to 15.2 cm thick. Within this, heavily coated with red cinnabar (?) paint, were the remains of two bundle burials, each probably containing at least one individual … Little remained of the acid-leached bones save for a mass of splinters, stained a dark chocolate-brown color. They appeared to be remnants of long bones mainly, and gave the impression of small light bones, probably of juveniles, as did the deciduous teeth found in Bundle 2. With each bundle was associated a number of small objects, for the most part of jade" (Drucker 1952:23). However, this was the only mention of skeletal remains from this site.

During the succeeding Middle Formative period (ca. 900-300 B.C.), Olmec influence spread through much of Mesoamerica, including parts of the central Mexican highlands, Chiapas, the Pacific coast lowlands of Guatemala, and parts of Honduras (Joyce and Henderon 2001).

During the same period, Tlatilco, the eponymous type site of the culture, located within what is today Mexico City, was apparently a large village. Unfortunately, much of the site was destroyed by clay mining for brickmaking before it could be studied by archaeologists. The site was first recognized in the 1930s, and although badly damaged, it has been excavated repeatedly since then because it is so extremely interesting (Piña Chan 1958; Porter 1953; Tolstoy 1989; Tolstoy and Paradis 1970). One of the main reasons archaeologists found Tlatilco so exciting is that it seems to be culturally affiliated with contemporaneous South American cultures (Porter 1953) such as Chavín. For example, some Tlatilco ceramics are almost indistinguishable from Peruvian examples but are quite different from Mesoamerican ones. The neo-evolutionary propensities of the processual archaeology that began in the 1960s have long precluded archaeologists from any serious discussion of diffusion or migration, and so the possible connections to South America have not been explored since the 1950s. The last comparative study of Tlatilco to other cultures (Porter 1953) before the paradigm shift highlighted similarities in ceramics to other cultures in Mesoamerica and Central America, but the emphasis in archaeology abruptly changed to examine other modes of cultural evolution besides migration. Nevertheless, the site has continued to fascinate archaeologists because of its remarkable art and ceramics. Because of the unfortunate destruction of much of the site, it is best known for its burials and associated burial furniture, and the literature about Tlatilco therefore focuses on those (Faulhaber 1965; García Moll *et al*. 1991; Joyce 1999, 2001; Tolstoy 1989).

Extensive information has been gathered concerning the osteological materials, burial practices, and cultural modifications to the crania at this site. Interestingly, the Tlatilco people as a rule exhibited "extreme artificial [cranial] deformation of fronto-occipital type" as well as dental modification, and possibly trephination, the earliest then known in Central Mexico (Porter 1953:34-35, 82). Joyce (2001:18) noted that sixty-seven percent of female crania analyzed in Tlatilco burials demonstrated the tabular erect style of cranial modification. These body modifications suggest an approach for exploring cultural affiliation through the use of a biocultural approach to the remains. Another practice found at Tlatilco was the use of red ochre on the bones of the remains, similar to the ritual utilized by the Olmec in use of cinnabar.

The relationship between the Olmec and the Tlatilqueños is confusing and ambiguous. They are largely contemporaneous and share important similarities (such as long-necked ceramic bottles) but are also different in significant ways. For example, the pottery figurines from the two cultures differ in style. Also, the famous stirrup spout vessels from Tlatilco are rare to non-existent at Olmec sites. Perhaps these differences derive from Tlatilco's participation in the central Mexican cultural tradition while Olmec origins lie in the Early Formative cultures of Pacific coastal Guatemala and Chiapas. Nevertheless, Olmec artifacts are found at Tlatilco and both cultures share ceramic stylistic attributes, such as the long-necked bottle with globular, sometimes gadrooned, bodies.

Manifestations of both Tlatilco and Olmec culture have been discovered in Honduras, evidenced in ceramic style (Healy 1989; Joyce and Henderson 2001) and sculpture. In fact, Los Naranjos on Lake Yojoa in Honduras is virtually the only site outside of the Olmec heartland of Gulf coastal Veracruz and Tabasco that has Olmec sculptures in the round. The other Olmec, or Olmecoid, sites in southeast Mesoamerica—from Xoc to Chalchuapa—exhibit only relief sculpture. In the following chapter I will briefly discuss the Honduran mortuary caves and their ties to the Olmec and Tlatilco cultures.

MORTUARY CAVES

Funerary caves in Mesoamerica have been documented at length, but there remains controversy over their use and meaning. Caves may function as ossuaries, cemeteries, special repositories for elite members of a group, familial deposits, sacrificial victims, or victims of war and conflict (Scott and Brady 2005). To infer cave function, many factors are taken into account, which include the special context of the cave, associated artifacts, and postmortem treatment of the skeletal remains. The research design for this project included investigations into cultural similarities that might be shared among mortuary caves in Nicaragua, particularly during the Middle Formative. In the paragraphs below, I describe one particular cave-oriented mortuary tradition from Formative Honduras, which has been found at the Copán caves, the Río Talgua caves, and the Cuyamel caves. I discuss them in the order in which they were discovered, which happens to correspond to their geographic distribution, moving from west to east, that is, toward the Nicaraguan border.

Copán Caves

The Copán caves are located in the Department of Copán in western Honduras, in a steep river valley a few kilometers north of the famous Classic Maya Acropolis. The Copán caves were originally discovered and documented by George Byron Gordon between 1896 and 1897. He was directing excavations at the nearby Classic Maya site for the Harvard Peabody Museum, and he recognized that the ceramics in the cave were completely different from those of the Classic Maya. Gordon noted extensive evidence of cremation within the caves, and he collected some ceramics, but he did not conduct any skeletal analyses (1898). David Rue and his colleagues re-investigated the Copán caves in the 1980s and discovered a new cave that Gordon had not described. In addition, Dianne Ballinger (1986) wrote her MA thesis on the analysis of the osteological remains.

Rue and his colleagues excavated the Copán cave, or Gordon's Cave, No. 3, as well as in the newly discovered Guerra Cave (Rue *et al.* 1989). They performed a skeletal analysis of 3268 bone fragments from Cave 3. The remains were severely fragmented, which limited the information that could be derived from the analysis. The sample was estimated to only represent 10% of the actual chamber, and thus there could be as many as 600-700 individuals buried within the cave. They reported the minimum number of individuals (MNI) as 68, which included 22 adults and 46 juveniles. Of the 22 adults, the researchers sexed 11, of which 6 were identified as males and 5 as females. We do not know what other interesting phenomena those remains might exhibit, such as pathologies or intentional modifications. They concluded that the caves were used mainly for ritual purposes during the Middle Formative. Ballinger's (1986) analysis also emphasized the large quantity of juvenile remains. She also commented on the presence of animal remains found within the caverns: turkey, dog, and turtle. However, neither of these analyses produced data concerning cranial or dental modification, nor evidence of trauma.

The skeletal analysis demonstrates that the cave was a formal depository for people in good health. In fact, the health of the population seemed superior to that of the Classic period inhabitants of the nearby city of Copán. The skeletal sample included a mix of males and females, and was dominated by sub-adult individuals (46 out of 68) in the form of both cremations and burials. "These patterns suggest a relatively egalitarian society compared to the individual-oriented burial treatments of the complex Middle and Late Classic period societies at Copán" (Rue *et al.* 1989:395-396). The assemblage demonstrates that the remains in the cave were deposited diachronically rather than synchronically, and Rue *et al*. suggest that "several different episodes of cremation and burial occurred" (1989:399). The diachronic nature of the deposits was explained by the variable burning of the bones. Cremation styles changed through time, and one can observe this variability depending on the heat of the fire. This site represents a burial cave with grave offerings that included ceramics similar to those recovered from the Cuyamel caves (Rue *et al.* 1989) and also similar in style to that of the Olmec and Tlatilco cultures.

Cuyamel Caves

The Cuyamel Caves are located north of the Cuyamel village in the Department of Colon in northeastern Honduras, a short distance south of the Colonial port of Trujillo. The group consists of Matilde's Cave, Cuyamel Cave, and Portillo Cave. The caves contain Middle Formative ceramics and human burials. Although documented by Paul Healy, much of the material was removed by collectors or looters and therefore not much has been described or analyzed. The ceramics are similar in form to Olmec and Tlatilco vessels, such as long-necked bottles, flat-bottomed flaring-wall bowls, hour-glass gourd-shaped jars, effigy vessels, and monochrome spouted bottles (Healy 1989). These sites were investigated and described by Paul Healy between 1973 and 1976, with a focus on ceramic data. Healy has published extensively with reference to these caves (Healy 1974, 1989, 2007; Scott and Brady 2005).

While Healy mentioned the presence of skeletal remains and noted that the caves were used as burial chambers, human remains were only observed *in situ*, not actually recovered. No osteological analysis has of yet been conducted or published. "All we can say at this time is that the caves appear to have been sacred areas for ritual disposal of the dead (both primary and secondary burials) and that during Period Iva, northeast Honduras was in contact with southern Mesoamerican groups, including the Olmec" (Healy 1989:131-132). The Cuyamel caves are often compared with the Copán Caves and Río Talgua caves due to striking similarities in ceramic style, contemporaneity, and the use of the caves as a place of ritual (Dixon *et. al* 1998; Healy 1989; Herrmann 2002; Joyce and Henderson 2001; Rue *et. al* 1989). For example, Healy observed, "Additionally, the Copán caverns (Gordon 1898), located near the famed Maya center of the same name, appear related to Cuyamel not only ceramically but functionally. As in the Cuyamel caves, there was an extensive accumulation of human bone, totally disarticulated on the surface, suggesting that Preclassic peoples had utilized the caves for secondary burials (perhaps deposited after partial cremation)" (Healy 1974:440).

Río Talgua

The Río Talgua Caves are located near the town of Catacamas in eastern Honduras, in the middle of the Department of Olancho, which borders Nicaragua. The Río Talgua Caves are significant because they also exemplify a mortuary cave complex associated with ceramics similar in styles to those of the Olmec and/or Tlatilco cultures during the Early to Middle Formative period (Herrmann 2002; Witschey and Brown 2012). This site was extensively documented between 1994 and 1996 by James Brady (Brady *et. al* 1995a, 1995b; Brady 1996). "In Talgua Cave, first excavated in 1994, unslipped, monochrome slipped, and bichrome painted ceramics, two marble vessels, and several pieces of jade were found in association with an ossuary containing the remains of 100-200 secondary burials" (Dixon *et. al* 1998:333). Subsequently, other nearby caves were discovered that also served as ossuaries. Radiocarbon dates as well as ceramic correlations place the caves squarely in the Middle Formative period, contemporary with Tlatilco, the height of Olmec expansion, and the other Honduran caves. Through a series of six radiocarbon dates, it has been suggested that later populations also utilized the cave (Herrmann 2002).

The bones from the Río Talgua Caves were defleshed, painted with red ochre, and stacked in small bundles within the chamber. Red ocher was used similarly at Tlatilco (Joyce 1999:23; Porter 1953), as was the cinnabar at one Olmec burial (Drucker 1952). The human remains from the Río Talgua caves were analyzed *in situ* because they could not be removed from the caves (Herrmann 2002). Multiple individuals representative of all ages had been transported into the caverns. The skeletal remains were bundled and some placed in containers, after which they were covered in red ocher or hematite. "These bundles were carried into the caves to fairly inaccessible areas and stacked into small piles in niches, within flowstone pools, and on shelves" (Hermann 2002:18). As they were often poorly preserved or covered with calcite deposits, the results from the analyses were limited. Although analyses were restricted, the importance of another burial cave system associated with Formative ceramics in far eastern Honduras cannot be overestimated (Dixon *et. al* 1998; Herrmann 2002).

Although three is perhaps the minimum number of cases required to make a pattern, nevertheless, we can now say that these Early to Middle Formative mortuary caves associated with Tlatilco and Olmec ceramics extend across the entire country of Honduras, nearly reaching the Nicaraguan border. It only made sense to explore whether the pattern continued across the modern political border into what is today Nicaragua.

NICARAGUAN ARCHAEOLOGY AND CUSIRISNA CAVE

As these three Honduran cave sites exhibited Olmec and Tlatilco traits, I thought that this cultural tradition might also be present in Nicaragua. As previously explained, Cusirisna cave in the Department of Boaco, near the town of Teustepe, housed skeletal remains and artifacts. This cave was documented by Dr. Earl Flint in the 1870s, but has not enjoyed additional research or analysis since that time. While this cave is not terribly far from the previously mentioned Honduran caves, no attempt has been made at investigating any similarities or parallels that might imply affiliation (Figure 5).

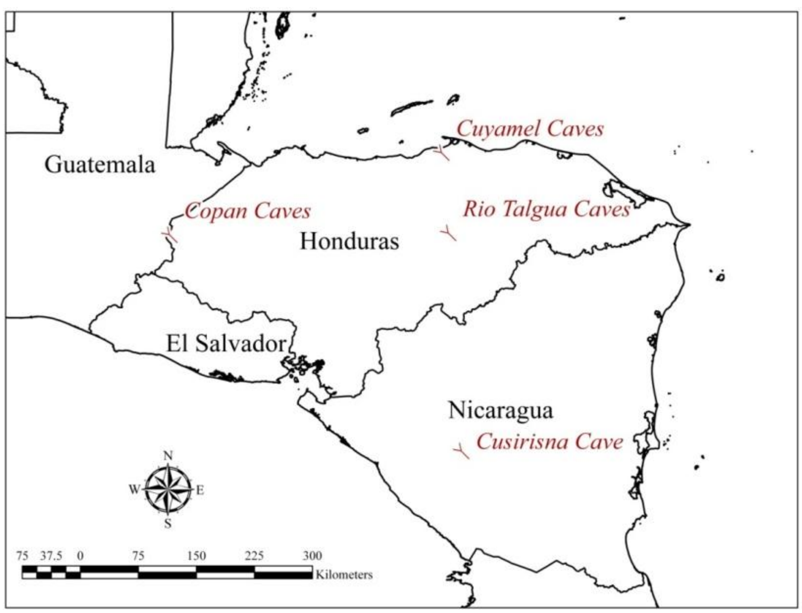

Figure 5. Map of Nicaragua and Honduras, showing proximity of caves.

The early archaeological exploration of Nicaragua was largely conducted by John Lloyd Stephens (1848, 1871), Ephraim George Squier (1856), John Francis Bransford (1881), and Carl Bovallius (1886). They all worked along the southern portion of the Pacific coastal plain and on the islands in Lake Nicaragua. More recently, Edgar Espinoza Pérez (1999) conducted several test excavations in the Department of Boaco. Healy analyzed a large collection of archaeological materials excavated by Gordon Willey in the early 1960s from the Rivas region (1980). Even more recently, new excavations have been conducted in the Rivas region, at Santa Isabel (McCafferty and Steinbrenner 2005) and at the El Riyo site on Lake Nicaragua (Wilke 2009). The Santa Isabel site has been dated from AD 890 to 1280. Similarly, the El Riyo site dates from AD 800 to 1200. It contained artifacts and poorly preserved skeletal remains, suggestive of a large burial site (Wilke 2009). Other areas of Nicaragua have also been explored, but much less intensively. This thesis reports the data obtained from Cusirisna Cave within the Department of Boaco by Dr. Flint during his Nicaraguan explorations in the 1870s.

Cusirisna Cave is located about 9 km southeast of the town of Teustepe and about 25 km north of the north shore of the great Lake of Nicaragua, also known by its aboriginal name of Lake Cocibolca. A dirt road runs south from the paved Managua-Juigalpa highway near Teustepe to a village near the cave. The highway is only passable when the rivers are low; after it rains, one cannot cross the many fords because the rivers rise quickly. Cusirisna Cave is close to the Las Lajas caldera, which is categorized as a large strato-shield volcanic center with a central caldera, and is probably less than 4.3

million years old (Ehrenborg 1996). It is a large structure that rises nearly 1000 meters and Cusirisna Cave lies within the tumbled margin of the lava flows of the caldera.

Dr. Flint was a medical doctor with an apparently anemic practice in Nicaragua in the 1870s. He supplemented his income by selling antiquities to the Harvard Peabody and to a lesser extent to the Smithsonian, although he does seem to have had a genuine interest in prehistory. His dubious career in Nicaragua has been reviewed by David Whisnant (1995). Much of his correspondence with the then-director of the Peabody, Frederick Ward Putnam, is preserved in the Peabody archives. The correspondences and fieldnotes (Flint 1879, 1880, 1882) have been examined and partly transcribed, and have proven to be useful in understanding his "excavation" of Cusirisna Cave. After Dr. Flint's exploration, no further research was conducted on the Cusirisna Cave or with the sample material that is now curated at the Harvard Peabody Museum. Almost nothing else was previously known about this unusual collection, which includes a variety of organic remains. Through my research, I have attempted to contribute information pertaining to several themes: cultural affiliation, the culture history of Boaco, and general questions in cave archaeology.

In order to determine whether the mortuary complex of Cusirisna Cave is related to that of the Honduran caves described above, it is necessary to demonstrate that the skeletal remains and artifacts exhibit similarities to those from Honduras, Tlatilco, or the Olmec culture. It is equally possible that the culture represented at Cusirisna is related to the local culture of the Gran Nicoya subregion of Nicaragua and Costa Rica or to that of the Department of Chontales, which lies east of Boaco. It would, of course, make sense if the Cusirisna material were related to the ancient cultures of the Department of Boaco, but since almost nothing is known about those cultures, it is impossible to make a direct comparison. It is also possible that the Cusirisna culture is affiliated with cultures in Costa Rica, but I have not been able to identify any cave mortuary complexes known in Costa Rica. The soils and climate of Costa Rica are not favorable for preservation of organic objects such as skeletal remains (Nagy 2008). Of course, to be affiliated, cultures must be at least approximately contemporaneous, and therefore radiocarbon dating of material from Cusirisna Cave was incorporated into the research.

Understanding the culture history of Boaco is a high priority in this study. Given that almost nothing is known of the archaeology or prehistory of this region, any contribution, including this thesis, is important and relevant. By investigating the osteological material and associated artifacts from the sample at Cusirisna Cave, we are given a glimpse at cultural practices and mortuary rituals in the Department of Boaco during this time.

In addition, analysis of Cusirisna Cave will make a general contribution to cave archaeology, the study of how humans use and interact with the subterranean part of their environment. As pointed out by Ann Scott and James Brady (2005), caves have different functional purposes (i.e. ossuaries, as places for war or sacrificial victims, and funerary rituals) and each deserves some potential explanation, both in reference to cultural and osteological material. Scott and Brady (2005) propose several scenarios in which cave burial patterns can be discerned. In terms of individual cave burials, one can investigate the skeletal remains and associated cultural material to determine whether the cave can be classified as an elite or non-elite cave burial site, held a purpose as a primary cave ossuary, a special deposit site, or a site that provides insight into human sacrifice. All of these questions are significant with regard to Cusirisna Cave. For example, the presence of a wooden *duho*—used as a throne by chiefs—in Cusirisna Cave may be interpreted as evidence of use by high status or elite individuals. One important aim of this research is to examine the social meaning behind the use of the cave and investigate connections with other mortuary cave sites. There is a need for non-Mayan research in southern Mesoamerica, and in order to grasp concepts of the role and importance of caves, archaeologists need to broaden their research interests geographically in order to compare groups which inhabited Mesoamerica (Healy 2007). "As more information becomes available, we expect to see greater refinement in our understanding of regional and temporal differences in the use of caves for the deposition of human skeletal material" (Scott and Brady 1995:278).

METHODS

The analytical methods were chosen to provide data useful for answering the research questions posed above. In general, the osteological analysis was conducted in accordance with established standards (e.g., Buikstra and Ubelaker 1994; White *et al.* 2011), with the addition of various classes of observations selected to help determine cultural affiliation and cave function. The osteological remains were examined and measured in December 2011 at The Peabody Museum of Archaeology and Ethnology at Harvard University, Cambridge, Mass., and the data were analyzed in early 2012. The spatial organization and taphonomy of remains in the cave are key to interpreting its function. Unfortunately, context was lost at Cusirisna due to lack of systematic excavation and recovery. However, transcription of Dr. Flint's field notes and review of his correspondence with former Harvard Peabody Museum director Frederick Ward Putnam has aided a little in understanding the contexts. In this chapter, I will describe the techniques used for collecting the osteological observations and the methods used for estimating the minimum number of individuals, sex, age, and stature, as well as those for assessing nonmetric variation, taphonomy, pathology, trauma, and cultural modification.

The osteological material was measured in millimeters and centimeters with digital sliding calipers, spreading calipers, flexible measuring tape, mandibulometer, osteometric board, and an Immersion MicroScribe MX.

Labeling and Coding

The 82 bones collected by Dr. Flint were commingled in a total of six boxes. In Appendix A, I provide a complete inventory of the bones in which I list the Peabody Museum's Object Number, which appears to be equivalent to an accession or catalog number; the number originally assigned by Dr. Flint, if any; and a specimen number I assigned. Museum policy dictated that a maximum of four boxes could be taken off the shelf at one time. Only one box could be opened at a time, and only one bone taken out for analysis. These policies and the commingled nature of the skeletal material have made articulation impossible. Most of the remains bore numbers in India ink that corresponded to the Museum object number, but some also carried additional numbers. The system had the potential to create ambiguity because sometimes multiple bones, possibly from different individuals, were identified with the same object number, and therefore there was no way to specify individual bones in my notes without creating my own identification system. For example, Object number 78-42-20/15170 contained four mandibles, only of which one had a distinguishing number assigned by Dr. Flint, "141."

Therefore, in my notes I labeled each bone with an element number (1-82) specific to each specimen. I also created my own identification code for each bone, and I have used that set of specimen IDs through this thesis (Table 1). The identification code is composed of the first two letters of the name of the skeletal element followed by a unique integer (Tables 2 and 3).

The data were recorded in a series of Excel spreadsheets. I also performed calculations in Excel. I documented other observations in text files. In addition to direct observation of the material, I took extensive photographs of all bone aspects for later review and comparison. Each cranial sample was photographed in norma lateralis, norma frontalis, norma occipitalis, norma verticalis, and norma basalis. Long bone samples were photographed in lateral, medial, proximal, and distal aspects. Additional postcranial remains were photographed in posterior and anterior planes.

Table 1. Labeling system.

Element	Philmon's number
Cranium	Cr
Mandible	Ma
Humerus	Hu
Radius	Ra
Femur	Fe
Tibia	Ti
Fibula	Fi
Innominate	In
Vertebra - lumbar	Vel
Vertebra - thoracic	Vet
Rib - left	Ril
Rib - right	Rir
Calcaneous	Ca
Talus	Ta
Phalange	Ph

Table 2. Elements.

Number	Peabody object number	Flint's number	Philmon's number	Element	Side
1	79-72-20 / 19906	n/a	Cr1	Cranium	
2	79-72-20 / 19907	n/a	Cr2	Cranium	
3	79-72-20 / 19905	n/a	Cr3	Cranium	
4	79-72-20 / 19904	n/a	Cr4	Cranium	
5	79-72-20 / 19903	554	Cr5	Cranium	
6	78-42-20 / 15169	126	Cr6	Cranium	
7	78-42-20 / 15168	n/a	Cr7	Cranium	
8	78-42-20 / 15167	124	Cr8	Cranium	
9	79-72-20 / 19908	554	Ma1	Mandible	
10	79-72-20 / 19908	557	Ma2	Mandible	
11	79-72-20 / 19908	555	Ma3	Mandible	
12	79-72-20 / 19908	5	Ma4	Mandible	
13	79-72-20 / 19908	n/a	Ma5	Mandible	
14	78-42-20 / 15170	141	Ma6	Mandible	
15	78-42-20 / 15170	n/a	Ma7	Mandible	
16	78-42-20 / 15170	n/a	Ma8	Mandible	
17	78-42-20/ 15170	n/a	Ma9	Mandible	
18	79-72-20 / 19911	n/a	Fe1	Femur	Left
19	78-42-20 / 15175	139	Fe2	Femur	Right
20	78-42-20 / 15175	136	Fe3	Femur	Left
21	78-42-20 / 15175	138	Fe4	Femur	Left
22	78-42-20 / 15175	137	Fe5	Femur	Left
23	79-72-20 / 19913	567	Ti1	Tibia	Right
24	79-72-20 / 19913	565	Ti2	Tibia	Right
25	79-72-20 / 19913	566	Ti3	Tibia	Right
26	79-72-20 / 19914	591	Ti4	Tibia	Left
27	78-42-20 / 15176	132	Ti5	Tibia	Left
28	78-42-20 / 15176	131	Ti6	Tibia	Right
29	78-42-20 / 15176	130	Ti7	Tibia	Left
30	78-42-20 / 15176	135	Ti8	Tibia	Left
31	78-42-20 / 15176	133	Ti9	Tibia	Right
32	78-42-20 / 15176	134	Ti10	Tibia	Right
33	79-72-20 / 19914	n/a	Fi1	Fibula	Left
34	78-72-20 / 15173	n/a	Fi2	Fibula	Left
35	78-42-20 / 15173	n/a	Ul1	Ulna	Right
36	78-42-20 / 15173	n/a	Ul2	Ulna	Right
37	78-42-20 / 15173	n/a	Ra1	Radius	Left
38	78-42-20 / 15173	n/a	Ra2	Radius	Left

Table 3. Elements (continued).

Number	Peabody object number	Flint's number	Philmon's number	Element	Side
39	79-72-20 / 19912	568	Hu1	Humerus	Right
40	79-72-20 / 19912	569	Hu2	Humerus	Left
41	79-72-20 / 19912	570	Hu3	Humerus	Right
42	78-42-20 / 15174	128	Hu4	Humerus	Right
43	78-42-20 / 15174	127	Hu5	Humerus	Left
44	78-42-20 / 15174	129	Hu6	Humerus	Left
45	78-42-20 / 15171	n/a	Sa1	Sacrum	
46	78-42-20 / 15171	n/a	Sa2	Sacrum	
47	78-42-20 / 15171	n/a	Sa3	Sacrum	
48	78-42-20 / 15171	n/a	In1	Innominate	Right
49	78-42-20 / 15171	n/a	In2	Innominate	Left
50	78-42-20 / 15171	n/a	In3	Innominate	Right
51	78-42-20 / 15171	n/a	In4	Innominate	Left
52	78-42-20 / 15172	n/a	Sc1	Scapula	Right
53	78-42-20 / 15172	n/a	Ril1	Rib	Left
54	78-42-20 / 15172	n/a	Ril2	Rib	Left
55	78-42-20 / 15172	n/a	Ril3	Rib	Left
56	78-42-20 / 15172	n/a	Ril4	Rib	Left
57	78-42-20 / 15172	n/a	Ril5	Rib	Left
58	78-42-20 / 15172	n/a	Ril6	Rib	Left
59	78-42-20 / 15172	n/a	Ril7	Rib	Left
60	78-42-20 / 15172	n/a	Ril8	Rib	Left
61	78-42-20 / 15172	n/a	Ril9	Rib	Left
62	78-42-20 / 15172	n/a	Ril10	Rib	Left
63	78-72-20 / 15173	n/a	Ril11	Rib	Left
64	78-42-20 / 15172	n/a	Rir1	Rib	Right
65	78-42-20 / 15172	n/a	Rir2	Rib	Right
66	78-42-20 / 15172	n/a	Rir3	Rib	Right
67	78-42-20 / 15172	n/a	Rir4	Rib	Right
68	78-42-20 / 15172	n/a	Rir5	Rib	Right
69	78-42-20 / 15172	n/a	Rir6	Rib	Right
70	78-42-20 / 15172	n/a	Vel1	Lumbar vertebra	
71	78-42-20 / 15172	n/a	Vel2	Lumbar vertebra	
72	78-42-20 / 15172	n/a	Vel3	Lumbar vertebra	
73	78-42-20 / 15172	n/a	Vel4	Lumbar vertebra	
74	78-42-20 / 15172	n/a	Vel5	Lumbar vertebra	
75	78-42-20 / 15172	n/a	Vel6	Lumbar vertebra	
76	78-42-20 / 15172	n/a	Vel7	Lumbar vertebra	
77	78-42-20 / 15172	n/a	Vet1	Thoracic vertebra	
78	78-42-20 / 15172	n/a	Vet2	Thoracic vertebra	
79	78-42-20 / 15172	n/a	Vet3	Thoracic vertebra	
80	78-42-20 / 15172	n/a	Ph1	Medial phalange	
81	78-42-20 / 15172	n/a	Ca1	Calcaneous	Right
82	78-42-20 / 15172	n/a	Ta1	Talus	Right

Metrics

Standard metric measurements are important for comparative analyses, and for inclusion in formulas such as stature estimations and cranial indices. These measurements can also be used in programs such as Osteoware and ForDisc for statistical analyses and biodistance investigations. Measurements on crania, dentition, and postcranial remains were taken as outlined by Buikstra and Ubelaker (1994) and White *et al*. (2011). As these are standard measurements collected by all bioarchaeologists, this information will serve as a useful database because this is the only baseline data available from the Cusirisna region, and therefore will aid in future comparative research. The osteological material was measured in millimeters and centimeters with digital sliding calipers, spreading calipers, a flexible tape, mandibulometer, an osteometric board, and an Immersion MicroScribe.

Most crania were complete, but some measurements could not be taken due to fragmentation or breakage. One cranium was particularly fragile, Cr6, which has some variant of strapping tape securing the different cranial elements together. Fragmentary crania were measured using extant landmarks, and those features not observable were recorded as "n/a". For the nineteen single and paired osteometric points outlined by Buikstra and Ubelaker (1994), measurements were obtained with spreading calipers (e.g., euryon to euryon). Distances lacking cranial obstruction and of shorter lengths were taken with plastic digital calipers (e.g., bregma to lambda). For paired points that required left and right measurements, I recorded both sides and also computed the average (e.g., orbital length and height). A total of 27 measurements were taken and 9 indices calculated, using criteria developed by Buikstra and Ubelaker (1994) and White *et al*. (2011). Digital calipers and a mandibulometer were used to document measurements of osteometric landmarks as well as gonial angles.

Maxillary and mandibular dental measurements were taken in millimeters with plastic digital calipers. Dental metrics included crown height, mesiodistal crown diameter, buccolingual crown diameter, and wear score according to Buikstra and Ubelaker (1994). Other, nonmetric, observations, aspects and features on the teeth were recorded and input into the respective cranial or mandibular spreadsheet, but have also been imported into a dental database for further comparison.

In addition to caliper measurements of the crania, I used digital measuring equipment to collect osteometric points. The Florida Atlantic University Department of Anthropology's Immersion MicroScribe was useful in some instances in reaffirming cranial measurements with the plastic digital calipers. The equipment was set up and connected to my Asus laptop which had the software installed. Set-up also included stabilizing the stand and cradling device, wrapping the cradling device in plastic wrap and using museum quality putty to prevent damage to the crania. The tip was calibrated, and then several tests were conducted to ensure the technology was working properly in relation to the measurements obtained with the plastic digital calipers. Prior to this research, an Excel spreadsheet was created with all corresponding osteometric points and was tested with crania available at Florida Atlantic University. This spreadsheet was also used for the Cusirisna Cave material and was prepared to perform immediate calculations. The spreadsheet was formulated to upload the osteometric point in space with the Immersion MicroScribe and compute millimeter measurement distances within the spreadsheet for comparison to measurements taken with the plastic digital calipers. These points were helpful in reaffirming caliper measurements, but there were also disadvantages to including this method.

Use of the Immersion MicroScribe technology was beneficial in that the osteometric point was recorded in three dimensional space. However, the equipment is less useful than traditional calipers for determining certain nonspecific points for measurement. For example, maximum cranial breadth is determined as the distance between two user-determined points, euryon to euryon. These points are not marked by the intersection of sutures or other precise features, and they vary by cranium. With spreading calipers, it is simple to move the calipers and find the widest breadth. However, with the Immersion MicroScribe, the single tip takes one point on each side and then calculates the distance between those two points, but the analyst must locate and identify those points. In practice, this would mean using some instrument like a caliper to find the maximum breadth and then, without marking them, relocating those points with the MicroScribe tip. Moreover, the plastic digital calipers allow for ease in re-measuring, and are overall more accurate and efficient.

Postcranial measurements were taken in millimeters and centimeters with an osteometric board, plastic digital calipers, and flexible tape. These measurements varied depending on skeletal element, but all include lengths, breadths, and diameters at different aspects of the bone, some of which are useful in determining stature and sex of the individual. All of these measurements were entered into Excel spreadsheets specific to the element (e.g., femora metrics and tibiae metrics). The osteometric board was used to obtain maximum length and some breadths. Plastic digital calipers were used in breadth measurements, maximum and minimum diameter, as well as those for smaller features. The flexible tape was used for the circumference of the long bone shafts.

Nonmetric variation

Nonmetric variation (e.g. discontinuous morphological traits, epigenetics, or discrete traits), are valuable in osteological analysis because those traits can be relevant to ancestry attribution (White *et al.* 2011; Hauser and DeStefano 1989). These heritable features can then be useful in investigating relatedness and biological distance. A total of 21 cranial nonmetric traits of primary importance (Buikstra and Ubelaker 1994) were investigated and described: 18 cranial and 3 mandibular. Some of these were taken on both left and right sides, or one singular observation.

The scoring system for each trait is fairly unique the following will define each code for the cranial observations. *Metopic sutures (single)*: 0 = absent, 1 = partial, 2 = complete, and 9 = unobservable. *Supraorbital notches (left and right)*: 0 = absent, 1 = present, less than ½ occluded by spicules, 2 = present, more than ½ occluded by spicules, 3 = present, degree of occlusion unknown, 4 = multiple notches, 9 = unobservable. *Supraorbital foramen (left and right*: 0 = absent, 1 = present, 2 = multiple foramen, 9 = unobservable. *Infraorbital suture (left and right)*: 0 = absent, 1 = partial, 2 = complete, 9 = unobservable. *Multiple infraorbital foramina (left and right)*: 0 = absent, 1 = internal division only, 2 = two distinct foramina, 3 = more than two distinct foramina, 9 = unobservable. *Zygomatico-facial foramina (left and right)*: 0 = absent, 1 = 1 large, 2 = 1 large plus smaller foramen, 3 = 2 large, 4 = 2 large plus smaller foramen, 5 = 1 small, 6 = multiple small, 9 = unobservable. *Parietal foramen (let and right)*: 0 = absent, 1 = present, on parietal, 2 = present, sutural, 9 = unobservable. *Sutural bones*: 0 = absent, 1 = present, 9 = unobservable – score for epiteric bone (left and right), coronal ossicle (left and right), bregmatic bone (single), sagittal ossicle (single), apical bone (single), lambdoid ossicle (left and right), asterionic bone (left and right), ossicle in occipito-mastoid suture (left and right), and parietal notch bone (left and right). *Inca bone (single)*: 0 = absent, 1 = complete, single bone, 2 = bipartite, 3 = tripartite, 4 = partial, 9 = unobservable. *Condylar canal (left and right)*: 0 = not patent, 1 = patent, 9 = unobservable. *Divided hypoglossal canal (left and right)*: 0 = absent, 1 = partial, internal surface, 2 = partial, within canal, 3 = complete, internal surface, 4 = complete, within canal, 9 = unobservable. *Flexure of superior sagittal sulcus (single)*: 1 = right, 2 = left, 3 = bifurcate, 9 = unobservable. *Foramen ovale incomplete (left and right)*: 0 = absent, 1 = partial formation, 2 = no definition of foramen, 9 = unobservable. *Foramen spinosum incomplete (left and right)*: 0 = absent, 1 = partial formation, 2 = no definition of foramen, 9 = unobservable. *Pterygo-spinous bridge (left and right)*: 0 = absent, 1 = trace (spicule only), 2 = partial bridge, 3 = complete bridge, 9 = unobservable. *Pterygo-alar bridge (left and right)*: 0 = absent, 1 = trace (spicule only), 2 = partial bridge, 3 = complete bridge, 9 = unobservable. *Tympanic dehiscence (left and right):* 0 = absent, 1 = foramen only, 2 = full defect present, 9 = unobservable. *Auditory exostosis (left and right)*: 0 = absent, 1 = less than 1/3 of canal occluded, 2 = 1/3 to 2/3 canal occluded, more than 2/3 of canal occluded, 9 = unobservable. *Mastoid foramen (left and right)*: location –

0 = absent, 1 = temporal, 2 = sutural, 3 = occipital, 4 = both sutural and temporal, 5 = both occipital and temporal, 9 = unobservable, number – 0 = absent, 1 = 1, 2 = 2, 3 = more than 2, 9 = unobservable.

Mandibular nonmetric traits were scored similarly. *Mental foramen (left and right):* 0 = absent, 1 =1, 2 = 2, 3 = more than 3, 9 = unobservable. *Mandibular torus (left and right):* 0 = absent, 1 = trace, 2 = moderate, 3 = marked, 9 = unobservable. *Mylohyoid bridge (left and right):* location – 0 = absent, 1 = near mandibular foramen, 2 = center of groove, 3 = both bridges described in 1 and 2 with hiatus, 4 = both bridges described in 1 and 2, no hiatus, 9 = unobservable, degree – 0 = absent, 1 = partial, 2 = complete, 9 = unobservable. Nonmetric dental traits included the absence/presence/degree of calculus, periodontal disease, caries, abscesses, and other dental anomalies such as supernumerary teeth, enamel pearls, and hypoplasias.

Additional postcranial nonmetric traits were also observed and documented. For example, nonmetric traits of the femora included examination of fovea capitus shape, presence/absence of a third trochanter, Allen’s fossa and Poirier’s facet, and bowing; for the tibiae, squatting facets, platycnemia, and bowing; and for the humeri, septal aperature and supracondylar process were noted.

Minimum number of individuals

The minimum number of individuals (MNI) was established after all data had been collected from the osteological material. This was done through counting the most frequent element. “The most common derivation of the MNI used for the analysis of human remains is simply calculated by sorting the bones by side and element and then taking the greatest number as the estimate" (Adams and Konigsberg 2008:244). This is a particularly appropriate method in this situation given the commingled nature and lack of contextual information of the remains.

Sex determination

Because most of the bones in this sample were relatively complete, I was able to determine sex in a large proportion of the long bones and the crania. The bones were categorized into five groups: definite male, probably male, indeterminate, probably female, and definite female. Assessments of sex were made using a combination of metric analyses and nonmetric assessments based on techniques outlined by Buikstra and Ubelaker (1994), White *et al*. (2011), and Bass (1995). Cranial sex determinations were based on standard criteria for nonmetric traits, such as nuchal crest, mastoid process, and supraorbital margin. Mandible sex determinations were made through observation of mental eminence, gonial angle, gonial eversion, and general robusticity. In addition, male mandibles are distinguishable based on a squarer chin, larger areas for muscle attachments, ramal flexion, and deeper rami.

Postcranially, sex estimations of the innominate bones were based on the ventral arc, the subpubic concavity, the ischiopubic ramus, and the greater sciatic notch. Long bones were sexed according to sexually dimorphic criteria such as degree of robusticity, based on assumptions that males are generally larger and taller than most females in most populations. Identifying the sex of the long bones is difficult when there is no information regarding gendered activities (i.e., more robust deltoids of the humeri or the linea aspera in the femora of male or female based on occupation) nor access to a comparable reference population, as in this case. Even though these musculoskeletal stress markers may be idiosyncratic, I used them to estimate the sex in order to then calculate stature.

Determination of sex in this context is important because a predominance of male or female remains could indicate a gendered preference for social roles, status, burial practices or sacrifice. Therefore, the sex ratio could contribute to understanding the mortuary function of Cusirisna Cave.

Age estimation

We wish to know whether the individuals from this mortuary cave were of varied ages or of a particular age class and, more generally, what the demographic distribution of ages was. Age is particularly important in comparing the Cusirisna Cave to the Honduran caves as there is a preponderance of juvenile and subadult remains represented in the Copán mortuary cave.

Adult age estimations were based on criteria outlined by White *et al.* (2011) and Buikstra and Ubelaker (1994), using a combination of features found on the cranial and postcranial remains. For age estimations, bones were generalized into seven classes: fetal (before birth), infant (birth to 3 years of age), child (3 to 12 years), adolescent (12 to 20 years of age), young adult (20 to 35 years), middle adult (35 to 50 years), and old adult (50+ years) (White *et al.* 2011). The estimates for age of the crania in the Cusirisna Cave sample were more specific than estimates for the postcranial remains. Ages of the crania were calculated based on observations of external suture closures at a total of 17 1-cm segmented sutural sites. These sites were scored as 0 for open, 1 for minimal closure, 2 for significant closure, or 3 for completely obliterated. The following sites were used: midlambdoid, lambda, obelion, anterior sagittal, bregma, midcoronal, pterion, sphenofrontal, inferior sphenofrontal, and superior sphenofrontal. There are debates over problems of aging based on cranial suture closures (Ginter 2005), but this was the only plausible means of assessing age classes of the adult crania. Age can also be estimated based on modal toothwear patterns (Lovejoy 1985); however, this was impossible with the Cusirisna Cave analysis because, in order to correctly estimate age through wear patterns, the dentition needs to be compared to a similar reference population with a similar diet. In this case, there is no known population that can plausibly be used for reference.

For the long bones of the sample, age generalizations were possible on four innominates, one tibia, one fibula, and two humeri. Age estimation of the four extant innominates was conducted through the Suchey-Brooks public symphysis scoring system. Epiphyseal closures of long bones are predictable and occur in short ranges of time throughout growth and development. Many long bones from the sample do not demonstrate epiphyseal lines, and are thus classified as young to old adult. However, more precise age estimates were possible for the tibia, fibula, and two humeri with epiphyseal lines.

Due to the commingled state of the material and museum policy, long bones could not be associated with the more correctly aged crania. There is additional difficulty in estimating the ages of individuals in this particular context as there is no comparative skeletal collection, and, therefore, we do not know if these standard estimation methods are appropriate for the small sample at Cusirisna Cave. These individuals could be an anomaly, and thus, for example, may not correlate with fusion rates of other populations.

Stature estimation

Stature provides valuable information about health status, among other themes. It is often used as a means to understand diet and ecology, and, along with dentition, to understand how a population dealt with pathology and health over time, and as a variable to compare different populations through space and time. Different formulas depend on geographic location, and are usually based on populations from specific locations or ancestry. Allometric regression formulas have been developed through analysis of macerated skeletal remains for which living stature is known.

Stature can be estimated by evaluating one or a combination of bones, and is appropriate in the assessment of commingled remains. I estimated stature for the sample through metric analyses of the tibiae and femora. In order to estimate stature, I utilized an osteometric board to obtain maximum length, employing the criteria that maximum length of the femur is the measurement from the most superior point of the head to the most inferior point on the distal condyles, and that maximum length of the tibia is the measurement from the most superior point of the intercondylar eminence to the distal point of the medial malleolus.

After these measurements were recorded, the estimated sex of each long bone was taken into account to then calculate the appropriate stature using allometric regression formulas. Stature was computed for each individual femur and tibia based on Genovés's calculations for male/female femora and tibiae (1967), and then modified for error in the original formulae (Ángel and Cisneros 2004). Subtracting 2.5 cm from the calculated stature for dry bone compensates for the extension of the cadaver on the autopsy table. Genovés's stature formulas are to be preferred because they are designed for Mesoamerican populations, specifically Mexican samples. The relevant formulas, based on assumed ancestry of Mesoamerica, split into male or female, were calculated as follows:

Males

Stature = 2.26 x Femur + 66.379 ± 3.417
Stature = 2.96 x Tibia + 93.752 ± 2.812

Females

Stature = 2.59 x Femur + 49.742 ± 3.816
Stature = 2.72 x Tibia + 63.781 ± 3.513

Stature is also a significant measurement because demographic stature has declined in association with declining health (Márquez and del Ángel 1997; Nickens 1976; Genovés 1967). Márquez and del Ángel (1997) conducted studies whose results indicate that among the Maya there was a reduction in stature between the Preclassic and the Classic period by comparing Preclassic, Classic, Postclassic, and modern series. They have speculated about possible explanations for this decline, including environmental adaptations, population expansion and fluctuation, change in activities, dietary variation, and work burdens (1997:60). When the Maya population expanded from the Preclassic to the Classic, demographic growth affected access to resources. Understanding how the Cusirisna Cave sample from Nicaragua correlates with this study is important in appreciating effects on stature outside of the Maya area, whether or not the individuals from Cusirisna followed that pattern in stature decline. However, we may not understand the stature history of the sample, or whether this sample adequately represents the population, or even if the individuals came from different populations in which varying statures might be expected. Nonetheless, stature estimations provide general demographic information that is pertinent to Cusirisna Cave and will provide a dataset for future comparisons.

Taphonomy

Taphonomy, the study of peri- and postmortem processes that provoke skeletal changes, is important to investigate in order to understand what has occurred to the skeletal remains. Taphonomic processes can be seen in postmortem trauma, fractures, rodent activity, bone coloring and staining, cultural and curation modifications, and additional environmental factors. Many processes can occur during mortuary rituals and especially secondary burial. In addition, the transportation process from Nicaragua to the Harvard Peabody Museum and the curation of the materials may have caused alterations. Thus, it was imperative to pay special attention to the timed nature of fractures, identified as: antemortem, perimortem, or postmortem. As outlined by White *et al.* (2011), attention was focused specifically on bone modification by physical agents (chemistry, abrasion, and fire), by non-human agents (plants and animals), and by humans (fractures, cut marks, chop marks, and scrap marks). Each bone modification was labeled and examined closely for sign of healing, discoloration, and degree of breaks or cuts.

Pathology

Paleopathology is important in bioarchaeological investigations for several reasons, which include inference of past health status, care of the sick, cause of death, and migration. Pathological studies can also potentially suggest several inferences, which might include that the cave was a deposit for old and sick individuals, or those with infection who were kept distant from the rest of the population, or those of high status who enjoyed very good health. "Bioarchaeology research on health and disease has much to offer identity studies, including the health effects of occupational (Mays 2006), status (Buzon 2006) and/or gender identities (Sullivan 2004), and the role of impairment in determining other identities. Future bioarchaeological work can use contextualized skeletal and dental data to reconstruct how an individual's social identity changed, or was sustained, after undergoing debilitating or disfiguring diseases" (Knudson and Stojanowski 2008:409).

The parameters of this research allowed only for macroscopic analysis of pathological features. This leaves opportunities for future microscopic and genetic research to be conducted on the Cusirisna Cave sample. Pathological investigations of the sample included description of the nature and distribution of the anomalous manifestations and diagnoses of the cause of any pathological manifestations. Close evaluation of every aspect of bone was conducted, and any anomaly was documented with respect to location.

Pathology was assessed, described, and analyzed on each individual bone and then compared to literature, documented cases, and known pathological specimens (Ortner 2003; Mann 2005; Buikstra and Ubelaker 1994; White *et al.* 2011; Waldron 2009; Steinbock 1976; Brothwell and Sandison 1967). Manifestations of pathology can be labeled as lytic (eaten away bone) or blastic (newly deposited bone), and this created a basic foundation for labeling pathologies of Cusirisna Cave. After this, pathologies can be organized into one of nine categories: abnormalities of shape, abnormalities of size, bone loss, abnormal bone formation, fractures and dislocations, porotic hyperostosis, cribra orbitalia, vertebral pathology, arthritis, and miscellaneous conditions (White *et al.* 2011:432). Specific attention in the Cusirisna Cave sample was paid to degenerative joint disease, platycnemia, platymeria, lesions, and infectious disease.

For any anomalies that could not be explained, I then consulted with other biological anthropologists. In addition to direct observation of the material, extensive photographs were taken of all bone aspects for later review and comparison. Each cranial sample was photographed in norma lateralis, norma frontalis, norma occipitalis, norma verticalis, and norma basalis. Long bone samples were photographed in lateral, medial, proximal, and distal aspects. Additional postcranial remains were photographed subsequently in posterior and anterior planes. These photographs were used for later reference as research material during analysis and for discussion with Dr. Broadfield concerning pathologies that were unfamiliar.

Trauma

Trauma is significant because signs of trauma have the potential to provide information relevant to cause of death and may aid in understanding cave function as a place for deposit of victims of violence. Trauma was observed macroscopically and noted as absent or present, then more completely described and analyzed. These observations were then compared to known cases and those outlined by Ortner (2003) and White *et al.* (2011). These included identification of blunt force trauma, dislocations, decapitation, scalping, radiating fractures, cut marks, trepanation, and discerning whether the indicators were representative of the trauma being antemortem, perimortem, or as postmortem taphonomic breaks.

Cultural modification

To assess cranial modification, close attention was paid to particular markers that remain on the crania depending on the method utilized for modification. We will use the term modification in this context, as the term "deformation" has derogatory connotations, and recently terms like modification and shaping have become common (Saul *et al.* 2005). Multiple sources of information were useful in understanding the different types of cranial modification, markers, and methods for the cultural practice (Ortner 2003; Buikstra and Ubelaker 1994; Dembo and Imbelloni 1938; O'Brien 2010). In order to macroscopically assess each case of modification in this sample, individual attention was focused on each sample. After an overall type was identified, e.g. tabular or annular, I further described the variability and specific details in each case. Intentional modifications can include physical changes to the crania and dentition. Cranial modifications were assessed as tabular, annular, circumferential, erect or oblique, then further described with posterior/anterior/lateral features. While these types can be further documented in specific ways, there is no universal classification system, so I recorded a detailed description of all aspects of change.

Detecting modification in the Cusirisna Cave sample included examination of the cranial vault for evidence of expansion, flattening, and for evidence of modification methodology. Notes were taken to define where pressure was centered, the plane of pressure in relationship to transverse plane, details of depressions and elevations, presence and number of pad impressions, location of pad impressions, pad shape, and presence or absence of binding impressions. Metric changes also occur to the crania as a result of modification, and particular attention was paid to the frontal chord, cranial height, length, and breadth in order to compare these measurements to known modified crania. After these visual and metric assessments were complete, typologies of modifications were then considered and types assigned to the crania.

Much of the literature is inconsistent with regard to categories and classifications, and while some researchers recognize only two, others identify upward of six types of cranial modification. For example, when classifying South American Andean cranial modification, some researchers differentiate or recognize two: annular and tabular (O'Brien 2011); some Peruvian studies use anteroposterior and circumferential (Anton *et al.* 1992, 1989); and still others refer to vertical, oblique, erect, and annular. Even though there is conflict within these different typologies, most continue to refer to the original typology established by Dembo and Imbelloni (1938). "Imbelloni divided Hrdlicka's 1912 original 'flathead' category into fronto-occipital oblique deformation, or Tabula Obliqiqua (tabular oblique), and fronto-occipital erect deformation, or Tabula Erguida (tabular erect). He adopted Hrdlicka's circumferential deformation as a third category" (Hoshower *et al*. 1995:149).

Dental modification can be observed macroscopically and microscopically, usually with reference to the Romero (1965) typology for Mesoamerica. This generally occurs on incisors and canines, whether through means of incrustation or filing.

Cultural modification has important implications for migration, cultural affiliation, and status. Although cranial modification may not be used to establish whether the individual was elite or non-elite (Saul *et al.* 2005), the practice is useful to investigate in order to locate patterns among different cultures. Modification occurs during the beginning of life and can act as a highly visible signal of identity and culture. "In populations where individuals exhibit this signal of identity, bioarchaeologists have elucidated the role of social diversity (Blom 2005; Blom *et al.* 1998), the use of cranial modification to maintain social boundaries in multiethnic polities (Blom 2005; Torres-Rouff 2002), and the loss of an ethnic marker during periods of culture change (Logan *et al.* 2003)" (Knudson and Stojanowski 2008:411).

Cranial and dental modifications are important aspects of this research project as they may link similar cultural practices among the people who utilized Cusirisna Cave and the Honduran funerary caves, or other cultures, and therefore might provide a significant association with Tlatilco and Olmec practices or with Postclassic Maya and Aztec cultures. Cranial and dental modifications are an important aspect of Tlatilco culture, which may be the earliest examples in Mesoamerica. This cultural tradition has thus been present since Preclassic times, and varies chronologically and geographically, as well as through different levels of social stratification. For instance, erect or vertical modification occurs more frequently at elevated levels of social structure, while oblique modification does not seem to be associated with the higher levels (Tiesler 1999). Erect modification is also more common in the Early to Middle Formative period, while the more oblique style does not become frequent until the Classic period.

Cultural comparison

The focus of this bioarchaeological research is not only to identify the cultural group represented by the sample recovered from Cusirisna Cave, but also to compare the findings to surrounding cultural groups. As previously mentioned, this will be done by examining cranial and dental modification and artifacts. In order to investigate similar practices, the literature on Mesoamerican ritual was reviewed. This included research specific to the Honduran mortuary complex represented by the Río Talgua, Copán, and Cuyamel caves, and more generally to funerary cave practice and burial in Mesoamerica. To narrow results, I had to limit the research to examples from comparable time periods, sites which included similar cranial modification types, and sites which have evidence of trauma.

Artifact analysis

The artifacts in this collection were described and analyzed by Dr. Clifford Brown. An important aspect of this thesis project, the artifacts, revealed cultural information pertinent to Cusirisna Cave and might help infer cultural affiliation. We have also investigated similar artifact types in adjacent regions and from contemporaneous periods. Analysis of the artifacts can aid in determination of the age of the site as well as cultural understanding of the individuals who utilized Cusirisna. Methods include comparing the recovered grave goods or offerings from Cusirisna Cave to the items recovered from the Honduran caves as well as the styles of Olmec and Tlatilco cultures, among other cultures.

Original documentation

Little is known about Cusirisna Cave, and for this research project in particular, context is very important in understanding the significance of the funerary cave's function. The only original documentation that exists for the extraction of materials from the cave was created by Dr. Flint. His field notes and correspondence with the Harvard Peabody Museum after his explorations of Nicaragua remain at the museum (1879, 1880). In order to thoroughly understand his exploration of the cave, it was necessary to review and study these documents. The Museum was kind enough to allow us access to the manuscripts, provided scanned copies, and granted permission for me to reproduce our transcription of Flint's original report on Cusirisna. We transcribed applicable parts of these documents in order to obtain details on context, collection, observations, and other information.

Radiocarbon dating

Dating this site was necessary not only for cultural-historical purposes, but also to determine with which other cultures Cusirisna was contemporaneous. Dating might show contemporaneity with the three caves in Honduras during the Early to Middle Formative, or it might not. Regardless of anticipated results, it is important to gain an understanding of the use period of Cusirisna Cave to appreciate the history of what is now the Department of Boaco. In applying radiocarbon dating to a sample from Cusirisna Cave, I have been able to place funerary use within a temporal context and attempt to understand the chronology. While dating one sample from the cave will not provide an overall chronology, it will provide a starting point which can be evaluated and refined in the future.

I hoped to be able to date the site both through chronometric methods and through ceramic correlation, but alas no ceramics were directly associated with the cave site, although non-ceramic artifacts did provide limited chronological information. Radiocarbon therefore became the only truly significant dating method used. I chose to utilize the accelerator mass spectrometry (AMS) technique to minimize the sample size needed, since the quantity of organic material from the cave was finite, and I had to depend on the generosity of the museum to obtain a sample. I expected that both sound curatorial practice as well as responsible and ethical archaeology dictate using the smallest possible sample in such as case.

We consulted with the curators and conservators at the Peabody Museum about taking a carbon sample, and then submitted a formal request for destructive sampling, which was graciously approved. After reviewing the organic remains from the Cusirisna collection, a decision was made in consultation with Dr. Steven LeBlanc to cut a small piece from one of the guacales. This was ideal because the jícaras are annual fruit, and thus we avoided the potential old wood problem that would have been presented by the *duho*, as well as assorted disadvantages of using either shells or human bone, which were the other choices. Thus, I acquired a 31 milligram sample of a gourd bowl, which I hand-carried to Beta Analytic in Miami, Fla on February 3rd, 2012.

I requested Beta Analytic perform standard pretreatments, which included acid/alkali/acid pretreatment, which is typically applied to charcoal, wood, some peats, some sediments, and textiles "acid/alkali/acid – solubles." It is best here to quote the definition of this pretreatment provided by Beta Analytic:

> The sample was first gently crushed/dispersed in deionized water. It was then given hot HCI acid washes to eliminate carbonates and alkali washes (NaOH) to remove secondary organic acids. The alkali washes were followed by a final acid rinse to neutralize the solution prior to drying. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of the sample. Each chemical solution was neutralized prior to application of the next. During these serial rinses, mechanical contaminants such as associated sediments and rootless were eliminated. This type of pretreatment is considered a 'full pretreatment' [Beta Analytic Inc. 2012a:1].

After delivery of the material, I was contacted by Mr. Ron Hatfield of Beta Analytic about the sample. We discussed possible contaminants that might have an effect on our results, such as fumigants which might have been used in the Peabody Museum while the gourd bowl was in collections. We do not know whether the artifact came into contact with any chemicals, but to ensure an accurate date on the sample, we requested, in addition to the standard pretreatment, the application of solvent extraction. Beta Analytic explains solvent exaction, and how our sample was treated, as follows: "The sample was subjected to a series of solvent baths typically consisting of benzene, toluene, hexane, pentane, and/or acetone. This is usually performed prior to the acid/alkali/acid pretreatments. This is applied to: textiles, prevalent or suspected cases of pitch/tar contamination, conserved materials" (Beta Analytic Inc. 2012a:2). In the case of the gourd bowl artifact, it is considered "conserved material" because it was curated at the Harvard Peabody Museum, and many museums fumigated extensively with various chemicals in the nineteenth and early twentieth centuries.

Beta Analytic provided a final report that describes their analytic procedures, details of the pretreatments, and a calendar calibration. The results will be discussed in the following chapter.

RESULTS

In this chapter, I will present the results of the investigation, in the order presented in the methods chapter: metrics and nonmetric variation, MNI, sex, age, stature, pathology, trauma, cultural modification, artifacts, and dating. For each topic I provide a description of the data, a synopsis of the results, and summary tables. The complete results, observations, and measurements are detailed in the appendices. The sample from Cusirisna Cave is small, but this chapter demonstrates that there is a large degree of variability. Moreover, I will show that the population from Cusirisna has highly specific, non-random, and very interesting characteristics.

Metrics

Metric data collection was conducted on all remains. These data were necessary for the calculation of stature, as well as for comparisons with other groups. The data may be entered into ForDisc or OsteoWare for further analysis and comparison to larger databases.

Table 4 displays a few, selected cranial metrics taken from the Cusirisna Cave sample. The measurements for length and breadth are of particular importance in the later discussion on cranial modification. Analysis of the metrics may show patterns among males that are not shared with the female(s), or may demonstrate a degree of variability that may indicate they are from different populations.

Table 4. Metrics of crania.

Peabody object number	Flint's number	Philmon's number	Sex	Modification	Maximum cranial length	Maximum cranial breadth	Bizygomatic diameter	Basion-bregma height
79-72-20 / 19906	n/a	Cr1	Female	Absent	151	131	123	126
79-72-20 / 19907	n/a	Cr2	Male	Present	160	157	n/a	na/
79-72-20 / 19905	n/a	Cr3	Male	Absent	156	153	140	129
79-72-20 / 19904	n/a	Cr4	Male	Absent	167	148	144	137
79-72-20 / 19903	554	Cr5	Male	Present	152	148	152	142
78-42-20 / 15169	126	Cr6	Male	Present	152	161	n/a	129
78-42-20 / 15168	n/a	Cr7	Male	Present	148	158	137	128
78-42-20 / 15167	124	Cr8	Male	Present	150	155	149	128

Other cranial and postcranial metrics were collected. The complete enumeration of all metric data collected is presented in the appendices. The data for each element are also presented in tables in the text for easier reference. Much of the data collected is not discussed here because this thesis focuses on specific questions and problems. The additional data were collected for various reasons, including for standard practice and future comparisons as baseline data.

Nonmetric variation

Noteworthy nonmetric variation was found on the crania as well the long bones. The following tables will highlight a few traits observed on the crania and mandibles, while I set forth a detailed list of all observations in the appendices.

Buikstra and Ubelaker's nonmetric traits of primary importance (1994) were used as a template for recording the nonmetric traits observed in the Cusirisna Cave sample. Eighteen traits were recorded for the crania, and 3 traits for the mandibles. These were recorded and scored in an Excel spreadsheet according to the scoring system by Buikstra and Ubelaker's recording form. I have consistently scored the nonmetric traits with Buikstra and Ubelaker (1994: Primary Nonmetric Traits Recording Form), refer back to the methods chapter for definitions of codes.

Tables 5 and 6 highlight a sample of the nonmetric traits observed and scored on the crania. Significant traits observed on the crania were the ossicles associated with the lambdoial sutures of the culturally modified crania (see Figures 7 and 8 for examples of a few of the lambdoial ossicles). A correlation between modification of the cranial vault and an increase in lamboidal complexity has been found in past research, but there is no clear understanding of exactly how the two variables are related. The complexities of the lambdoidal suture and the numerous wormian bones have been correlated and associated with cranial modification in past research (O'Loughlin 2004; El Najjar and Dawson 1977; Anton *et al*. 1992; van Arsdale 2012). To ascertain a relationship between wormian bones and cranial modification, the sample from Cusirisna Cave can be used in future research.

Table 5. Sixteen nonmetric variants of Cusirisna Cave crania.

Peabody object number	Flint's number	Philmon's number	Sex	Modification	Epiteric bone left	Epiteric bone right	Coronal ossicle left	Coronal ossicle right	Bregmatic bone	Sagittal ossicle	Apical bone	Lambdoid ossicle left
79-72-20 / 19906	n/a	Cr1	Female	Absent	1	1	0	0	0	0	0	0
79-72-20 / 19907	n/a	Cr2	Male	Present	9	0	0	1	0	0	0	0
79-72-20 / 19905	n/a	Cr3	Male	Absent	0	9	0	9	0	9	1	0
79-72-20 / 19904	n/a	Cr4	Male	Absent	0	0	0	0	0	0	1	0
79-72-20 / 19903	554	Cr5	Male	Present	0	0	0	0	0	0	0	0
78-42-20 / 15169	126	Cr6	Male	Present	9	1	9	9	0	0	0	1
78-42-20 / 15168	n/a	Cr7	Male	Present	0	2	0	0	0	0	1	1
78-42-20 / 15167	124	Cr8	Male	Present	1	1	0	0	0	0	0	0

Table 6. Sixteen nonmetric variants of Cusirisna Cave crania (continued).

Peabody object number	Flint's number	Philmon's number	Sex	Modification	Lambdoid ossicle left	Lambdoid ossicle right	Asterionic bone left	Asterionic bone right	Ossicle in occipito-mastoic suture left	Ossicle in occipito-mastoid suture right	Parietal notch bone left	Parietal notch bone right	Inca bone
79-72-20 / 19906	n/a	Cr1	Female	Absent	0	0	1	0	0	0	0	0	0
79-72-20 / 19907	n/a	Cr2	Male	Present	0	0	1	0	1	9	0	0	0
79-72-20 / 19905	n/a	Cr3	Male	Absent	0	0	0	1	0	1	0	0	0
79-72-20 / 19904	n/a	Cr4	Male	Absent	0	1	0	1	0	0	0	0	0
79-72-20 / 19903	554	Cr5	Male	Present	0	0	0	0	0	0	0	0	0
78-42-20 / 15169	126	Cr6	Male	Present	1	1	9	9	0	0	0	0	0
78-42-20 / 15168	n/a	Cr7	Male	Present	1	1	0	0	0	0	0	0	0
78-42-20 / 15167	124	Cr8	Male	Present	0	0	0	0	0	1	0	0	0

Figure 6. Posterior aspect of Cr7 at lambda, showing ossicles and a highly complex lambdoidal suture.

Figure 7. Posterior aspect of Cr6 showing the complexity of the lambdoidal suture.

Three primary nonmetric traits were observed on the mandibles: mental foramen, mandibular torus, and mylohyoid bridge, as outlined by Buikstra and Ubelaker (1994). It would be interesting to correlate these traits with those of the crania. However, as previously explained, this is not possible because I could not re-associate the crania and mandibles.

Other postcranial nonmetric traits that were included in the analysis were outlined by White *et. al* (2011), and are listed in the appendices. A few of those observations included the septal aperture of the humeri (Figure 9), cross sectional shape of the fibula shaft, third trochanter and fovea capitus shape of the femora, and platycnemia and squatting facets of the tibiae.

Figure 8. Septal aperture of Hu1.

Minimum number of individuals

The MNI identified was nine, ascertained through count of the most frequent element, the mandible. Re-articulation of the remains would probably provide for a more accurate estimate of the number of individuals, and this could be possible in future research if museum policy allows. Because of the museum's policies, mandibles could not be associated with crania, or long bones with one another, so all analyses are based on isolated, single bone observations. There were a few exceptional instances in which associations between long bones were made through precise observations, cross-referenced with Dr. Flint's notes. For example, in the case of the "mummy", the tibia and fibula could be re-associated because of their unusual condition, including the retention of soft tissue.

Sex determination

The results from sex determination demonstrate that the Cusirisna Cave sample is largely represented by males. I identified six crania as definite male, one as probably male, and one as definite female (Table 7). Sex of crania was determined on the basis of several criteria, as shown in the Table 7 as well as other male and female characteristics mentioned in the methods chapter. I determined five mandibles were definite males, one was probably male, one indeterminate, and two probably females (Table 8, specific to mandibles). Sex was determined for mandibles through scoring of the mental eminence as well as other criteria outlined in the methods chapter. Sex was difficult to determine for mandibles because they were not associated with sexed crania (i.e. probable male or female and indeterminate). Rather than incorrectly determine sex, it is preferable to classify these elements as indeterminate or intermediate.

Table 7. Sex determination of crania.

Peabody object number	Flint's number	Philmon's number	Nuchal crest	Mastoid process	Supraorbital margin	Glabella	Sex
79-72-20 / 19906	n/a	Cr1	1	1	2	1	Female
79-72-20 / 19907	n/a	Cr2	5	4	5	5	Male
79-72-20 / 19905	n/a	Cr3	1	3	4	3	Probably male
79-72-20 / 19904	n/a	Cr4	5	5	5	5	Male
79-72-20 / 19903	554	Cr5	5	5	5	5	Male
78-42-20 / 15169	126	Cr6	3	3	5	3	Male
78-42-20 / 15168	n/a	Cr7	5	5	5	5	Male
78-42-20 / 15167	124	Cr8	5	5	5	5	Male

Table 8. Sex determination of mandibles.

Peabody object number	Flint's number	Philmon's number	Mental eminence	Sex
79-72-20 / 19908	554	Ma1	3	Male
79-72-20 / 19908	557	Ma2	5	Male
79-72-20 / 19908	555	Ma3	2	Intermediate
79-72-20 / 19908	5	Ma4	3	Male
79-72-20 / 19908	n/a	Ma5	3	Male
78-42-20 / 15170	141	Ma6	4	Male
78-42-20 / 15170	n/a	Ma7	4	Male
78-42-20 / 15170	n/a	Ma8	2	Probably female
78-42-20 / 15170	n/a	Ma9	3	Probably male

Twenty-two of the postcranial bones were determined to be definite male, one definite female, and two probably females (Table 9). The long bones within the sample were mostly robust and muscle attachment sites were large. Sex estimations were thus based on this robusticity. For example, an enormous deltoid tuberosity may indicate maleness. Saul *et al.* (2005:312) have stated that this area for muscle attachment may indicate that the individuals were engaged in vigorous arm activity. As we do not know the female or male occupations, it may have been normal for a female to have enlarged deltoid tuberosities. As previously acknowledged, we do not have information on the degree of sexual dimorphism of this population; therefore this is only a determination of sex within the sample as compared to general assumptions of sex differences between males and females. The long slender bones identified as probably female could be those of a smaller male depending on the population characteristics. However, taking into account the multiple lines of evidence provided by the dimensions of the bones, the sizes of the attachments, the variation observed in the sample, as well as the variation I have seen in other samples, I believe the sex assignments described above are reasonable and would be replicated by most analysts.

In summary, 42 bones were assessed as male or female, while the remaining 40 postcranial bones are indeterminate and of unknown sex, in part because they do not carry distinctly sexually dimorphic features that I can identify within this small sample: ulnae, radii, fibulae, sacra, ribs, vertebrae, talus, calcaneus, and one medial phalange. The sample from Cusirisna Cave therefore exhibits a high proportion of males to females. The significance of these results will be discussed later with reference to cave function.

Table 9. Sex determination of postcranial remains.

Peabody object number	Flint's number	Philmon's number	Element	Side	Sex
79-72-20 / 19911	n/a	Fe1	Femur	Left	Male
78-42-20 / 15175	139	Fe2	Femur	Right	Male
78-42-20 / 15175	136	Fe3	Femur	Left	Female
78-42-20 / 15175	138	Fe4	Femur	Left	Male
78-42-20 / 15175	137	Fe5	Femur	Left	Male
79-72-20 / 19912	568	Hu1	Humerus	Right	Male
79-72-20 / 19912	569	Hu2	Humerus	Left	Male
79-72-20 / 19912	570	Hu3	Humerus	Right	Male
78-42-20 / 15174	128	Hu4	Humerus	Right	Male
78-42-20 / 15174	127	Hu5	Humerus	Left	Male
78-42-20 / 15174	129	Hu6	Humerus	Left	Male
78-42-20 / 15171	n/a	In1	Innominate	Right	Male
78-42-20 / 15171	n/a	In2	Innominate	Left	Male
78-42-20 / 15171	n/a	In3	Innominate	Right	Male
78-42-20 / 15171	n/a	In4	Innominate	Left	Male
79-72-20 / 19913	567	Ti1	Tibia	Right	Male
79-72-20 / 19913	565	Ti2	Tibia	Right	Male
79-72-20 / 19913	566	Ti3	Tibia	Right	Male
79-72-20 / 19914	591	Ti4	Tibia	Left	Male
78-42-20 / 15176	132	Ti5	Tibia	Left	Male
78-42-20 / 15176	131	Ti6	Tibia	Right	Probably female
78-42-20 / 15176	130	Ti7	Tibia	Left	Probably female
78-42-20 / 15176	135	Ti8	Tibia	Left	Male
78-42-20 / 15176	133	Ti9	Tibia	Right	Male
78-42-20 / 15176	134	Ti10	Tibia	Right	Male

Age estimation

The ages of the individuals represented in this sample range from young adult to old adult. Possibly two young males were identified through analysis of epiphyseal lines on one tibia, one fibula, and two humeri. All other individuals were aged based on cranial data, which indicate a range from young adults to old adults. The ages of the crania ranged from 26 to 64+ years, while the previously mentioned postcranial remains indicated young male, 20 to 23 years old. A large portion of the material was aged using broad age intervals and therefore the age classes are more general than specific.

The age estimate for each cranium is shown in Table 10. While age estimates are more precise through use of all 17 1-cm sutural sites, I only utilized sites 1 – 7 (vault sutures) and sites 6 – 10 (lateral-anterior sites) as these ectocranial sites were those available for this study. There was no way to assess the endocranial sites as the crania were all intact. Table 8 demonstrates the age results from both assessments, and a combination of the two estimates from the vault and lateral-anterior scores. We cannot precisely estimate age for the individuals at Cusirisna Cave because we do not know the whether the rates of suture closure are similar to those used for analysis today. Thus, they will be generalized within age broad age classes.

Table 10. Age estimation of crania through ectocranial scoring.

Peabody object number	Flint's number	Philmon's number	Vault sutural age	Lateral-anteror age	Combined age range	Age class
79-72-20 / 19906	n/a	Cr1	39.4±9.1	56.2±8.5	30.3 - 64.7	Young to middle adult
79-72-20 / 19907	n/a	Cr2	>51.5	>56.2	56.2+	Old adult
79-72-20 / 19905	n/a	Cr3	>51.5	>56.2	56.2+	Old adult
79-72-20 / 19904	n/a	Cr4	45.2±12.6	51.9±12.5	32.6 - 64.4	Young to old adult
79-72-20 / 19903	554	Cr5	39.4±9.1	51.9±12.5	30.3 - 64.4	Young to old adult
78-42-20 / 15169	126	Cr6	34.7±7.8	<32	26.9 - 32	Young adult
78-42-20 / 15168	n/a	Cr7	34.7±7.8;	43.4±10.7	26.9 - 54.1	Young to old adult
78-42-20 15167	124	Cr8	48.8±10.5	56.2±8.5	38.3 - 64.7	Middle to old adult

For example, one cranium, the female Cr1, was estimated to be 30.3 – 64.7, and is most likely in the middle adult range due to degree of suture closures, especially the lateral-anterior sutures. However, the lack of pathology and wear in the dentition conflict with the estimate from sutural closure, and may indicate an individual closer to the young to middle adult range. There may be issues with age estimations based on ectocranial suture closures and, especially, the efficacy of this approach for crania with cranial modification (O'Brien and Sensor 2008); however, this was the only possible method. The Cusirisna Cave specimens would provide insight into current studies on the application of the efficacy of age estimation through ectocranial suture closures as compared to endocranial sites, but this does not fit into the scope of our current study. O'Brien and Sensor (2008) discuss the processes that can affect cranial suture synostosis, and how these can be altered by intentional modification. "Apparently the application of undue stress of a deforming apparatus on an infant's head tends to retard normal processes of ectocranial suture closure along the lambdoid and sagittal sutures in the older individual while promoting sutural synostosis along the lateral aspects of the ectocranium in the younger individual" (O'Brien and Sensor 2008:31). We were not able to employ other techniques (i.e. endocranial observations) for age estimation, but with the guidance of ectocranial suture closures, we can generally say whether the individual was a young, middle, or old adult.

Another example of this type of discrepancy with aging comes from the mummy. We do not know which cranium belongs to the mummy that Flint recovered because he did not note which individual it was or label the cranium with a number and corresponding note. It seems most likely that Cr3 corresponded with the mummified tibia and fibula because of soft tissue remains and immaculate dentition that one would expect with a young adult. However, with cranial suture closure scores, this particular cranium was estimated to be over 53 years of year. Complete reliance on cranial sutures may provide incorrect results, and we need to take in multiple features to understand the larger demographic significance of the presence of adults and an absence of subadults and juveniles. Thus it is better at this time to label these individuals according to general age classes while also incorporating other observations that aid in understanding age, at least until more precise techniques can be used or are developed.

Most long bones are classified between young and old adult categories. These ages might have been precise if we knew which long bones were associated with particular crania. Long bones that were assessed for a specific age range were four bones with epiphyseal lines (Table 11). This included the single individual represented by one tibiae and fibula (Ti4 and Fi1). These remains belonged to the mummy that Dr. Flint mentioned in his field report. The degree of fusion observed with these two bones (proximal and distal ends of tibia, and proximal end of fibula) indicates that the individual was between 20 and 22 years of age. Another individual, not associated with mummified remains, is represented by two humeri (Hu2 and Hu3). Dr. Flint notes that he only recovered the tibia, fibula, and cranium of the mummy. This separate individual is estimated to have been very close in age to the mummy represented by the tibia and fibula, between 20 and 23 years old, due to the degree of fusion on the proximal head and the complete fusion of the medial epicondyle. Other bones were generically assessed as belonging to adults due to the absence of epiphyseal lines, and the presence of degenerative joint disease.

Table 11. Age estimation of long bones using epiphyseal closure.

Peabody object number	Flint's number	Philmon's number	Element	Side	Sex	Age
79-72-20 / 19914	591	Ti4	Tibia	Left	Male	20 - 22
79-72-20 / 19914	n/a	Fi1	Fibula	Left	Male	20 - 22
79-72-20 / 19912	569	Hu2	Humerus	Left	Male	20 - 23
79-72-20 / 19912	570	Hu3	Humerus	Right	Male	20 - 23

The most definitive age established for the sample is for the ages of the long bones, with a narrow range allowed because of the epiphyseal closure rates. The cranial range is much wider, and it is better here to discuss the presence of adult age classes, rather than estimated numerical age ranges. The Cusirisna Cave sample represents individuals of all adult categories (young, middle, and old), but no subadult, juvenile, or fetal classes.

Stature estimation

Stature was estimated using femora and tibiae taking into account the sex inferred for the individual largely based on robusticity. As previously mentioned, these calculations are significant because they reflect health and can be compared with other samples. The calculated statures range from 152.385 cm to 173.231 cm using Genoves's standard deviations and formulas (Table 12). This shows a large amount of variability within a small sample. The shortest estimate was from an estimated female femur (approximately 5') while the tallest was from a male femur (approximately 5'8"). Males in this sample are taller than the females; the former range between 164.869 ± 3.46 and 173.231 ± 2.66 cm, while the female femur and tibiae range between 152.385 and 158.157 ± 2.6 cm.

Márquez and del Ángel (1997) have provided average heights across periods in the Maya region, demonstrating a decline in stature over time:

> Even though there are discrepancies, depending on the bone from which the calculation is made, based on tibia length it is possible to distinguish an average height of 164.35 cm for Preclassic males; 162.06 cm for Classic males; 161.51 cm for Postclassic males' and 160.03 cm for present day males. For women, the average values obtained from femur lengths are 148.52 for the Preclassic, 148.14 cm for the Classic, 146.10 cm for the Postclassic, and 148.49 for the present [Márquez and del Ángel 1997:57].

Cusirisna Cave does not match up perfectly with the averages for these time periods. We are working with a small sample that may not necessarily represent the entire population, but could very well be outliers. For example, the shortest Cusirisna female, estimated to be 152 cm, is taller than all female averages by several centimeters, and the shortest male, 164 cm falls within the average height for Preclassic males. However, the tallest male from Cusirisna Cave, 173 cm, is much taller than the averages from all of the periods. Comparing height distributions and examining the decline and rise in stature is appropriate for large scale projects, but may not be a plausible endeavor in the present research.

While studies such as Nickens (1976) and Márquez and del Ángel (1997) demonstrate a decline in stature over time, Cusirisna Cave demonstrates a contrary pattern, a relatively tall Late Postclassic sample. Whether this is due to genetics--Márquez and del Ángel's data mostly come from the northern Maya lowlands, which could have had a genetically distinctive population--or environment, we cannot yet say. However, their large stature contributes to the overall impression of a healthy and perhaps wealthy (i.e., elite) group of people interred in the cave.

Table 12. Estimation of stature, femora and tibiae.

Peabody object number	Flint's number	Philmon's number	Side	Sex	Stature (cm)	Stature (in)	Stature (ft)
79-72-20 / 19911	n/a	Fe1	Left	Male	173.231±3.46	68.2011	5' 8.2"
78-42-20 / 15175	139	Fe2	Right	Male	169.389±3.46	66.6885	5' 6.68"
78-42-20 / 15175	136	Fe3	Left	Female	152.385	59.994	4' 11.9"
78-42-20 / 15175	138	Fe4	Left	Male	168.033±3.46	66.1429	5' 6.14"
78-42-20 / 15175	137	Fe5	Left	Male	164.869±3.46	64.909	5' 4.9"
79-72-20 / 19913	567	Ti1	Right	Male	168.908±2.66	66.4992	5' 6.5"
79-72-20 / 19913	565	Ti2	Right	Male	172.83±2.66	68.0433	5'8"
79-72-20 / 19913	566	Ti3	Right	Male	169.3±2.66	66.6535	5' 6.7"
79-72-20 / 19914	591	Ti4	Left	Male	167.008±2.66	65.7511	5' 5.8"
78-42-20 / 15176	132	Ti5	Left	Male	166.752±2.66	65.6503	5' 5.7"
78-42-20 / 15176	131	Ti6	Right	Probably female	158.157±2.6	62.2665	5' 2.3"
78-42-20 / 15176	130	Ti7	Left	Probably female	154.484±2.6	60.8204	5' .8"
78-42-20 / 15176	135	Ti8	Left	Male	173.612±2.66	68.3511	5' 8.4"
78-42-20 / 15176	133	Ti9	Right	Male	169.398±2.66	66.69.12	5' 6.7"
78-42-20 / 15176	134	Ti10	Right	Male	172.632±2.66	67.9653	5' 8"

Taphonomy

Taphonomic conditions were recorded for each element. These include bone discoloration, weathering, and other postmortem changes that occurred to the remains while subjected to environmental conditions in Cusirisna Cave. There was minimal postmortem damage to the remains, and no evidence of gnawing or animal activity. There was no evidence that the skeletal material had been buried (i.e., lack of soil and root marks).

The general taphonomic characteristics of the elements were variable and dissimilar. That is, while the bones were in general well preserved, they varied considerably in their coloration, texture, and condition. For example, the female cranium, Cr1, has a thin layer of dark brown to black, apparently resinous substance adhering to it, especially on the hard palate, which Dr. Flint refers to as “smoky” (Figure 10). Other bits of discoloration appear sporadically on the long bones, specks of red discoloration on some, splotches of orange and brown discoloration on others. Some of the crania show evidence of weathering, possibly through water exposure and corrosion, especially in areas that may have rested on the floor of the cave. The variation in the condition of the bones might reflect different positions within the mortuary deposit; varying age, if the cave was used as an ossuary for a long time; or different postmortem treatments prior to secondary interment in the cave.

Figure 9. Inferior aspect of Cr1 showing coating of dark resinous residue adhering to the maxillae and sphenoid.

Other postmortem changes that occurred to the remains include cutmarks and perforations on a few of the long bones. These instances of modification will be further discussed in the section on cultural modification.

Pathology

Numerous minor pathologies were observed in the Cusirisna Cave sample, ranging from moderate to severe osteoarthritis, osteoporosis, and porotic hyperostosis.

General pathology in the form of arthritis was expected, but lack of major pathological conditions indicates overall good health. The following paragraphs highlight the results of my observations of pathologies and differential diagnosis of a sample of the crania and postcranial remains.

Several of the femora have been affected by moderate to severe osteoarthritis, where osteophytic lipping, build-up, and ridging are present around the condyles and epicondyles (Table 13). Femur Fe1 has some arthritic lipping on the head, but most of the lipping is concentrated on the distal condyles. This individual also has severely knocked knees, or genu valgum, and a very large lateral epicondyle. Most curious are two strange circular indentations drilled into the lateral edge and interior of the lateral condyle. These perforations were made while the bone was still green, as fragments of bone remain within the circular. The perforations will be discussed in more detail below, with respect to cultural modification.

The most severe case of osteoarthritis is on Fe3, and it is coupled with osteoporosis (Figures 11 and 12). The arthritis is restricted to the distal portion of the femur, and complete condylar destruction has occurred due to the erosive nature of the arthritis. The condyles are flattened and irregular in shape, which would have made movement extremely difficult, if not impossible. The frailty of this femur cannot be overstated, as the midshaft circumference is no more than 56 mm. The atrophy of this bone can be attributed to immobility of the individual. Another femur, Fe5, is arthritic and also has an osteochondritis pit, or osteochondritic dissicans, in the wide fovea capitus of the large femoral head (Figure 13).

Table 13. Pathology of femora.

Peabody object number	Flint's number	Philmon's number	Side	Sex	Osteoarthritis	Osteoporosis	Platymeric index	Other
79-72-20 / 19911	n/a	Fe1	Left	Male	Present	Absent	118.55	Genu valgum
78-42-20 / 15175	139	Fe2	Right	Male	Present	Absent	116.53	
78-42-20 / 15175	136	Fe3	Left	Female	Present	Present	115.23	Atrophy
78-42-20 / 15175	138	Fe4	Left	Male	Absent	Absent	116.94	
78-42-20 / 15175	137	Fe5	Left	Male	Present	Absent	107.41	Osteochondric dissicans

Figure 10. Distal posterior aspect of Fe3 showing severe erosion from osteoarthritis.

Figure 11. Distal posterior aspect of Fe3 showing osteoarthritis, porous an hypertrophic irregular bone .

Figure 12. Proximal medial aspect of femoral head of Fe5 showing the fovea capitus.

Eight of the ten tibiae were also affected by arthritis, with cases ranging from minimal to moderate osteoarthritis on distal and proximal ends (Table 14). Three of the tibiae display nonspecific periosteal lesions, and there are also four possible cases of Osgood-Schlatter Disease. One tibia, Ti2, has osteoarthritis on both proximal and distal articulations, as well as periosteal lesions. The lesions are clustered on the posterior and anterior aspects of the shaft, as well as on the distal medial surface (Figure 14). The midshaft of this tibia also has a healed lesion or exostosis that protrudes laterally. The tibial tuberosity has extensive growth and consists of two overlapping pieces of bone, an indicator of Osgood-Schlatter Disease (Figure 15).

Osgood-Schlatter Disease usually occurs during adolescence and is a result of irritation between the quadriceps, patella, and the attachment of the quadriceps tendon by the patellar ligament on the tibial tuberosity (D'Ambrosia and MacDonald 1975; DiGangi *et al.* 2010). "The disease occurs when there is repetitive strain on the patellar ligament from the powerful pull of the quadriceps muscles and part of the tubercle becomes avulsed" (DiGangi *et al.* 2010:434). The pathology is described in the contemporary clinical literature as having an association with sports (D'Ambrosia and MacDonald 1975). Alternatively, the pathological condition has been attributed in other osteological cases to an array of extensive activities, for example, the physical stresses experienced by early mariners sailing wooden ships (Stirland 1986; Cope *et al.* 2006). Three other tibiae from the Cusirisna Cave sample display similar evidence for Osgood-Schlatter Disease: Ti5, Ti8, and Ti9.

In addition to the healed lesions observed on Ti2, there are also nonspecific periosteal reactions on Ti6 and Ti8, though they are active in Ti6 and healed in Ti8. Six of the ten tibiae are platycnemic, also known as saber shins, which is the flattening of the tibia mediolaterally. “It has been suggested that this flattening of the two large bones of the lower extremity is due to either posture or gait or both, or to such activities as mountain climbing. It has been suggested that it may be associated with the relative development of certain muscles which are attached to the femur and tibia” (Buxton 1938:31). The presence and significance of the platycemic index and Osgood Schlatter Disease will be discussed in more detail in the following chapters, as these pathological conditions may permit inferences about the population’s activities or occupations.

Table 14. Pathology of tibiae.

Peabody object number	Flint's number	Philmon's number	Side	Sex	Osteoarthritis	Periosteal lesions	Platycnemic	Other
79-72-20 / 19913	567	Ti1	Right	Male	Absent	Absent	Yes	
79-72-20 / 19913	565	Ti2	Right	Male	Present	Present	Yes	Probable Osgood Schlatter
79-72-20 / 19913	566	Ti3	Right	Male	Present	Absent	No	
79-72-20 / 19914	591	Ti4	Left	Male	Absent	Absent	No	
78-42-20 / 15176	132	Ti5	Left	Male	Present	Absent	Yes	Probable Osgood Schlatter
78-42-20 / 15176	131	Ti6	Right	Probably female	Present	Present	No	
78-42-20 / 15176	130	Ti7	Left	Probably female	Present	Absent	Yes	
78-42-20 / 15176	135	Ti8	Left	Male	Present	Present	Yes	Probable Osgood Schlatter
78-42-20 / 15176	133	Ti9	Right	Male	Present	Absent	Yes	Probable Osgood Schlatter
78-42-20 / 15176	134	Ti10	Right	Male	Present	Absent	No	

Figure 13. Distal medial aspect of Ti2 showing periosteal reaction.

Figure 14. Proximal anterior aspect of Ti2 showing tibial tuberosity.

No pathologies besides modest arthritis and periosteal reactions were observed on the fibulae. One young male, represented by the mummified fibula Fi1, has no sign of arthritis, but does have one periostitic lesion in the anterior fibular neck just inferior to the fibular head. A fragmentary fibula, Fi2, displays arthritic lipping on the malleolar articular surface. There is also a periosteal reaction on the surface for the interosseous membrane.

The upper extremities show relatively little pathology. Minimal arthritis was observed on one humerus, Hu1, where lipping occurred on the lateral edge of the capitulum, and a small nonspecific periosteal lesion appeared on the medial surgical neck. A second humerus, Hu2, has minimal arthritis on the trochlea and capitulum, as well as one small erosive lesion on the posterior portion of anatomical neck, medial to the greater tubercle. A small circular erosive lesion is present on the anterior medial aspect of the trochlea of Hu3. These last two humerii, H2 and Hu3, are those estimated to be young adults, ranging in age from 20 - 23. Very minimal arthritis was observed on Hu4, Hu5, and Hu6. The two extant ulnae, Ul1 and Ul2, have minimal arthritis on the olecranon process, the coronoid process, and the radial notch border, and within the trochlear notch. Similarly, the two radii, Ra1 and Ra2, have minimal arthritic lipping on the radial heads. Table 15 summaries the pathologies of the upper extremities.

Table 15. Pathologies of upper extremities.

Peabody object number	Flint's number	Philmon's number	Element	Side	Osteoarthritis	Periosteal lesions
79-72-20 / 19912	568	Hu1	Humerus	Right	Present	Present
79-72-20 / 19912	569	Hu2	Humerus	Left	Present	Present
79-72-20 / 19912	570	Hu3	Humerus	Right	Present	Present
78-42-20 / 15174	128	Hu4	Humerus	Right	Present	Absent
78-42-20 / 15174	127	Hu5	Humerus	Left	Present	Absent
78-42-20 / 15174	129	Hu6	Humerus	Left	Present	Absent
78-42-20 / 15173	n/a	Ul1	Ulna	Right	Present	Absent
78-42-20 / 15173	n/a	Ul1	Ulna	Right	Present	Absent
78-42-20 / 15173	n/a	Ra1	Radius	Left	Present	Absent
78-42-20 /15173	n/a	Ra2	Radius	Left	Present	Absent

The vertebrae within this sample represent three individuals. Each vertebra displays varying degrees of enthesophytes and osteophytosis, which are spur-like ridges of bone. Those that display moderate arthritis and osteophytic lipping are a commingling of two individuals, represented by five lumbar and three thoracic elements. The third individual, represented by two distinct lumbar elements, has severe osteophytic lipping and additional ridges of bone around the border of the two vertebral bodies (Figure 16).

Figure 15. Superior aspect showing arthritic lipping on lumbar vertebra Vel3.

There are several pathological manifestations on mandibles in this collection, relating to both dentition and to bone pathology. I highlight a sample of the findings from the mandibles and mandibular dentition (see Table 16). Ma1 is notably triangular in shape, and demonstrates severe tooth loss, resorption, and bone remodeling. Teeth present at death were LC, RC, RP3, RP4, and possibly LP3. All other areas are completely smoothed and remodeled. In comparison to Ma1, the dental arcade of Ma2 is much more parabolic in shape. This mandible had all teeth present at death, however, only several remain in place. Four caries were observed, one large on the lateral occlusal surface of LM3 and three small pit caries, one on the buccal side, and two on the occlusal surface of RM1. Ma3 had few teeth present at death, though root cavities display signs of porosity, which indicates they could have been lost close to the time of death. There are large areas of bone remodeling, especially on the right side of the mandible. No dentition remains for examination of caries; however, there was a very large infection on the left side which penetrated and hollowed out this portion of the mandible (Figure 17).

Figure 16. Ma3 showing left posterior infection, resulting abscess, bone remodeling, and antemortem tooth loss.

Ma4 was in very good condition, all dentition present at death, no bone loss or remodeling. A total of two caries were found, one interproximal between LM1 and LP4, and one between RM2 and RM3. Plaque is also present on buccal aspect of LM1 and LM2. There is a minimal to moderate amount of plaque on the buccal and lingual surfaces of extant molars. Ma5 was in good condition as all teeth were present at death; those that remain are RM1, RM2, and RM3, however, these were extremely worn, to a score of 8 and 9. The roots of RM1 have eroded to the outer edge of the mandible due to abscess. There is also arthritic lipping and destruction on the mandibular condyles. There is one interproximal cavity between RM2 and RM3, as well as plaque which surrounds these three molars. All teeth were present at time of death in Ma6, and one pit cavity was present on the occlusal surface of LM2. However, a light brown substance which adheres to most of the dental surfaces obstructed close examination of additional caries. Both LM2 and RM2 were impacted by LM3 and RM3. Ma7 contains five teeth, while there was complete resorption and remodeling of RI1, RI2, RC, and RP3. Plaque surrounds the molars and premolar, but only one interproximal cavity is located on RM2, which would have correlated with RM3. Two supernumerary incisors are located at internal mental spine, just barely seen through a small break. All teeth were present at time of death for Ma8 that remain are RC and LM3. There is one large and discolored interproximal cavity on LM3 but all which would have been shared with LM2, as well as a large cavity located on the buccal side of LM3. There is plaque buildup around the entirety of RC. Ma9 had all teeth present at death, but all that remain now are RM1, RM2, and RM3. RM3 has a large cavity on the occlusal surface with is deep enough to have affected the dentin and possible the pulp chamber. RM2 had a severe cavity that can be seen because of a postmortem break that caused the loss of the lingual posterior quadrant. There is also an abscess associated with RM3. In addition to the caries and abscess, the mandibular condyles are severely arthritic, and would have constantly been in a dislocated state. The condyles are destroyed to the point of developing an irregular and flattened surface which would have been severely painful and difficult to move (Figures 18 and 19).

Table 16. Pathologies of mandibles.

Peabody object number	Flint's number	Philmon's number	Dentition present at death	Extant dentition	Caries	Abscess	Bone remodeling	TMJ Osteoarthritis
79-72-20 / 19908	554	Ma1	LC, RC, RP3, RP4, ~LP3	None	n/a	0	Present	Absent
79-72-20 / 19908	557	Ma2	All	LM1, LM3, RM1, RM3	4	0	Absent	Absent
79-72-20 / 19908	555	Ma3	LC, RC, RP3, RP4, RM2, RM3	None	n/a	1	Present	Present
79-72-20 / 19908	5	Ma4	All	LM1, LM2, LM3, RM1	2	0	Absent	Absent
79-72-20 / 19908	n/a	Ma5	All	RM1, RM2, RM3	1	1	Absent	Present
78-42-20 / 15170	141	Ma6	All	LP4, LM1, LM2, LM3, RM1, RM2, RM3	1	0	Absent	Absent
78-42-20 / 15170	n/a	Ma7	LI1, LI2, LC, LP3, LP4, LM1, LM2, LM3, RP4, RM1, RM2, RM3	LM1, RP4, RM1, RM2, RM3	1	1	Present	Absent
78-42-20 / 15170	n/a	Ma8	All	RC, LM3	2	0	Absent	Absent
78-42-20 / 15170	n/a	Ma9	All	RM1, RM2, RM3	2	1	Absent	Present

Figure 17. Left aspect of Ma9 showing bone remodeling on the left side in replacement of the molars. Also demonstrated the flattening of both mandible condyles due to destructive arthritis.

Figure 18. Right aspect of Ma9 showing flatness of the right mandibular condyle.

The crania in this sample show relatively little pathology, but do show evidence of dental caries, abscesses, degenerative joint disease, vault porosity, and cribra orbitalia (Table 17). As with the mandibles, in the crania there are relatively few extant teeth that would have been present at death. This may be a result of secondary burials (i.e., tooth loss through travel and postmortem body movement), through transport from Nicaragua to Peabody Museum, or periostitis at alveolous (i.e., after death and loss of soft tissue, dentition may have been lost because bone was not strong enough to retain teeth). "Loss of teeth can stem from a variety of causes, including dental caries (tooth decay), gum disease or, indeed, from heavy dental wear. When wear is heavy, teeth continue to erupt from their sockets to maintain occlusion. When wear is advanced, this continued eruption of teeth may proceed to the point at which they are held in their sockets only by the root tips. The weakening of the support for the tooth may precipitate its loss" (Mays 2010:76).

Table 17. Pathologies of crania.

Peabody object number	Flint's number	Philmon's number	Dentition at death	Extant dentition	Caries	Abscess	TMJ OA	Occipital condyle OA	Other
79-72-20 / 19906	n/a	Cr1	All	LM1, LM2, RM1,	0	6	Absent	n/a	Possible congenital defect
79-72-20 / 19907	n/a	Cr2	n/a	n/a	n/a	n/a	Present	n/a	Cribra orbitalia
79-72-20 / 19905	n/a	Cr3	All	RP4, RM1, RM3, LP4, LM1, LM2,	1	0	Absent	Absent	
79-72-20 / 19904	n/a	Cr4	All except RP4	LM2	1	4	Present	Present	Lytic reaction and infection
79-72-20 / 19903	554	Cr5	RM3, RM2, RM1, RP4, RP3, LP4, LM1, LM2, LM3	None	n/a	6	Present	Present	Lytic reaction and infection
78-42-20 / 15169	126	Cr6	n/a	n/a	n/a	n/a	Present	Present	Porosity on parietals and lambda
78-42-20 / 15168	n/a	Cr7	All except RI1, RI2, and RC	None	n/a	0	Present	Absent	
78-42-20 / 15167	124	Cr8	RP3, RC, RI2, LI1, LI2, ~LC, LM2,	None	n/a	4	Absent	Present	

Cr1 exhibits two indentations or impressions on the inferior aspect of the occipital (Figure 20). After consultation with Dr. Douglas Broadfield, I believe these may indicate a congenital defect. This female cranium exhibits no caries, but does have a large number of abscesses. All teeth would have been present at death, and the extant ones were in very good condition at time of death in comparison to some of the severely worn dentition of others from the sample.

Figure 19. Inferior aspect of Cr1 showing unusual indentations.

Cr2 has abscesses present on the maxilla superior to LI1, LI2, LC, RI1, RI2, and RC. Cr2 has degenerative joint disease of the temporomandibular joint (TMJ), as well as cribra orbitalia in the right orbit (Figure 21). This cranium was fragmentary, and only the superior portion remains.

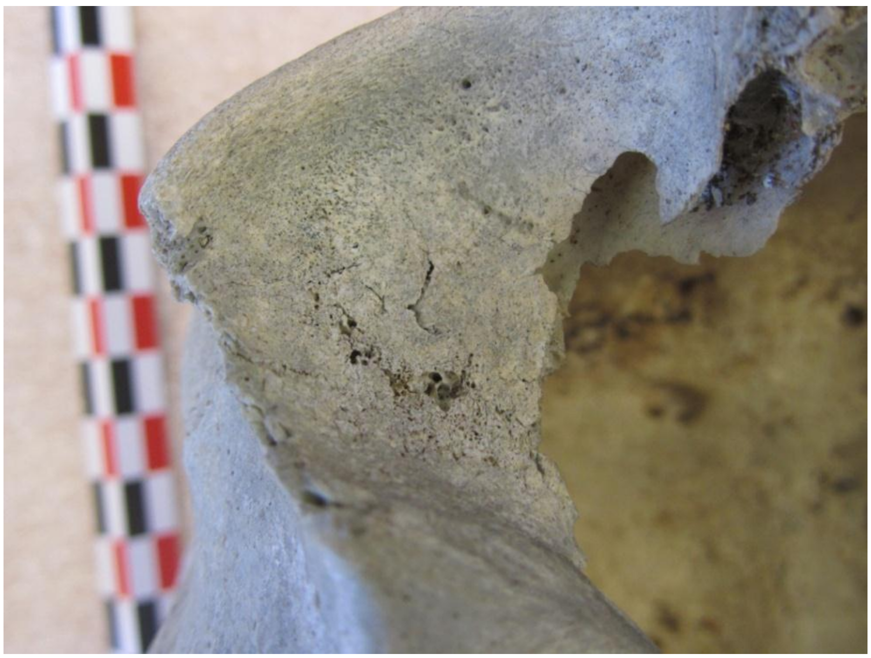

Figure 20. Cribra orbitalia, superior aspect of right orbit, Cr2.

Cr3 has immaculate dentition, much like Cr1. All teeth were present at death. The extant ones exhibit minimal wear and no abscesses (Figure 22).

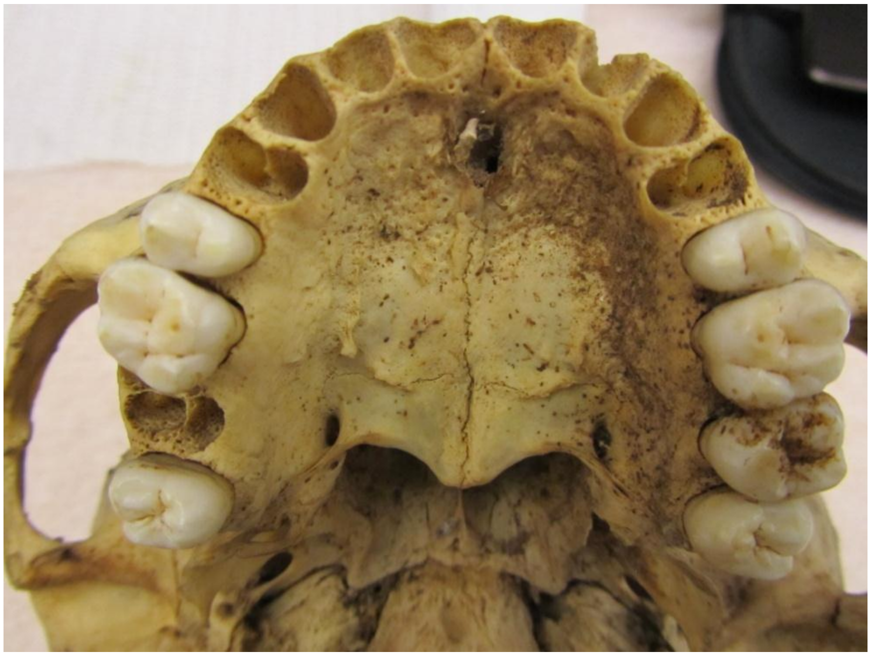

Figure 21. Inferior aspect of maxillae, Cr3, illustrating the excellent condition of the dentition.

In stark contrast, Cr4 displays severe destruction of maxilla due to bone loss, and multiple abscesses in possible conjunction with a lytic reaction or dental infection, and only one left molar remains (Figures 23 and 24). The bone on the alveolar ridge was very thin and was broken in the molar region, and infection could have easily infiltrated the sinus. In addition, degenerative joint disease (DJD) was noted on the occipital condyles and TMJ. Also worth mention is the thinness of the bone in the orbits and palate, which is extremely fragile. The bone is transparent from within the orbits to the postorbital construction on the frontal, and is also very thin on the right maxilla (Figure 25).

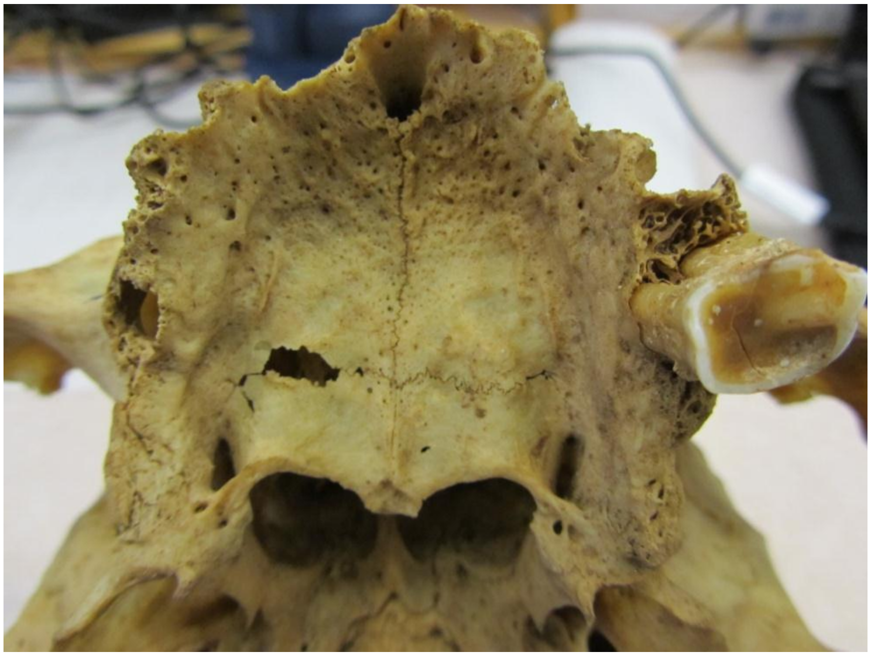

Figure 22. Inferior aspect of maxillae, Cr4, showing antemortem tooth loss and the only present molar.

Figure 23. Left aspect of maxilla, Cr4, showing state of remaining molar and exposed roots.

Figure 24. Anterior aspect of cranium Cr4.

Cr5 has degenerative joint disease present on the occipital condyles as well as the anterior portions of the TMJs. Additional pathology is located on the maxilla, where the porosity at the point of bone remodeling and loss is so severe that the sinus is visible through the maxilla. Pathology includes multiple abscesses and infection on the maxillae (Figures 26 and 27).

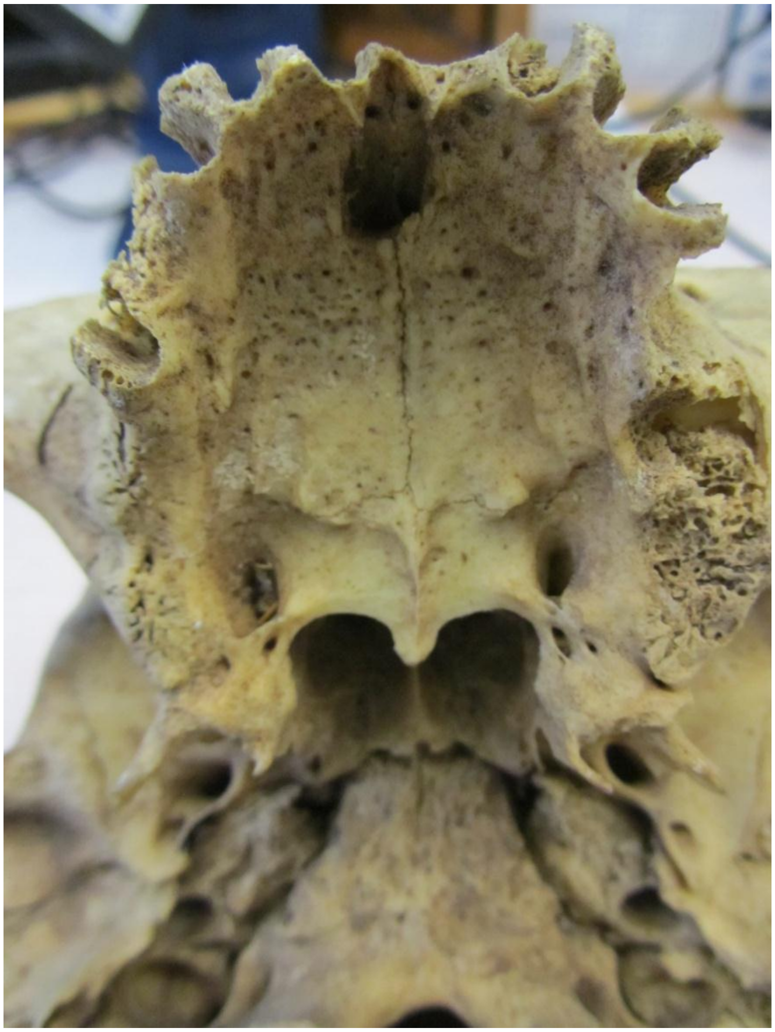

Figure 25. Inferior aspect of maxillae, Cr5, showing antemortem tooth loss and bone infection.

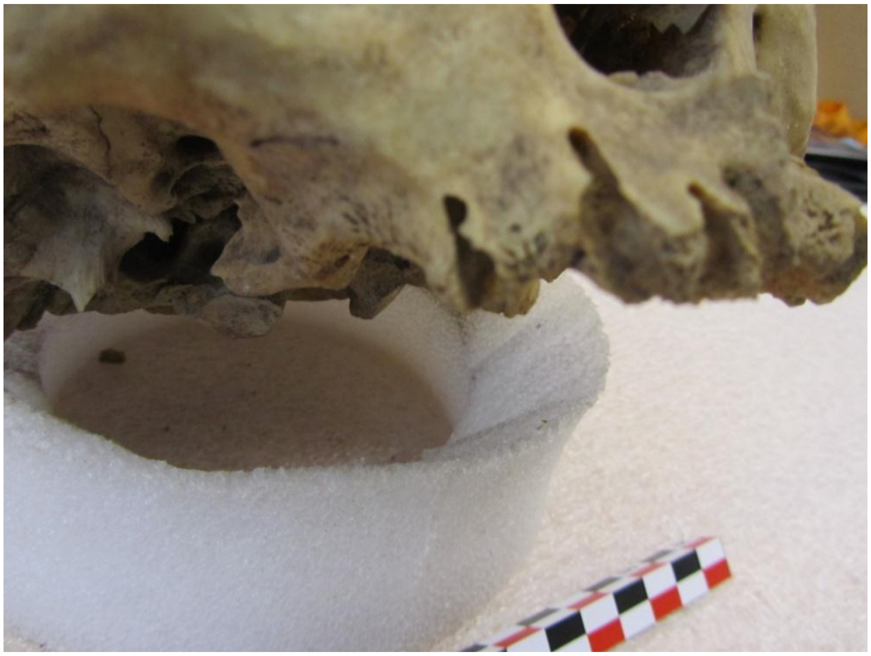

Figure 26. Right aspect of maxilla, Cr5, showing antemortem tooth loss and abscesses.

Cr6 has porosity on both parietals, as well as at lambda on occipitals. The mandibular fossae are flat, which could have caused easy dislocation at this joint. The TMJ and occipital condyles both display porosity (Figure 28). Because of the fragmentation of this particular cranium and missing maxillae, no observations of the dentition were possible.

Figure 27. Right inferior aspect of mandibular fossa, Cr6.

Cr7 has osteoarthritis and porosity at the TMJ, and the mandibular fossae are flattened, as with Cr6 (Figures 29). Much of maxillae were destroyed by bone loss, no bone was rebuilt, and the hard palate surface is flat (Figures 30 and 31).

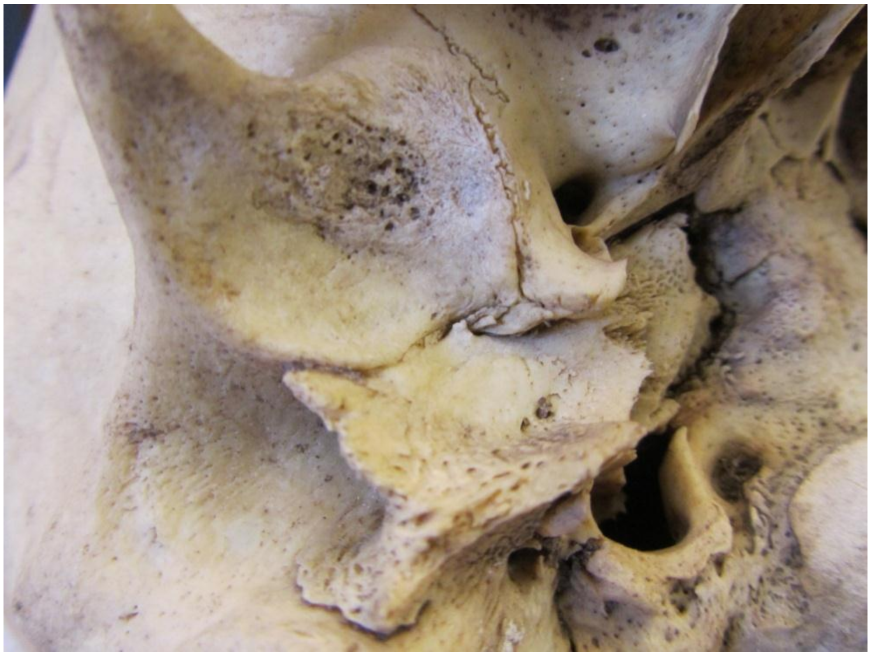

Figure 28. Inferior aspect of right mandibular fossa porosity, Cr7.

Figure 29. Left aspect of maxilla, Cr7, showing bone remodeling after antemortem tooth loss.

Figure 30. Anterior aspect of Cr7 maxillae, showing abscesses.

Cr8 also had osteoarthritis and porosity at the TMJ, accompanied by flattened fossae. Several dental abscesses are located superior to LI1, LI2, LC, and RI2. The individual also suffered from bone loss of the maxillae (Figure 32). The cranium also has minimal lipping on the occipital condyles.

Figure 31. Inferior aspect of maxillae, Cr8, showing antemortem and postmortem tooth loss. Also notice the different appearance of this cranium as compared to the others as it was affected through different taphonomic conditions and weathering of the bone.

Trauma

Trauma found within the Cusirisna Cave sample was largely observed on the crania in the form of perimortem blunt force and resulting fractures, but two examples of cutmarks were found on tibiae. There also appears to have been postmortem activity or treatment on the mummy, seen in straight cuts through the flesh and muscles on the tibia and fibula. Table 18 summarizes the trauma observed within the sample, and the following section is a description of each trauma.

Table 18. Trauma.

Peabody object number	Flint's number	Philmon's number	Element	Sex	Trauma
79-72-20 / 19913	566	Ti3	Tibia	Male	Cutmarks
79-72-20 / 19914	591	Ti4	Tibia	Male	Cutmarks
78-42-20 / 15176	134	Ti10	Tibia	Male	Cutmarks
79-72-20 / 19914	n/a	Fi1	Fibula	Male	Cutmarks
79-72-20 / 19911	n/a	Fe1	Femur	Male	Circular perforations
79-72-20 / 19905	n/a	Cr3	Cranium	Male	Perimortem blunt force trauma
79-72-20 / 19904	n/a	Cr4	Cranium	Male	Possible cutmarks
79-72-20 / 19903	554	Cr5	Cranium	Male	Perimortem fractures
78-42-20 / 15169	126	Cr6	Cranium	Male	Perimortem blunt force trauma
78-42-20 / 15168	n/a	Cr7	Cranium	Male	Perimortem fractures

One tibia, Ti3, has three small cutmarks located on the medial aspect, midshaft. The superior cut is 3.2 mm long, the second measures 2.5 mm, and the third measures 10 mm, while each cut is spaced 12 mm apart. A second tibia, Ti10, has one 15 mm long cutmark midshaft and a very small perimortem break below the tibial plateau and above the tibial tuberosity on the medial aspect. I believe this to be a perimortem break; it contains small fragments of bone as if the puncture occurred before death or shortly after while the bone was still fresh and malleable. A third tibia, Ti4, which retains soft tissue, has no direct cutmarks remaining as evidence on the bone, however, there are clear marks showing that material was defleshed from the bone with a very sharp object. The proximal ligaments for the patella are clear-cut (Figure 33), while the inferior soft tissue and ligaments appear to be haphazardly torn apart (Figure 34). This raises questions to whether the mummy was defleshed prior to placement in the cave, or if Dr. Flint and his guide dismembered the mummy in order to get the bones out of the cave. It appears likely that the cutmarks on the proximal aspect would have been cut when the ligaments were malleable, closer to time of death, allowing for a sharp edge to easily cut through the material, while the destruction to the distal end of the tibia may have been done when the material was extracted from the cave during the 1870s, being ripped apart from the articulated fibula. There was similar treatment to the corresponding fibula, Fi1, where the distal portion was haphazardly and destructively torn, while there is a small circular portion of remaining soft tissue on the head that appears to have been cut with a sharp implement.

Figure 32. Cutmarks through the surviving flesh on the proximal aspect of Ti4.

Figure 33. Cutmarks on distal end of Ti4.

Another incidence of trauma, that likely occurred perimortem, is found on a right femur, Fe1. There are two perforations or drillings on the lateral epicondyle. They appear to have been most likely made while the bone was still green, as there are still fragments of bone within the circular perforations on the lateral edge of the lateral condyle (Figures 35 and 36) as well as on the medial portion of the same condyle (Figure 37). Neither discussions with other biological anthropologists nor a literature search has aided in explaining this phenomenon. However, Beck and Sievert (2005) describe the use of pointed implements for dismemberment of bodies at Chichén Itzá's Sacred Cenote.

Figure 34. Distal lateral aspect of Fe1 showing circular indentation drilled in the lateral epicondyle.

Figure 35. Distal lateral aspect of Fe1 showing a closer view of the indentation and lateral epicondyle.

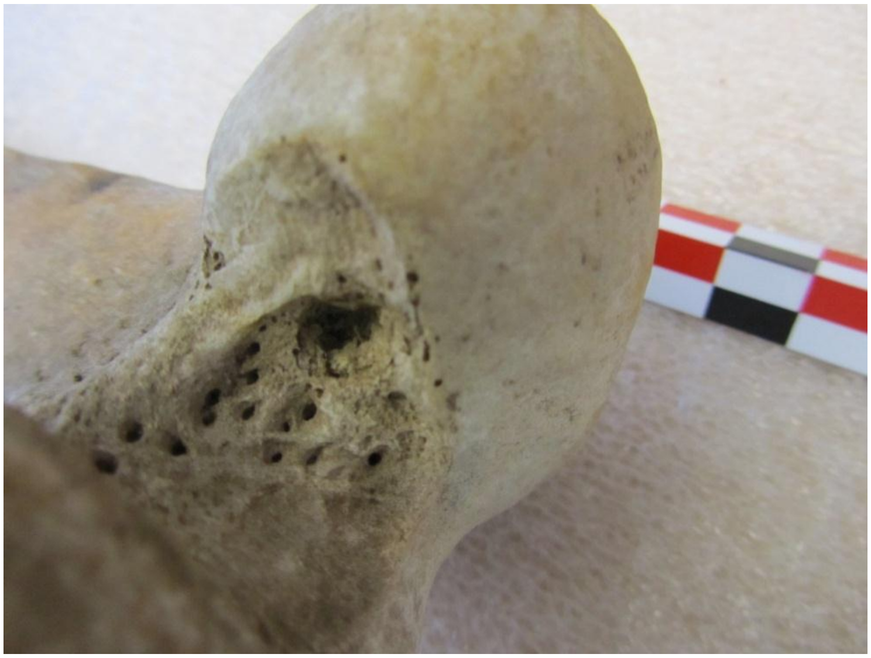

Figure 36. Interior aspect of lateral condyle and intercondylar fossa, Fe1.

Cr3 has evidence of trauma on the right side of the cranium. Three healed linear wounds are visible on the right parietal, just superior to the temporal (Figure 38). The three lines are well healed and the bone has smoothed over the trauma. These wounds could be explained by a weapon or possibly an animal, but it is difficult to be certain. Dr. Stanley Serafin suggests (personal communication, 2012) that these marks may also be explained by blood vessels or cranial deformation band impressions.

A separate incidence of trauma is located just anterior to these markings. An obtusely angled perimortem fracture occurred near the sagittal suture on the right parietal (Figures 39). This occurrence would have been closer to death, either as cause of death due to blunt force trauma to the right parietal, as postmortem damage, or a combination of both. The damage is observable all throughout the right side, and the left side is enlarged, which may have expanded as result of resting in water in the cave. The elongated break extends from the right parietal inferior to the temporal (Figure 40). One section acts like an island of bone, which was either removed and re-secured, or held in with soft tissue, evidenced by remaining reddish substance. Still more of the break extends anteriorly to the frontal, and then into a rounded curved perimortem fracture across the face through the frontal and orbits (Figure 41). Personal communication and discussion of the photographs with Dr. Serafin has resulted in agreement that this individual suffered from major blunt force trauma with possible postmortem damage.

Figure 37. Cr3, posterior view of occipital and right parietal. On the right parietal, notice the two healed marks of trauma, a third is less apparent in the photo.

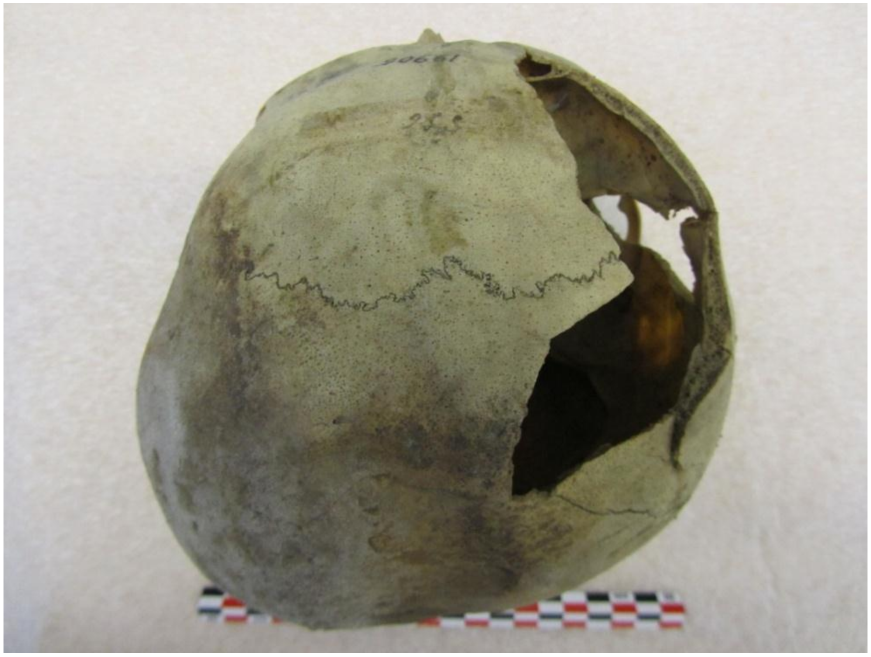

Figure 38. Perimortem trauma, superior aspect, Cr3.

Figure 39. Perimortem trauma, right aspect, Cr3.

Figure 40. Perimortem trauma, anterior aspect, Cr3.

Cr4 exhibits possible trauma in the form of two parallel linear cut marks on the frontal bone which are oriented anterior to posterior. They are healed and smooth, possibly from blood vessels, but their cause difficult to discern. This cranium also has some sort of soft tissue remnant clinging to the left parietal, which also appears to have distinguishably sharp edges, possibly cut (Figure 42). The material on the cranium may be part of occipital belly of the epicranius, though there are no significant details on the paper-thin remains. This is very different from the material remaining on Ti4, the mummy, where outlines and striations of muscles are still visible. There is also the possibility that this is not soft tissue, but instead a thin layer of organic material from the gourd bowls or other plant material that adhered to the cranium.

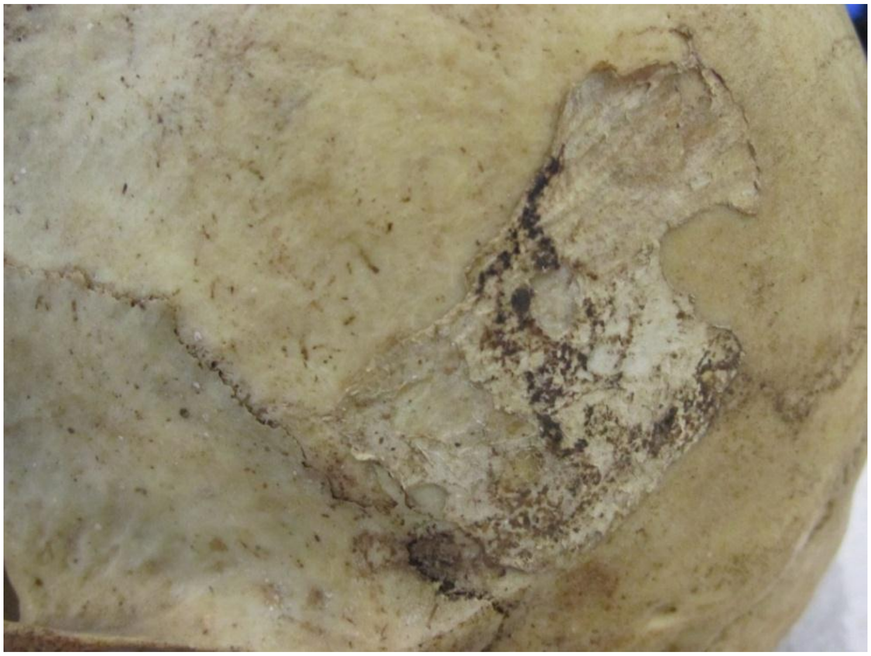

Figure 41. Soft tissue or another type of organic material on the left parietal, Cr4.

Cr5 presents two areas of trauma. One unusual cut mark or indentation is located on the right maxilla. It is smooth, and if this was a result of trauma, it healed (Figure 43). On the left maxilla, there are two concentric fractures (Figure 44). These fractures radiate superiorly from the location of a resorbed molar to the alare region within the nasal cavity. The fracture lines are superficial, thin, curved, and appear healed. One hypothesis is force or accident to the left side of the maxilla, which then resulted in loss of the maxillary molars, and a radiating fracture from this point. There is also a posterior infection in this region, which may support this hypothesis about the relationship between the fracture and tooth loss.

Figure 42. Linear indentation, right maxilla, Cr7.

Figure 43. Concentric fractures, left maxilla, Cr5.

Cr6 shows a perimortem radiating fracture on the right parietal with a small superior point perforation, one large indentation, and an outward linear fracture extending superiorly on the parietal from point of weapon contact as well as on the inferior aspect of the temporal (Figures 45, 46, and 47). "The perimortem depressed fracture of the right parietal is clear-cut, as indicated by the hinge fractures, adhering flakes, and concentric and radiating fracture lines, including one which terminates in the squamous suture" (Serafin, personal communication, 2012). Consultation with Dr. Serafin has provided insight as to how the injury may have been caused, possibly through a pointed or sharp-edged implement, such as an axe or spear. This is an example of a depressed fracture because "there is an in-bending at the impact site and this fracture form is characterized as one in which several fragments of bone usually angle inward" (Galloway 1999:67-68). The weapon would have been used in a chopping or stabbing manner at low velocity speed. "The wedge shape of an axe, for example, would cause the cranium to split open beyond the initial point of impact resulting in fracture lines radiating from the injury termini" (Wenham 1989). If the implement had been traveling at higher velocity, such as in the case of an arrowhead, we would not expect so much plastic deformation" (Serafin, personal communication, 2012). In addition to the blunt force trauma, there is also an indentation on the left occipital, which may be a healed wound, or an impression from a blood vessel or band used in cranial deformation (Serafin, personal communication, 2012).

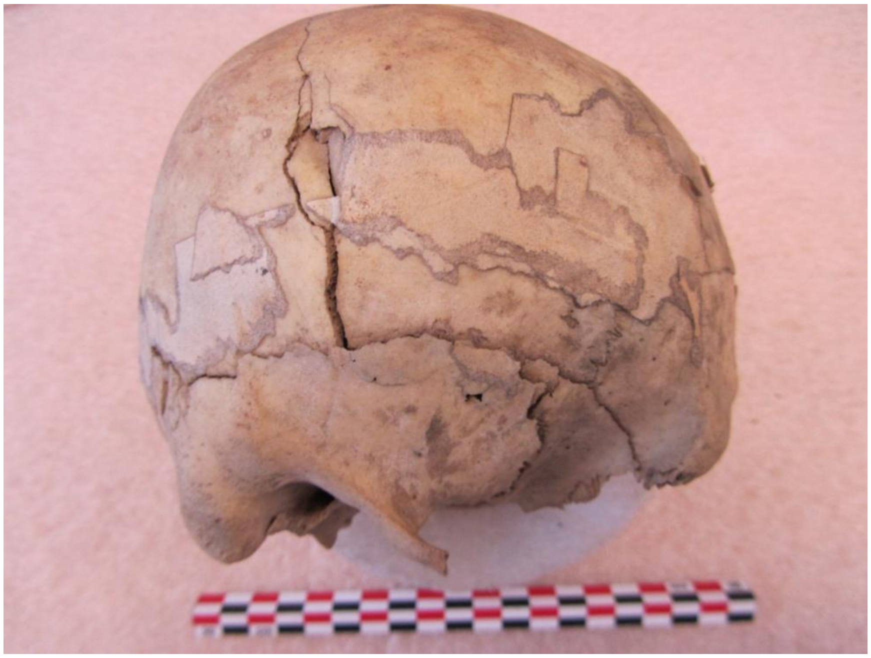

Figure 44. Left aspect, perimortem blunt force trauma, Cr6.

Figure 45. Left aspect, perimortem blunt force trauma, Cr6.

Figure 46. Left aspect, perimortem blunt force trauma, Cr6.

Cr7 has trauma isolated on the right aspect, on the inferior posterior portion of the frontal and anterior inferior aspect of the right parietal near the greater wing of the sphenoid (Figure 48). Superior to the coronal squamous junction, there is a small perforation that is visible, with a linear fracture extending 33 mm on the anterior aspect of the frontal. Posterior to the coronal suture on the parietal are a series of three small puncture marks, or depressed fractures, each with remnants of bone fragments. Dr. Serafin commented that this looks like a "simple linear fracture with possible expansion of the coronal and squamous sutures" (personal communication, 2012). This explains the fracture on the frontal bone but not the small depressed fractures that are limited to the outer table. "While low-velocity impacts caused by forces with a large mass often result in linear fractures, higher-velocity forces with a small mass often result in depressed fractures" (Galloway 1999:67). Therefore, I would argue that the fractures were caused by two different impacts; one of low-velocity and the other by a higher velocity power.

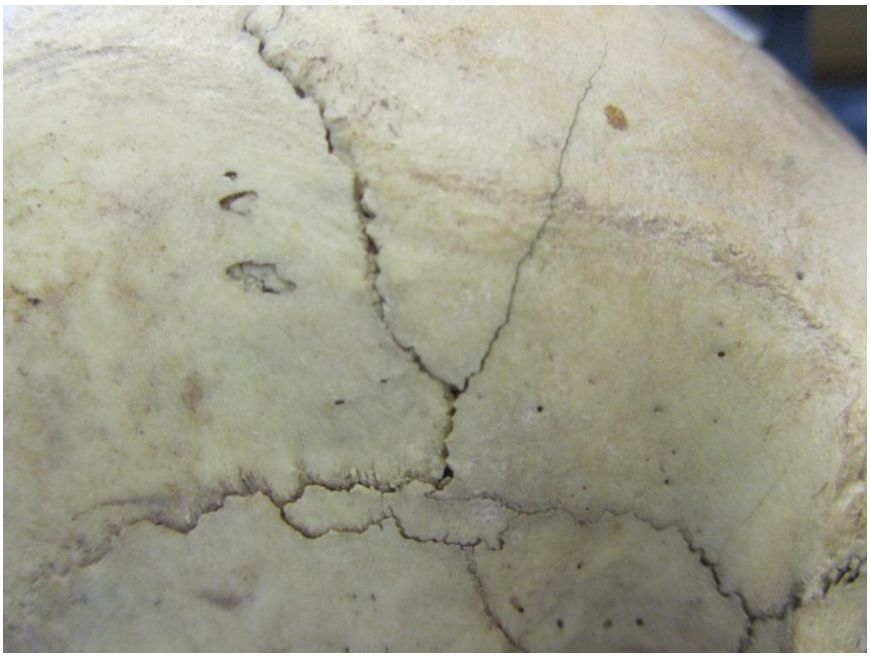

Figure 47. Right aspect of frontal and parietal, showing the perimortem fracture on Cr7.

The variable cases of trauma found in this sample may be further assessed by examining the endocranium of the crania, as understanding how the internal structure was affected will allow the researcher to better assess what could have caused the damage. This will also allow for a more complete description of the damage. This was not possible in this study because only ectocranial evaluation was conducted as this was the only surface area available for analysis. Endocranial analysis would have required major invasive procedure of cutting the bone or perhaps use of scanning equipment which is unavailable at the time of research, and procedures for this type of analysis was not explored in depth.

Cultural modification

The original research design included study and evaluation of cranial and dental modification. There are no extant anterior teeth in the mandibles or maxillae, so only cranial modification could be observed in this sample. However, "absence of evidence is not evidence of absence" and therefore we cannot rule out dental modification as a possible practice for these individuals. Five crania show evidence for modification, and one femur also appears to have been modified, which may have cultural implications (Table 19). This femur was mentioned in the section on trauma, but will be more thoroughly discussed here.

Table 19. Cultural modification.

Peabody object number	Flint's number	Philmon's number	Element	Sex	Modification
79-72-20 / 19907	n/a	Cr2	Cranium	Male	Tabular erect type
79-72-20 / 19903	554	Cr5	Cranium	Male	Tabular erect type
78-42-20 / 15169	126	Cr6	Cranium	Male	Tabular erect type
78-42-20 / 15168	n/a	Cr7	Cranium	Male	Tabular erect type
78-42-20 / 15167	124	Cr8	Cranium	Male	Tabular erect type
79-72-20 / 19911	n/a	Fe1	Femur	Male	Circular perimortem perforations on distal condyles

Others have previously investigated the physical features of cranial modification and its implications for growth, and also have conducted metric analyses of the phenomenon (Lekovic *et al.* 2007; Moss 1958; O'Brien and Stanley 2011; O'Loughlin 2004; Perez 2007; van Arsdale and Clark 2012). Here I will only explore the cultural implications of the practice in order to examine cultural affiliation among groups. The Cusirisna Cave material would make for a good study on the physiological stress of the practice, but this exceeds the scope of this thesis. Generally, the crania demonstrate characteristics of tabular erect deformation, but display some variation within this type. "'Tabular' shaping is produced by fronto-occipital compression and 'orbicular' or 'annular' shaping by the use of bands that compress the head circumferentially. These two basic categories are further subdivided into the 'erect' variety (the direction of pressure resulting in an essentially vertical or anteriorly tilted orientation of the occipital bone) and the 'oblique' variety (the entire occipital flattened and tilted posteriorly)" (Saul *et al.* 2005:310). Pressure was applied on the occipital in all five cases at Cusirisna Cave, and two individuals show evidence for pressure and flattening of the frontal bone. This caused the erection of the cranial vault with a flattening of the occipital and consequent expansion of the parietals. "The tabular form utilizes boards or hard flat surfaces bound across the child's forehead and tied laterally to a board placed across the back of the head" (O'Brien and Sensor 2008:25). This then results in a boxy vault which is high and short, or postero-lateral bossing on the parietals which results in a lateral expansion and a vertical occipital and lengthened frontal (O'Brien and Sensor 2008). There are a wide array of descriptions and types of cranial modification; however, the following systematically and clearly describes several applicable types for this research:

> Occipital deformation is a vertical flattening of the nuchal portion of the occipital bone. Lambdoid deformation is a flattening of the cranium around the region of lambda. Fronto-vertico-occipital deformation is a vertical flattening of the upper portion of the occipital, as well as an oblique flattening of the frontal bone. Parallelo-fronto-occipital deformation flattens the frontal region and the occipital bone proper. The occipital bone is flattened obliquely, whereby the frontal and occipital bones are approximately parallel to each other. Annular deformation compresses the cranium cylindrically, so that the cranium becomes ovoid [O'Loughlin 2004:148].

The types of modification present within the Cusirisna Cave sample include fronto-vertico-occipital and occipital deformation, and an absence of annular, lambdoid, and parallel-fronto-occipital types. These types can be achieved through several means during childhood: use of a cradleboard or strapping freeboards to the infant's head (Wells 1964).

Cranial deformation is present on Cr2. Pressure was applied at lambda, which is accompanied by lambdic depression. It appears that pads were used, as there are impressions visible on the right side. The fragmentary nature of this cranium precluded examination of possible pad impressions on the left side and I can only speak to observations for the right side. The pad shape on the right side appears circular or oval, with round edges, consistently smooth, which are visible in a line running superior to inferior on the parietal and sphenoid, as well as an impression running in an inferior posterior angle from temporal to occipital. The modification is not symmetrical, and the right side is more deformed. The frontal bone does not appear to have been affected in this cranium, but there is notable postorbital constriction (Figure 49). The most telling aspect of the modification is visible in the verticality of the occipital and the expansion of the parietals, giving a blocky or square appearance (Figure 50). Of the sample, Cr2 exhibited the least degree of modification in comparison to the others, though it is evident and clear.

Figure 48. Anterior view showing the postorbital constriction of Cr2.

Figure 49. Posterior view showing the vertical occipital of Cr2.

Cranial modification is also present on Cr5, with pressure applied at lambda and near the frontal bossing. There is lambdic and postcoronal depression, and sagittal and bregmatic elevation as a result of modification. Impressions of bindings are visible posterior to the coronal suture, and they appear to be circular or oval in shape. In contrast to Cr2, this individual shows evidence for modification on the frontal bone, with a posterior slope. The photo (Figure 51) demonstrates the slope of the frontal bone as well as the robusticity of the supraorbital ridge, which were not affected by the modification. This frontal slope combined with the vertical occipital together confer a more conical shape on the cranium. The left parietal is more modified that the right, with more lateral expansion. The focus of this modification appears to have been deformation of the frontal bone, rather than the occipital like in Cr2 (Figure 52). While there is occipital pressure and verticality, it is to a lesser degree than in Cr2, as the frontal slope is more extreme in the case of Cr5. Another difference between the two modifications is the position of the sutures after modification. In Cr2, the lambdoidal suture is more superior in position, while in Cr5, the lambdoid is not so much affected as is the coronal suture. The coronal suture in Cr5 is located as the peak of the cranial vertex, which is apparently different when compared to Cr2 which is located in a more “normal” position.

Figure 50. Left aspect of Cr5 showing the vertical slope of frontal bone after modification.

Figure 51. Posterior aspect of Cr5 showing slight parietal bossing.

Cr6 is much more symmetrical in the modification reshaping. Pressure was applied and centered at lambda. There is resulting sagittal and lambdic depression present. There is a large degree of postorbital constriction, and the parietals expand laterally more so than in Cr2 and Cr5 (Figure 53). The frontal was not modified on this cranium as it was in Cr5, but instead more closely resembles the type observed on Cr2 with the verticality of the occipital and as well as the resulting change in location of the lambdoidal suture which increased in height (Figures 54 and 55). As mentioned previously in the section on nonmetric variation, there are several very complex lambdoidal sutures, as well as multiple lambdoidal ossicles in this sample. One could argue that simplicity or complexity of the lambdoidal suture is correlated with the cranial modification. In comparison to Cr2 and Cr5, the modification of Cr6 is more symmetrical and exact.

Figure 52. Anterior aspect of Cr6 showing post oribital constriction and expansion of the parietals.

Figure 53. Posterior aspect of Cr6 showing parietal expansion and the complexity of the lambdoidal suture.

Figure 54. Superior aspect of Cr6 showing constriction posterior to the coronal suture and expansion of the parietals.

Cr7 presents modification similar to Cr5, but appears more annular with the frontal involved. Pressure was centered at lambda, and there is postcoronal depression, as well as lambdic and sagittal depression. This cranium is very symmetrical, such that the modification of Cr7 and Cr6 appear more advanced or done by those more skilled in symmetrically shaping the head. Similar to Cr5, the frontal bone slants posteriorly, but less extremely so, as the degree of slope is much less. Because the frontal bone has been modified, the position of the coronal suture is also different, placed more anteriorly at the peak of the bone at the most superior vertex, which also affects the shape of the sphenoid (Figure 56) . The occipital bone is vertical, but the lambdoidal suture has not been compromised, and it has been maintained in the normal location (Figure 57). The parietals show large bossing and expansion as a result of pressure pushing the cranium forward and through flattening of the occipital. Again, very complex sutures and ossicles have been noted in conjunction with modification.

Figure 55. Left aspect of Cr7 showing the slope of the frontal bone.

Figure 56. Posterior aspect of Cr7 shows the complexity of both the lambdoidal and sagittal sutures.

Cr8 resembles the deformation type of Cr2 and Cr6, with pressure at lambda and the focus of the deformation centralized on the occipital. The modification is not symmetrical; the left parietal expands more laterally than the left parietal (Figures 58 and 59). There is sagittal and bregmatic elevation, also with lambdic depression. Pressure also seems to have been laterally applied superior to the brow ridges, presenting two distinct ridges of bone distinct from the other four crania in the sample (Figure 60). Also present on this cranium is another feature which may be a form of cultural modification: possible evidence for an artificial tooth. A brown substance is present within the right central incisor root cavity with a circular perforation (Figure 61). No literature supports this hypothesis, but there does not seem to be another possible explanation for this observation. It will be explored further in the literature and with other Mesoamerican bioarchaeologists in order to find similar practices with dentition.

Figure 57. Left aspect of Cr8 showing the elevation of the parietals posterior to the coronal suture.

Figure 58. Superior aspect of Cr8 showing the larger and disproportionate left parietal in comparison to the right parietal.

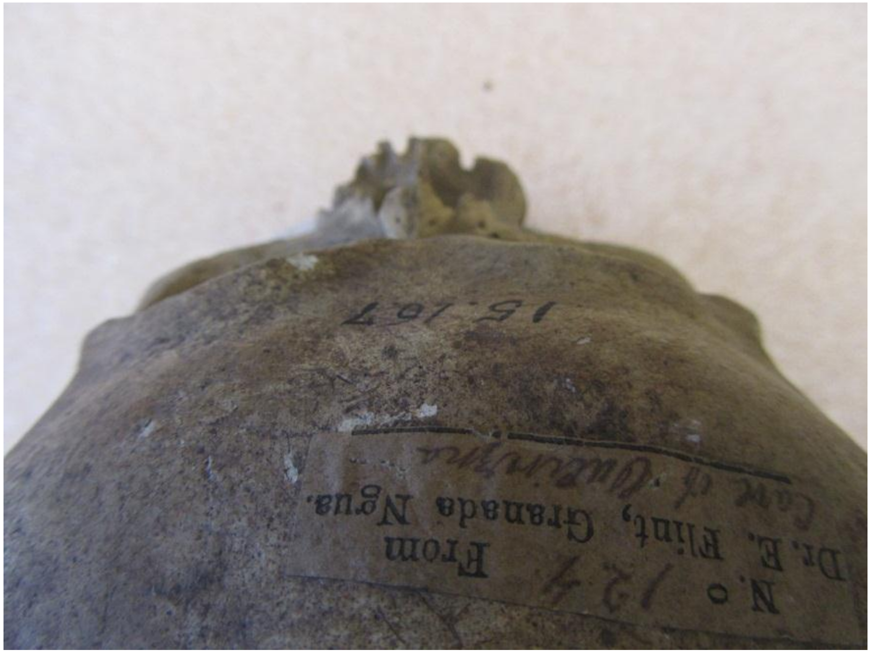

Figure 59. Superior anterior aspect of the frontal of Cr8 showing the large and singular browridge.

Figure 60. Inferior view of the maxillae of Cr8, showing the brown substance within right central incisor root cavity.

Cultural modification was observed in the form of cranial modification on five males of the eight crania. Generally, the crania exhibit characteristics of the tabular erect type with some slight variation and range among the individuals. To be more specific, the classifications may better be understood as fronto-vertico-occipital and occipital modification. This is the vertical or erect flattening of the occipital, with pressure applied to both the occipital and the frontal, which in some cases creates varied degrees of slant on the frontal bone characteristic of the oblique type. In the oblique type, the modification applied to the frontal bone slopes the frontal to a degree that aligns the nose with the retreating forehead (Romero-Vargas *et al.* 2010). In all of the observed crania, the parietals expand laterally, accompanied by an erect occipital and superior elevation of the lambdoidal suture. This is the same type of modification observed at Tlatilco, an extreme artificial deformation of the fronto-occipital type (Porter 1953:34). The variability in cranial modification type at Cusirisna Cave may exhibit continuity through time and re-visitation, as modification types vary both by cultural group, space, and time (Romero-Vargas *et al.* 2010; Dembo and Imbelloni 1938; Hoshower *et al*. 1995). It should be clear from the foregoing discussion that the typologies of cranial modification that have been proposed in the literature focus on ideal types. Though the classifications have proven useful to archaeologists, real skulls inevitably exhibit considerable variation and can be difficult to classify in terms of previously defined categories. The variation undoubtedly derives in part from the dynamic nature of human growth processes but also from individual and cultural variation in the modification processes.

Duncan (2009) has reviewed the utilitarian value of the study of cranial modification in Mesoamerica. He states that cranial modification has been used by archaeologists and physical anthropologists to understand different aspects of the process, the biological and cultural implications. The most pertinent aspect of past studies in the context of this current project is the use of modification to examine change through time.

> Romano Pacheco (1974) found that tabular erect modifications were the most common in all Pre-Columbian periods in Mexico but that they were most common in the Pre-Classic (ca. 2500-300 BC) and Postclassic (ca. AD 900-1500) periods. Romero Molina (1970) found that tabular varieties seemed to predate annular varieties. The former date to the Early Preclassic (at some 1400-1200 BC) in the Valley of Mexico, while the latter appear in Oaxaca in the Middle Preclassic (after 1200 BC). Vera Tiesler Blos (1998) found considerable temporal and geographic variability in types of cranial modification, but she notes that the tabular oblique style seem to have been less frequent in the Postclassic. Erect forms were more common overall in the highlands, and oblique forms were more common in the southeastern areas in the lowlands [Duncan 2009:179].

These studies of the temporal and geographical distribution of cranial modification types are important here because there are no other skeletal features at Cusirisna Cave that allow us to propose cultural affiliation with groups in Mesoamerica. Perhaps these data can be used in future research in comparing Cusirisna Cave to a larger cultural landscape.

In association with the modified crania were very complex lambdoidal sutures. The complexities of the lambdoidal suture and the numerous wormian bones have been correlated and associated with cranial modification in past research (O'Loughlin 2004; El Najjar and Dawson 1977; Anton *et al.* 1992; van Arsdale 2012). To ascertain a relationship between wormian bones and cranial modification, the sample from Cusirisna Cave can be used in future research.

The last modified bone in the collection is of the right male femur previously mentioned, Fe1, which has circular depressions drilled in the medial condyles of the bone. I have not been able to draw any conclusions from these features, but there are many cases in Mesoamerica in which the femur is an important bone and has significant implications for cultural practice. The importance of femora in funerary practice, industry, and as utilitarian items has been noted in Mesoamerican ritual. Human long bones, especially femora, were modified for use as rattles, awls, punches, and other items (Fitzsimmons 2011; Beck and Sievert 2005; Bloomster 2011).

Artifact analysis

While I was examining the human remains, Dr. Clifford Brown studied the artifacts from Cusirisna Cave. He examined a total of 63 artifacts from the cave as well as one recorded as coming from "Teustepe," the town nearest to the cave. A few of the artifacts could not be conveniently retrieved or were undergoing conservation. For example, the guacal ("gourd") bowls, in which the crania had rested in the cave, were difficult to locate and, once found, were taken to the conservation lab where at our request the conservators, in consultation with Dr. LeBlanc, removed a sample for radiocarbon assay. For logistical reasons, Brown was not able to examine a group of *Oliva* shell "tinklers" from Cusirisna (Catalog Number 78-42-20/15166), nor an object cataloged as an "ornament" (Catalog Number 80-27-20/22640).

The catalog entries were in several cases ambiguous about which artifacts came from Cusirisna Cave. The confusion probably arose as the original museum catalogers in the 1870s attempted to match up the donated artifacts to the descriptions from Flint's correspondence with Director Putnam using object numbers assigned by Flint. Nineteenth century penmanship and quill pens also seem to have played a role. Flint's handwriting was archaic and variable. The reports are sometimes written in a clear hand, but the correspondence, which, as he himself explained, was sometimes penned in haste, is often crabbed and awkward. All the documents occasionally have words or phrases that are illegible. Among the problematic catalog entries, for example, are Objects 80-27-20/22638 to 80-27-20/22640, which are recorded as coming from Cusirisna (spelled "Cicuizma") but they evidently came from the site of Tola on the plain of Rivas, as one can see from the scanned images of the original catalog entries, helpfully posted on the museum's website. Dr. Brown also examined the ceramics from the Copán Caves, as at that time we thought they might be affiliated with the Nicaraguan materials. As we have now discarded that hypothesis because of the dating of the Cusirisna collection, I will not discuss those materials here.

Ceramic artifacts would have been most useful in understanding the dating, cultural affiliation, and perhaps function of the cave, but unfortunately the collection includes no ceramics. Of course, we do not know how Dr. Flint chose the artifacts he collected, and by extension, whether the cave originally contained any pottery. Brown did, however, examined Object Number 78-42-20/15177, a single potsherd which is listed as "From Teustepe," because it is the only pottery fragment with a provenience near the cave (Figure 61). The sherd is a modeled animal head lug from a pottery vessel. It displays gray "graphite" paint over a red-orange slip on nearly fine paste. It looks almost identical to the Segovias Red group defined by Edgar Espinoza in the Segovias highlands of northern Nicaragua (Espinoza Pérez, Fletcher, and Salgado Galeano 1996), perhaps Cacaulí Red-on-orange or Fraile black-on-red type.

Figure 61. 78-42-20/15177, pottery fragment.

The paste is nearly fine but some small temper particles are visible: some clear, some white, some gray. This may be pumice or ground ignimbrite. Some particles are angular, some round. The sherd's surface is well smoothed, and the slip is thin but adherent. The graphite paint is thin and slightly translucent. The slip shows wavy parallel lines from shrinkage during drying or firing. So does the gray paint, which proves it is pre-fire. If applied post-firing, the paint would have filled in these cracks. The colors are:

Slip color Exterior: 2.5 YR 6/8, Light Red

Slip color Interior: 2.5 YR 6/8 Light Red

Paste color: (fresh break): 5 YR 6/6 Reddish yellow

"Graphite" paint: 5N Gray to 4N Dark Gray

The monkey-head lug was applied just below (12.5 mm) a slightly everted rim on the out-curving wall of a bowl. The rim is slightly thickened: 9.5 mm. Below the lug, the wall thickness is 5 mm. The only scientific excavation ever carried out in the Department of Boaco, by Edgar Espinoza, yielded (Espinoza Pérez 1999) Segovias Red-type ceramics, which tends to affirm our identification of this sherd. Ceramic cross-dating between the Segovias Red group in the Segovias region and the Cajón region of central Honduras, specific with the Sulaco group, suggests a Classic period date for the Nicaragua ceramics. Because the Teustepe sherd does not come from Cusirisna Cave, however, it may not be relevant to the osteological remains. It merely hints at a northern (Mesoamerican) rather than a southern (Intermediate Area) cultural affiliation for the region.

The two guacales are fascinating because of their excellent state of preservation and their contexts. They presumably come from either the *Crescentia alata* or the *Crescentia cujete* tree, which are usually called calabash trees in English but should not be confused with the squashes or gourds (*Cucurbita* spp.) that are also called calabashes. In Nicaragua, the tree is called the *jícaro*, the fruit, *jícara*, and the bowl formed by bisecting the fruit, *guacal*. The *jícaro* is extremely common in Pacific and highland Nicaragua today, but some have argued that their modern distribution has been heavily influenced by the historical introduction of large herbivores such as cattle and horses (Janzen and Martin 1982). However, this environmental reconstruction, while influential (Guimarães *et al.* 2008) is partly conjectural and controversial (Howe 1985). Flint mentions the placement of crania within the bowls, some covered with a second bowl to cover the cranium. This demonstrates that the burials were secondary and that the crania were removed from the rest of the body and treated differently. Flint noted that one of the guacal bowls, No. 559, housed the female cranium, Cr1 (Flint 1879:11). The association between the guacales and the crania immediately calls to mind the episode in the *Popol Vuh* in which One Death and Seven Death, lords of Xibalba, the underworld, hang the head of One Hunahpu in a calabash tree, which for the first time bears fruit.

Beads are by far the most common artifacts in the collection. Fifty-four greenstone beads are currently strung together, but we do not know whether they were found as a group or picked up separately (Figure 62). The largest beads are tubular, but most are disk-shaped. A few of the beads may be true jade, but most are probably serpentine or other minerals. One long (ca. 85 mm) tubular bead was made of *Spondylus* shell (Figure 63). Two smaller tubular beads were fabricated from white or cream-colored shell (Figure 64). A whole, small cowry shell and a white chert biface are relatively uninformative elements in the collection (Figures 65 and 66).

Figure 62. 79-72-20/19916, string of greenstone beads.

Figure 63. 80-27-20/22637, *Spondylus* shell bead.

Figure 64. 79-72-20/19915, cream colored shell beads.

Figure 65. 79-72-20/19917, cowry shell bead.

Figure 66. 78-72-20/15165, white chert biface.

A miniature (or diminutive) jade earflare (Object Number 80-27-20/22639) is more interesting. It is a type known from the Classic period in the Maya area (Taube and Ishihara-Brito 2012: 260-265): it has a central depression surrounding the main perforation and a corresponding bulge on the back, as well as a smaller hole offset from the center. Jade earflares are found in many parts of Mesoamerica from Olmec times onward, and therefore it is difficult to ascertain with certainty whether this specific type is distinctly Classic Maya, but the predominance of evidence suggests it is.

Figure 67. 80-27-20/22639, jade earflare.

Arguably, the most charismatic artifact in the collection is a wooden *duho*, or stool (Object Number 79-72-20/19910), which he describes in his report as follows:

> Wooden stool, as perfect as when it was made—the only specimen in wood I ever saw in a residence of here of over 28 years. At the time of the conquest mention was made of them, at El Viejo—used by the chiefs for a seat of state in the day and as a pillow at night—called "Duho". In 1875, sent one made of stone supporting an Idol—both of one block—to the Smithsonian—another similar one was forwarded by Captain Branch—to same place but not delivered. It was 7 in high, including Idol, beautifully made—description was received by Prof. Baird. The stool shows marks of the tool used in its cutting—material resembles the ordinary rosewood—still found here—feet project toward the end, giving the seat, at the point requiring the greatest resistance—and also avoid tilting—feet 2 ¾ inches long and 1 ½ thick—point 1 ¾ wide 1 thick. Seat 11 ½ inches long, ends 5 1/8 in wide centre 5 ½. Thickness ½ inch—depression of curve at centre 7/8 of an inch—upper surface well polished [Flint 1879:11-12].

Dr. Brown described the artifact in similar terms. The stool is 4-legged with a concave seat, carved out of a single piece of wood without joinery (Figure 68). The bottom, particularly between the legs of the object, is more roughly worked than the seat, which is smooth (Figure 69). He observed fine incisions on the upper surface of the seat, which he described as follows:

> At one end of the seat, 3 incised lines cross the short axis of the upper surface, creating three zones with the edge of the seat forming the border of the final zone. The first line is 22 mm from the edge, the second is ~14.23 mm from the first, and the third is 13.46 mm from the first, but they are neither truly straight nor parallel. At the other end, there are four very fine incised lines that cross the short axis of the upper surface of the seat. The first is 9.37 mm from the edge, the next is ~6 mm further in, the third is ~11.67 mm further in, and the fourth is 10.5 - 11 mm further in. Between the first and second lines appear faint, diagonal, parallel incised lines forming a hatching pattern. Only 5 lines are still visible. The others may have eroded. Between the third and fourth lines are faint traces of a twisted meander or guilloche design similar to that on a Castillo Engraved vessel from the Smithsonian (Cat. A022386). For another example of a similar design, see Object Number 80-27-20/22607 from the Peabody catalog. See also Healy (1980) Figures 31 and 32. See also designs carved on some Nacascolo-type metates.) All of these things are Middle Polychrome (ca. A.D. 900-1200). At the other end of the duho, there is a series of adjacent triangles incised between the parallel lines. I can see two sets of three adjacent triangles, one toward each edge, but it is possible that it was a continuous band of triangles that has eroded. All these designs are very faint and difficult to see. Similar triangles also appear on incised pottery from Nicaragua [Clifford Brown, personal communication, 2012].

Figure 68. 79-72-20/19910, wooden duho.

Figure 69. 79-72-20/19910, wooden duho, inferior view.

The *duho* is perhaps the most useful artifact from Cusirisna Cave for understanding cultural affiliation. These types of seats were often used for chiefs with a pillow placed on the upper smoother surface. Saville (1910) mentions the Cusirisna Cave *duho* in comparison to fifty-two similar objects of variable material (wood, stone, clay) covering locations “extending southward of Florida, and to the Bahama Islands in the West Indies, across the northern part of South America, and northward into Central America as far as Honduras, as well as down the west coast of South America to Peru” (Saville 1910:104). Saville continues to elaborate on Flint’s description of the *duho* from Cusirisna Cave. “This is the only specimen of an ancient wooden stool which have ever seen from Central America, and it is not like the type of seat now used in the southern part of the Republic of Panama, but in every way resembles an ordinary metate of the four-legged class. Curiously enough, the common type of stone seat (metate) from Nicaragua is of the three-legged class” (Saville 1910: 118). Curet (1996) mentions the religious use of *duhos* in Puerto Rico and Hispaniola (Rouse 1992:119-121). With specific reference to *duhos* found in the Caribbean, Curet states that “*duhos* (stool) used only by the chiefs in religious ceremonies, and related to their position, are another kind of artifact present only in the Chican Ostionoid subseries and which also emphasize the supernatural source of chiefly power (Fernandez de Oviedo 1959:117,145)” (Curet 1996:126-127). The Chican Ostionoid period is defined as A.D. 1200-1500 (1996:114). Recent investigations have shown that duhos have not only a broad, circum-Caribbean distribution, but great time depth as well (Ostapkowicz *et al.* 2011a, 2011b).

Fortunately, at least three other wooden duhos have been found in Nicaragua. They are on display at the Museo de Arte Indígena Imabite at the archaeological site of Leon Viejo, Department of Leon. Their provenience is listed as “Isla Rosa,” presumably a nearby archaeological site, and their date is given as “Periodo Ometepe, 1350-1550 D.C.” They are similar in size to the Cusirisna example. Two of them have four rectangular legs, like the Cusirisna one, but the third Imabite stool has solid supports on the long sides, making it look more like a low bench. One of the Imabite artifacts has elaborate woven mat or guilloche designs deeply engraved on the lateral ends of the seat, in the same locations as the fine incisions on the Cusirisna. As I will show below, the Cusirisna duho probably also dates from the Ometepe period, and so the similarities among the duhos is probably not accidental.

The analysis of the artifacts allows for the interpretation that the burials are elite or are of at least elite association. The duho is essentially a throne and points towards elite personages. The jade earflare is also an uncommon and prestigious artifact. Jade beads, greenstone beads, Oliva shell tinklers, and a Spondylus shell bed are also relatively high-class items. The guacales are ordinary in themselves; however they were used as receptacles for the crania, which makes their function special.

Original documentation

Transcription of Dr. Flint's fieldnotes and correspondences with the Harvard Peabody Museum proved to be useful in understanding the context of the cave, and provided additional details about the proveniences of some objects. Dr. Flint, as a medical doctor, had extensive knowledge of the human body and correctly assessed much of the skeletal material, and even took his own measurements, which he assembled into tables in his report. He estimated sex and noted pathologies and anomalies. Dr. Flint also described associations among some of the remains, referring to his own catalog numbers which are sometimes still visible on the objects. His notes have also been crucial in understanding the practice of cave burial. Details such as the crania being placed vertex down, within gourd bowls with cotton, are important in this bioarchaeological analysis because they help us to reconstruct the funerary practices and interpret meaning.

While we gained valuable insight in the layout of the skeletal material in the cave, we cannot by any means fully reconstruct the spatial organization of the assemblage. Apparently, the bones were stacked and commingled, and were not mapped or photographed in situ. He does state that the cave was visited seventeen years earlier by a local priest who threw some of the bones into the adjacent ravine.

Radiocarbon dating

To help evaluate the cultural affiliation of the Cusirisna collection, I radiocarbon dated a small organic sample taken from one of the guacales by the conservators at the Peabody Museum under the supervision of Dr. LeBlanc (Figures 70 – 72). The 31 mg sample was assayed by Beta Analytic using the AMS technique. In additional to the standard pretreatment, we requested special solvent extraction designed to eliminate various kinds of chemical contamination because older museum collections were often fumigated. Though we had no specific information indicating that the artifact was fumigated, we requested the special solvent extraction out of an abundance of caution. Beta Analytic reported that our sample resulted in a conventional radiocarbon age of 430 bp ± 30 (Beta-315973; plant material; δ13C = -22.5 o/oo).

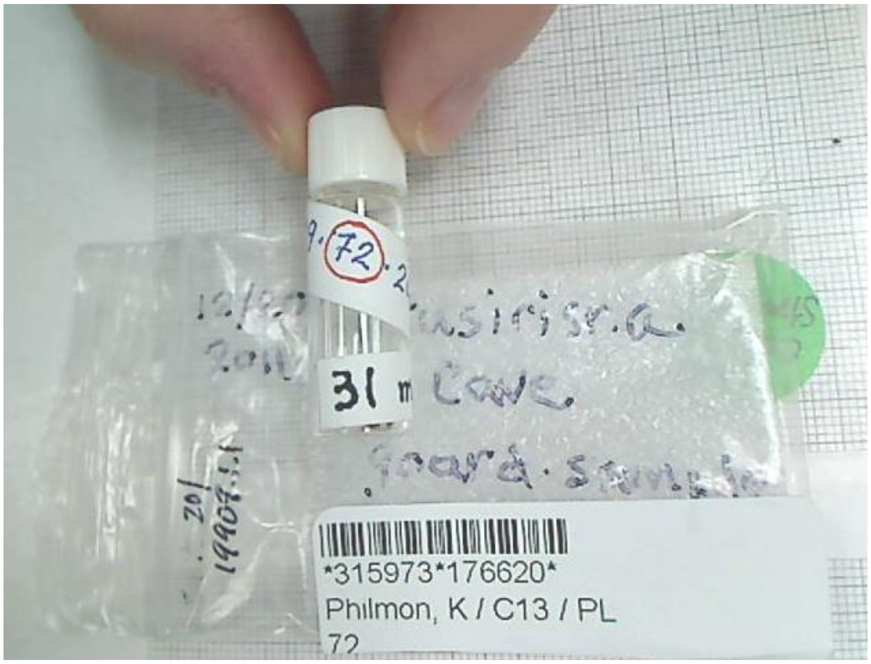

Figure 70. Gourd bowl sample.

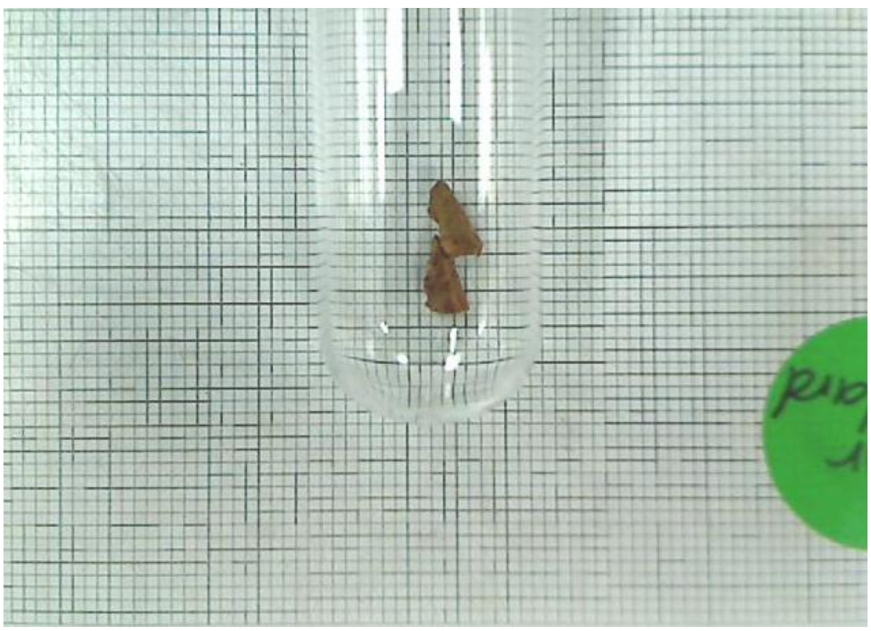

Figure 71. Gourd bowl sample.

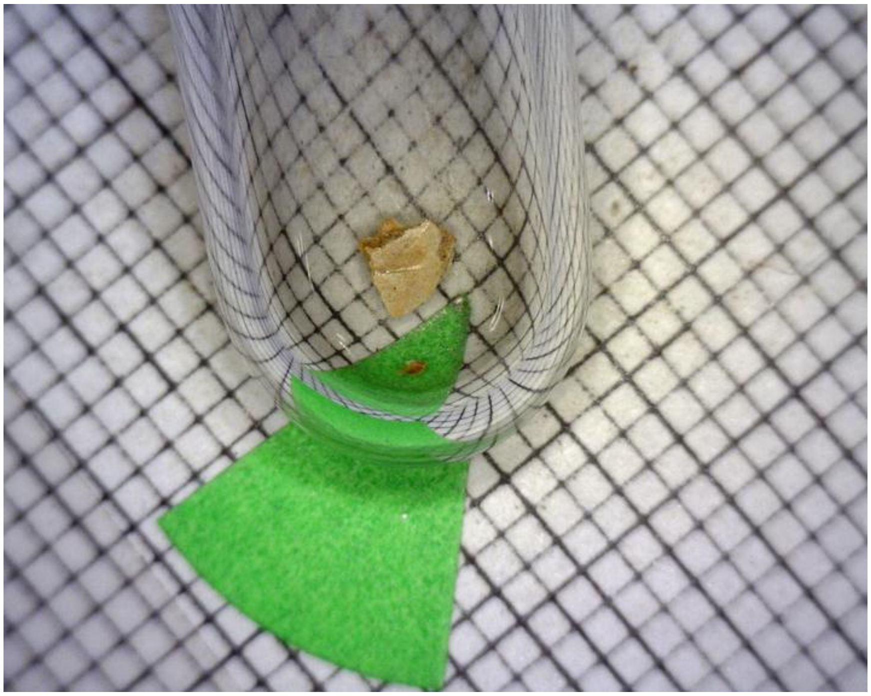

Figure 72. Gourd bowl sample.

Beta Analytic used a wiggle-matching algorithm and the INTCAL09 dataset to calibrate our sample's date (Heaton *et al.* 2009; Stuiver *et al*. 1993; Oeschger *et al*. 1975; Talma and Vogel 1993). The calibrated intercept is cal A.D. 1450 with a 2-sigma calibrated interval (95% probability) of Cal AD 1430 to 1483 (Cal BP 520 to 470), and a 1-sigma calibrated interval (68% probability) of Cal AD 1440 to 1450 (Cal BP 510 to 500) (Figure 73). The 1-sigma interval is unusually narrow because the slope of the calibration curve is especially steep in that period.

In addition to the calibration conducted by Beta Analytic, we conducted our own calibration using the OxCal program and the same database, INTCAL09 (Figure 74). The results were similar but slightly less precise.

Taken as a whole, the weight of evidence suggests a date for the guacal close to A.D. 1450, contemporaneous with the Maya Late Postclassic period and more generally the Aztec culture in Mesoamerica, much later than we originally anticipated. This date is still important for understanding the history of Mesoamerica, Nicaragua, and specifically the Department of Boaca during this period.

I would like to emphasize that this is one date of one object, and does not necessarily provide all encompassing information but rather one single point in time of an artifact that was placed in the cave. This does not necessarily represent the chronology of the site because it is certainly possible that the cave was utilized over a long period. By itself, the fine preservation of the guacales suggests they might be late additions to the assemblage, although Flint describes the skulls as being hidden deeply in depths of the cave, which implies a stratigraphically early position. There are a number of factors that need to be considered when interpreting the results from the radiocarbon date and the implications the date has when interpreting the activity within the cave.

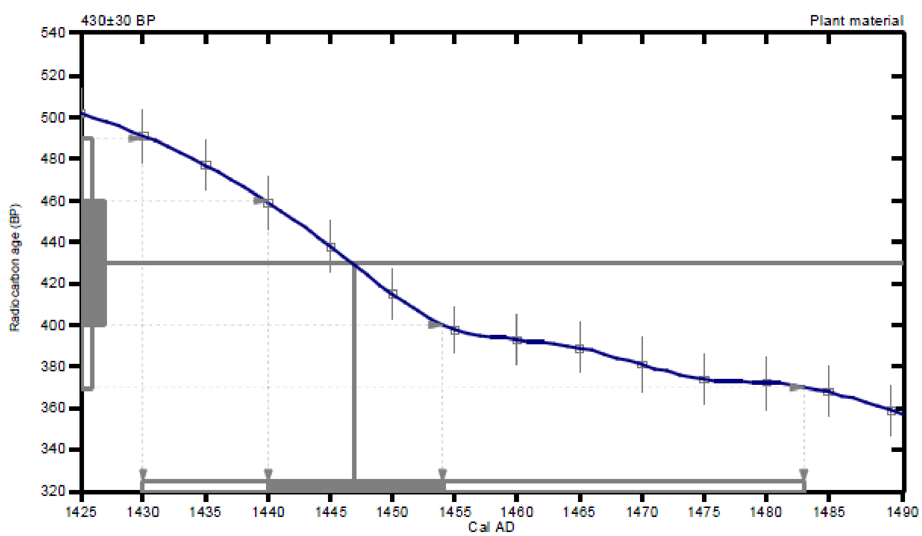

Figure 73. Calibration of radiocarbon age to calendar years, Beta Analytic, February 27th, 2012.

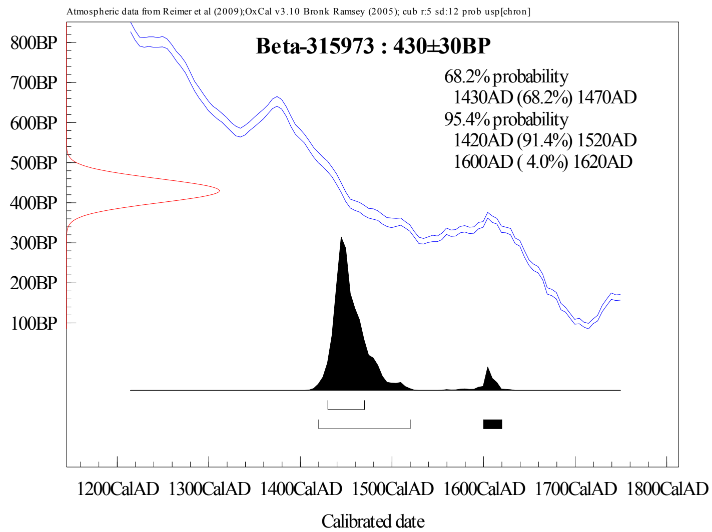

Figure 74. Calibration of radiocarbon years to calendar years, OxCal, February 29th 2012.

The combination of data obtained through osteological analysis, examination of the artifacts, and radiocarbon dating has resulted in a number of plausible conclusions. The following chapter will situate some of these conclusions with respect to the direct findings from Cusirisna Cave and apply them to the larger landscape of ritual in Mesoamerica.

COMPARISON TO OTHER SITES

The osteological sample from Cusirisna Cave is small in comparison to those from some other mortuary sites, representing only approximately nine individuals, but it nonetheless can be, and should be, compared to other funerary traditions in Mesoamerica and Central America. The primary difficulty is deciding which comparisons are valid and instructive because there are many interesting possible ones. Costa Rica, for example, shares archaeological cultures with southern Nicaragua, but mortuary caves seem to be rare and in general preservation of human remains is not good (Nagy 2008). More generally, much of Nicaragua shares some cultural traits with the Circum-Caribbean culture area, including the use of duhos, for example. Looking north and west toward Mesoamerica also seems appropriate given the close cultural affiliation with that culture area during the later centuries of Nicaraguan prehistory. In the fourteenth and fifteenth centuries, Pacific Nicaragua was occupied by immigrants from Mesoamerica, including the Chorotega, the Maribio, and the Nahua. The Chorotega were speakers of an Otomanguean language closely allied to Chiapanec. The former are thought to have immigrated from Cholula in the modern Mexican state of Puebla to Nicaragua during the Epiclassic period (ca. A.D. 650-850) under pressure from the Olmeca-Xicalanca people. These facts suggest at least two potential apt comparisons: to the Chiapanec region of central Chiapas and to Mixteca-Puebla region of central and southern Mexico. The

Maribio spoke another Otomaguean langauge, one related to Tlapanec in Guerrero and Oaxaca, which suggests we could expand the latter comparison geographically to include at least part of Guerrero as well as western Oaxaca. There is considerable uncertainty about when the Nahua moved into Guatemala, El Salvador, and Nicaragua, but they had certainly arrived by the date provided by our radiocarbon assay. A Nahua connection opens the door to comparisons with, obviously, the Aztecs of central Mexico as well as with their Nahua and Pipil cousins elsewhere in northern Central America. Northern and western Nicaragua share archaeological culture traits with adjacent parts of Honduras and El Salvador, which suggests the potential for fruitful comparisons with those regions. Finally, the nearby Maya area also offers a reasonable comparison if only because of its geographic proximity. A review of cave use and mortuary practices in all these areas would be an enormous undertaking that is well beyond the scope of this thesis. I therefore limited myself to two comparisons, one to the Formative Honduran caves and a second to the Maya area.

Therefore, I started by comparing Cusirisna to the three Formative period mortuary caves in Honduras because my original research proposal focused on the comparison of the Honduran mortuary complex with its roots in the Olmec and Tlatilco cultures. In order to do so, I took a bioarchaeological approach to gain insight to cave activity and function by examining variability in cave type, artifacts, and osteological material (Healy 2007:258). To summarize briefly, the remains deposited within Cusirisna Cave represent young to old adult males, with few female elements. Most of the individuals were in good general health, as reflected by lack of serious pathology (besides moderate arthritis and caries, which are expected). There is high incidence of trauma within the sample, consistent with perimortem blunt force trauma, as well as evidence of antemortem healed fractures and wounds. Also present within this sample is cranial modification exhibited in five male crania of the eight total crania. For comparison with other sites, we used these baseline data and looked for similarities and differences in the Honduran mortuary complex and other sites. I performed a meticulous comparison of the Cusirisna materials with the Honduran ones, and I concluded that they were not culturally affiliated. Then I received the results of the radiocarbon dating, which revealed that Cusirisna was not contemporaneous with the Honduran Formative period. While it was gratifying to have reached the correct conclusion, it would have been more fruitful to have expended the same effort making a more relevant comparative analysis. I deleted the comparison from this document but the details are available upon request. I next looked to the Maya area for comparable assemblages.

As this experience highlights, one of the key issues in comparing cave sites in Mesoamerica is the lack of dated sites. McNatt (1996) has noted the technical problems of dating cave sites (e.g. lack of stratigraphy, obstruction of artifact analysis by calcite deposits) as well as practical difficulties (e.g. radiocarbon dating is expensive, and expertise in ceramic chronology is necessary for dating a site through pottery style). Even though dating cave sites and understanding their chronology is a most important factor, it is often difficult given the location, cave conditions, available material, and cost.

Another issue with comparing sites is a lack of clarity in site reports with reference with skeletal data. For example, human remains, representing about 200 individuals, have been reported from at least 23 caves in Belize (McNatt 1996:87). In a discussion on elite status cave burials in Belize, three caves have been described as containing "flattened skulls." "One of these contained 26 burials of which at least one had a flattened skull but no grave goods. A second cave held six individuals, three of whom had flattened skulls, but again no associated grave goods. In the third cave, which contained an estimated 40 burials, a minimum of five had flattened skulls" (McNatt: 1996:88). It would be useful to compare these sites to Cusirisna Cave, but in the absence of more detailed information, including dates, I cannot. More generally, it is useful to situate Cusirisna Cave within the two primary cultural traditions in Nicaragua: the Nicoya and Paya.

The Nicoya tradition, 3600 – 500 BP, is located on the Pacific coast of Nicaragua and Costa Rica. Two major sites with skeletal material have been identified: the El Rayo site and Los Angeles cemetery. El Rayo contained a few burials but did not demonstrate any individual identifying data, other than a large proportion of subadults and adult females (Wilke 2011; McCafferty *et al*. 2011). The remains were in subsurface burials, and excavation was not possible in many scenarios because the fragility of the remains. While the osteological analysis did not provide specific details concerning individual identity, the burials have been incredibly useful in understanding regional mortuary practice and the use of burial urns. This site is similar in time (both are Late Postclassic) and are in proximity to Cusirisna Cave, but there are no other indicators of cultural similarity. Another site with skeletal remains is the Los Angeles cemetery located in Rivas on Ometepe Island (Haberland 1986, 1992). This is the largest burial site in

Nicaragua with 59 primary burials. There were very few grave offerings, which seems typical of the Nicoya tradition. The position of the mostly adult burial site showed that the individuals were buried face down (Peregrine and Ember 2001:336). There may have been cranial modification of some of the remains.

The second tradition in this region is the Paya, 1500 – 500 BP, which is located in northeastern Honduras and eastern Nicaragua. Diagnostic material for this cultural tradition includes polychrome ceramics, red and black on orange, as well as chipped T-shaped axes (Peregrine and Ember 2001:351). Although no skeletal analyses have been conducted in this area, it has been suggested that because of the settlement's defensive nature, conflict may have been a large aspect of political life (Peregrine and Ember 2001:352). There are no known sites within this region that have been excavated or explored outside of what has already been mentioned. We have no diagnostic ceramics or other artifacts that would directly associate Cusirisna Cave with this tradition, but it does seem likely that this should be explored in the future when there is more archaeological data.

Cultural comparison between Postclassic Maya and Cusirisna Cave

Once we received the radiocarbon date, we shifted the focus of our review from the Middle Formative material in Honduras to Postclassic period sites contemporaneous with Cusirisna. These included the burials and osteological material associated with Iximche, Mixco Viejo, Utatlan, and Zaculeu, all in Guatemala, as well as a collective study on may osteological sites from the Yucatán Peninsula.

Márquez and del Ángel (1997) examined the height of Preclassic, Classic, Postclassic, and modern Maya tibiae and femora from the Yucatán Peninsula, and here we would like to compare their data to the Cusirisna Cave stature results. Their stature data provided an excellent source for comparison and we can examine the differences in number, mean, standard variation, and variance. Márquez and del Ángel demonstrated that both bone length and stature of males and females throughout the periods showed differences, and "through these differences, we can observe a trend toward stature reduction after the Preclassic Period" (1997:57). Through stature estimation of the tibiae, Márquez and del Ángel found an "average height of 164.35 cm for Preclassic males; 162.06 cm for Classic male; 161.51 for Postclassic males; and 160.03 cm for present-day males. For women, the average values obtained from femur length are 148.52 for the Preclassic, 148.14 cm for the Classic, 146.10 cm for the Postclassic, and 148.49 for the present" (1997:57). The following tables demonstrate our stature estimations of the Cusirisna Cave sample in direct comparison to the Postclassic Maya skeletons from the 1997 study, which clearly shows a much taller group of individuals (Tables 20 – 25). The average stature obtained from Cusirisna Cave for male femora was 168.88 cm, and 170.06 cm for male tibiae. Though our sample of females is small, the stature estimates are 152.39 cm for female femora, and 156.32 cm for female tibiae. These averages from Cusirisna Cave are higher than those obtained for even the tallest Mayan sample in the 1997 study from the Preclassic period.

In the following statistics tables, we compare the available data from Marquez and del Ángel's 1997 study, specifically the Postclassic data, to the measurements and stature estimations of the Cusirisna Cave individuals. In our study, each bone was evaluated as an individual; there were no discernible pairs that would indicate they were of the same individual. Due to the nature of our data and available comparable data, we were limited to *z* and *t* tests. We lack a total data set on the Postclassic Maya because the authors only published summary statistics. The *t*-tests are parametric tests that assume height and stature are usually normally distributed, but we cannot test for normality because of our small samples. However, human stature tends to be normally distributed in populations (Hirchhorn *et al.* 2001) and so the use of the *t* statistic is reasonable under the circumstances. The following tables present the results of the two sample t-tests (Madrigal 1998).

Table 20. Descriptive statistics, maximum long bone length. Postclassic Maya data from Márquez and del Ángel (1997).

	Postclassic Maya Skeletons				Cusirisna Cave				Two sample *t* test		
	n	Mean	sd	var	n	Mean	sd	var	2-sample *t*	*df*	*p* (2-tailed)
Males											
Femur	29	42.87	2.51	6.3001	4	44.28	1.53	2.3409	-1.062053	31	0.2964158
Tibia	25	35.88	2.28	5.1984	8	37.68	1.36	1.8496	-2.0506517	31	0.0488363
Humerus	22	30.65	1.52	2.3104	6	30.62	1.25	1.5625	0.04280593	26	0.9661833
Ulna	19	26.33	1.61	2.5921	2	28.08	0.67	0.4489	-1.4490104	19	0.1636391
Females											
Femur	11	38.2	1.48	2.1904	1	38.7	0	0	-0.3084023	10	0.7641048
Tibia	5	32.02	2.47	6.1009	2	33.13	0.95	0.9025	-0.5219079	5	0.6240216
Humerus	13	27.02	1.09	1.1881	0						
Ulna	17	22.99	1.08	1.1664	0						

Table 21. Descriptive statistics, stature estimations. Postclassic Maya data from Márquez and del Ángel (1997).

	Postclassic Maya Skeletons				Cusirisna Cave				Two sample *t* test		
	n	Mean	sd	var	n	Mean	sd	var	2-sample *t*	*df*	*p* (2-tailed)
Males											
Femur	29	160.85	5.67	32.1489	4	168.88	3.46	11.9716	-2.6773803	31	0.0117563
Tibia	25	161.51	4.47	19.9809	8	170.06	2.66	7.0756	-4.9695594	31	2.344E-05
Females											
Femur	11	146.1	3.84	14.7456	1	152.39	0	0	-1.4953016	10	0.1657087
Tibia	5	148.38	6.72	45.1584	2	156.32	2.6	6.76	-1.3717477	5	0.228493

The *t*-tests show that the differences among the two sets of bone lengths are generally not significant, with only one marginal exception (the male tibiae). In contrast, the differences in estimated stature are significant for males. Even though the sample sizes are modest, the magnitude of the differences in the means and modest degree of variance lead to statistically significant differences. The differences are not significant for the females. The lack of significance for the females clearly seems due to the small sample sizes ($n = 1$ and $n = 2$ for Cusirisna females) rather than because of the magnitudes of the differences between the mean stature estimates.

Márquez and del Ángel discuss possible reasons for their observations in the decline in stature over the different periods, suggesting that "possible causes of stature change include the process of biological adaptation to the environment change of activities, dietary variations, population fluctuations, and excessive work burdens" (1997:60). They continue to explain that "these circumstances may have led to selection of those individuals whose smaller sized bodies allowed them to survive with a smaller quantity of nutrients until they reached the age of reproduction" (1997:60). It is most likely that there are multiple factors and variables at work here, and not one single explanation can be used to understand stature change. It is also likely that the complexity of health and socioeconomics have a role in explaining the increased stature of the individuals at Cusirisna Cave. These results could indicate that those buried within Cusirisna Cave were of better health, and provides support for an interpretation that they were of elite status. This complexity needs to be further explained, and perhaps dietary and DNA studies will aid in understanding the discrepancy between this particular sample and other archeological populations.

In addition to examining the potential for relationships through skeletal similarities, we also examined potential cultural associations with nearby sites. Iximche was the capital of the Cakchiquel kingdom in the Late Postclassic period. It has provided evidence of human sacrifice, decapitation, and burials beneath houses and palace platforms. Some of the human bones were modified to make musical instruments (flutes and multiply-notched rasper bones) and jewelry (a bracelet made from an occipital bone) (Guillemin 1967). One individual with mortal cranial damage was noted in Burial 27-A, which contained extravagant grave goods. Guillemin interpreted this as possibly the son of one of the founders of Iximche who had been killed in battle (Guillemin 1967:33). Metcalfe (2005) speaks to evidence for interpersonal violence through evidence from the skulls and cervical vertebrae. “Out of 69 total burials, at least 29 (and possibly 50) decapitations were identified, which were presumed to be sacrificed prisoners of war or captive non-combatants. Lesions, fractures, puncture wounds, and perimortem cuts provide further evidence of violence” (Metcalfe 2005:65). There is no evidence of Spanish metal weapons; all damage appears to have been inflicted by stone weapons (Metcalfe 2005). Nance *et al*. (2003) have written extensively on the burials from Iximche. While this site shares evidence of violence and conflict with Cusirisna Cave, they are very different. For example, males and females were both present at Iximche while females were rare at Cusirisna, and the human remains from Iximche were buried, not placed on the surface of a funerary cave.

Mixco Viejo, another Postclassic site located in Guatemala, has three associated caves, two of which were artificially modified (Brady and Veni 1992). The three caves are Cueva de la Lola, Cueva del Murcielago, and Cueva de la Campana. Cueva del Murcielago contained the skeleton of a chicken, which Brady and Veni interpreted as evidence of modern ceremonial use. Found inside Cueva de la Campana “were a large number of bones from small animals which had apparently been sacrificed” (Brady and Veni 1992:154). There is no mention of human sacrifice at these cave sites, nor presence of human skeletal remains. Thus, they will not be useful in understanding Cusirisna Cave.

Utatlan, the Quiche Maya capital in Guatemala, also has artificial or man-made caves present. Though there are no human remains present within the caves, they had ceremonial functions and were associated with the larger site spatial organization (Brady 1991). I reviewed the literature for this site, but did not find data concerning burials or skeletal remains that would be useful in understanding Cusirisna Cave.

Zaculeu, the ancient Mam capital near Huehuetenango, Guatemala, provides another contemporaneous site for comparison to Cusirisna Cave. There were 108 total burials of various type of at least 249 individuals at Zaculeu, including one tomb, vaults, crypts, cists, urns, cremations, and “elementary” catchall type burials (Trik 1953). T. D. Stewart (1953) conducted skeletal analyses on the remains recovered from the burials which were situated beneath ceremonial structures. The demographic profile included males and females, adults and children. “Of the 249 skeletons included in the analysis approximately 45 percent were males, 15 percent females and 40 percent undetermined. Distribution of the age groups ranged from newborn to old, 75 percent being adults, 20 percent children, and 5 percent undetermined” (Trik 1953:79). Trik suggests that the representation of males and females of mixed ages indicates that the ceremonial center was not a place for members of the priesthood or for particular political rulers. “That it may perhaps be a special population is indicated by the obvious reversal of in the normal Indian mortality pattern: namely, the scarcity of newborns and preponderance of adult males. Whether or not, on the other hand, these remains represent sacrificial victims could not be determined in the laboratory. Had it been possible for me to examine the skeletons *in situ*, possibly I could have learned more” (Stewart 1953:295). Even though

Stuart was not able to study the materials in their original contexts he was able to infer some cultural information based on cranial and dental modification. Crania were modified in the same manner as those at Cusirisna Cave, resulting in the fronto-vertico-occipito type (Stewart 1953). Stewart's Table 11 (306-307) records his observations of variation in cranial modification types, where the fronto-vertico-occipito type becomes more frequent during the later Qankyak Phase. There are also numerous examples of dental modification, representing several filing styles. Examples of the cranial and dental modification published in Woodbury and Trik (1953:453-463) confirm the similarity to the cranial modification type observed at Cusirisna Cave (i.e parietal expansion, occipital flattening and verticality of the vault). There is no mention of trauma in the remains from Zaculeu. However, Trik (1953) notes that human sacrifice might explain the numerous individuals buried concurrently, which would not likely be explained by coincidental deaths at the same time. "The simultaneous natural death of all seven in time for the elaborate funeral rites seems improbable, and it may well be that they were of one family or closely related group, and had been sacrificed on the occasion of the death of the leading member" (Trik 1953:80). This interpretation (of sacrifice) has subsequently been challenged, however, in favor of the idea that the tomb was reused (Weiss-Krejci 2003).

Several other Maya caves are worthy of mention: Huxjal, Lacandon, and Moxviquil Caves. Scott and Brady (2005:265) mention that Huxjal, Moxviquil, San Felipe, and Lake Lacandon are similar in that they contain secondary burials with human remains present on the surface of the floor. Blom (1954) discussed numerous caves that contained skeletal material and artifacts, noting cranial modification. The first cave, Huxjal, is located in Chiapas, Mexico on the western shore of Lake Tepancuapan (Blom 1954). "Bones and skulls were piled helter skelter and the one thing which was quite plain was that the skulls showed artificial deformation" (Blom 1954:124). Blom does not explicitly assign crania modification types, but draws two types, *a* and *b*, which can be vaguely divided as tabular and annular. The crania from Huxjal are of the *a* type, which appears tabular. Another cave has similar cranial modification, Moxviquil, Cave on the northern rim of the valley of San Cristobal de las Casas. Here again, the bones were laid on the surface of the floor loosely. In an attempt at relating the caves to one another, Blom states "the skulls found at Huxjal are of type a as are also the two skulls from the Moxviquil cave whether this has any ethnic significance or expresses customs prevalent centuries apart, I am unable to say" (1954:131). Blom went on to describe the Lake Lacandon Caves which also contained human skeletal material arbitrarily placed within the cavern. He commented on the action of dripping water and lime, which fused many of the bones together. "This would have made a fine museum exhibit but unfortunately the block was too bulky and too heavy to transported on muleback, so we left it under an overhanging cliff at the entrance to the cave" (Blom 1954:132). Blom states that the type of cranial modification present at Lake Lacandon is *a*, and he provided photos of three modified crania in his Figure 12, which confirm that type *a* does indeed equate to the tabular type, characterized by extreme parietal expansion. Artifacts included seven spindle whorls, turtle carapaces, and crude bits of broken pots. As I found in the Cusirisna Cave collection, Blom noted that teeth were rare, especially modified ones:

> This might be the place to remark that ossuaries and secondary burials are a constant annoyance to the archaeologist who will be looking in vain for

> filed and inlaid incisor teeth. At times canines still stick to their sockets, but the much sought after incisors are absent. Whether this is because they were lost when the skulls were exhumated to be moved to the ossuaries, or whether the undertakers and medicine men or the brujos (witch doctors) appropriated them to sell for medicinal or magical uses, it is impossible to say. Search as you may for mutilated or inlaid incisors it will be a rare occasion if you find one [Blom 1954:133].

Although there are thousands of Maya archaeological sites and millions of caves in the Maya area, the number of Postclassic sites with mortuary caves is small. Or, more accurately, only a small number of Postclassic period sites have funerary caves that have been identified, investigated, and reported. One of them is Mayapán, in Yucatán, Mexico (Brown 2005). Many of the caves within the site have small quantities of human remains, but a true ossuary containing a large number of individuals was recently discovered in a cave-like cenote outside the city wall (Tiesler 2005). The human remains were immersed in shallow water. The skeletons represent both male and female adults, while children are absent. A significant proportion of the crania exhibit cradle-board modification of the tabular erect variety.

The Maya cultural region has not produced cave assemblages that closely resemble the one from Cusirisna, nor are there many that are contemporaneous. It seems likely that fruitful comparisons might be made to Aztec, Mixtec, or Zapotec funerary caves, and I will explore them in the future. Similarly, I will explore parallels with funerary practices in the Circum-Caribbean area, if only because the duho is an artifact characteristic of that area. The historian Herrera (1728) described Taino funerary practices on Hispañola as follows:

> Quando moría un Cazíque, le abrían, y desecavan al fuego, para que se conservasse entero, y le enterravan en alguna cueva, o parte hueca, adonde

> le ponían, pan, vino, y sus armas, y de las mugeres que tenía, la que quería mostrar que le avía amado mas, se encerrava con el, y allí moría, y algunas vezes eran dos. De la gente del pueblo solamente guardavan la cabéça de los que morían [Herrera, 1728, Tomo 1, Década I, Libro III, Capítulo III, p. 56].
>
> [When a chief died, they opened him and dried him over a fire so that he would be conserved whole, and they buried him in a cave or hole, where they placed bread, wine, and his arms, and of his women, she who wished to show that she had loved him the most was shut in with him and there died, and sometimes there were two [women]. Of the townspeople, only the head was kept of those who died….]

This description is intriguing in light of our findings at Cusirisna.

Next, I turn to the function and meaning of Cusirisna cave and its archaeological assemblage. What can be said about ritualistic function in context of this atypical volcanic cave, taking into account its demographic profile, location, and artifacts? We pose several scenarios that explore the possibility that the cave served as a place for sacrificial or war victims, witches, elites, or ballplayers.

INTERPRETATIONS

In order to say something meaningful about cave function, all elements of the cave, its location, associated artifacts, and the context of the skeletal remains, need to contribute to the explanation. Scott and Brady (2005) discuss potential explanations for individual cave burial scenarios (elite or non-elite burial), ossuaries, rockshelter cemeteries/ ossuaries, and special deposits. "The physical removal of the dead from the community and the living to places such as caves, also deemed as sacred places in the landscape, separated the individual from their social positions within the community – either emphasizing their importance, or removing them all together and negating their position" (Lucero and Gibbs 2007:68). This chapter will suggest several possible interpretations of Cusirisna Cave unrelated to the earlier Honduran mortuary complex, which now appears irrelevant. We have devised several hypotheses for the function of Cusirisna Cave as a place for skeletal remains and artifacts based on context and the demographic profile.

It seems that something can be said concerning the use of caves and rockshelters by elites and nonelites. Caves have been found to be more commonly used for religious practices by the elite, and rockshelters are more commonly employed by those who "do not have enough economic resources to build sumptuous tombs that could be used for the same ritual purposes" (Glassman and Bonor Villarejo 2005:293). Cusirisna Cave is not a rockshelter, and some of the artifacts suggest an association with elite status burials.

Social Status

I found a high proportion of young to old adult males in generally good health. These are secondary burials: all skeletal material was left on the surface of the cave except for the mummified remains that Flint noted. The crania were treated differently, placed away from the postcranial material and protected in gourd bowls (a practice we have not found elsewhere in the literature concerning funerary caves). Cusirisna Cave was not a mass burial; these select individuals were intentionally interred. The small size of the number of individuals is significant in itself as this might demonstrates a practice that would appear to be outside of the norm for other individuals in this locale. However, the complete number of individuals buried in the cave is unknown, as only a few may have been selected by Flint to send to the Peabody (Flint did note that there were "cartloads of ribs" which would indicate that there were quite a few individuals). These facts, in combination with the artifacts, contribute to the interpretation of the cave as an elite burial place. Here we explore possibilities of burial or placement of nonelite individuals in a particular cave context. "As Oliver Ricketson (1925) pointed out so cogently eighty years ago, caves are not normal burial contexts, so there is every reason to assume that a special context will contain a special population" (Scott and Brady 2005:277).

To understand function, we looked at several variables: location and accessibility of the cave, context of the cave as compared to other funerary caves throughout

Mesoamerica, found on the surface as opposed to subsurface burial, age, sex, health, trauma, postmortem treatment, and associated artifacts. Our assumption that few individuals were buried within Cusirisna Cave (MNI estimated at nine through presence of mandibles, however there may have been many more originally) might indicate that the cave was a place for elite individuals if cranial modification was specific to elite groups, and if the cave was revered as sacred by the culture. This could also demonstrate a funerary cave for a local family or a place for males within a particular lineage over time. Function may also be explained as placement for warriors, or participants in ballgames.

Ballgame players

Trauma has been observed in the crania, and the presence of Osgood-Schlatter Disease in conjunction with robusticity may allow us to infer that these individuals were engaged in vigorous activity, like that associated with violent sports. However, one might anticipate antemortem evidence of violence in the form of healed fractures to support this argument. Several studies have explored the individuals that were involved with the ballgames and boxing in Mesoamerica, using iconography and skeletal remains to interpret the players (Scott 2009; Aguero and Annick 2009; Mazariegos 2009; Taube and Zender 2009; Buikstra *et al.* 2004). Buikstra *et al.* (2004:195) describe K'inich Yax K'uk' Mo', the presumed founder of the dynasty at Copán, Honduras, as exhibiting the "classic tabular erect definition" (195) of cranial modification, with slight fronto-occipital, similar to the type observed on crania recovered from Cusirisna Cave. The authors mention evidence of blunt-force trauma sustained throughout life, and "if the

Early Classic rubber ball was as massive as that recorded at the time of the conquest (3 kg), a blow to an unprotected portion of the body could have caused considerable physical damage" (Buikstra *et al.* 2004).

The majority of trauma in the individuals from Cusirisna Cave is on the cranium. Scott (2009) discusses physical mutilation evidenced from participation in the ballgame while referencing a face carved in relief. Scott continues by mentioning the damage one might accrue when playing the ballgame, especially in those areas not protected. Could partaking in the ballgame have caused the damage that we have observed? A lack of postcranial trauma on the few long bones from Cusirisna Cave also provides little support for a hypothesis that the individuals were engaged in damaging physical activity such as the ballgame. However, the presence of Osgood-Schlatter Disease in three of the tibiae is curious because it is today thought to be a sports injury. Mazariegos (2009) examined the stelae from the Bilbao Monument Plaza, Monuments 1 – 8, and identified the individuals depicted in the stelae as being ballplayers for several reasons, one that "the left knee of the characters being swollen and calloused, especially on 3, 4, 5, 6, and 8. Parsons (1969) observed that this was most probably the result of their engagement in the ballgame" (Mazariegos 2009:148). This characteristic swelling of the knee, or just inferior to the knee on the tibial tuberosity, could be evidence for the presence of Osgood-Schlatter Disease on the athletes involved in the ballgame, though no mention of this pathology has been found in the literature regarding skeletal analysis. In addition to trauma and swollen knees, evidence of human sacrifice, specifically decapitation, would aid in an argument that Cusirisna Cave was a repository for ballplayers and associated sacrifices. Human sacrifice is associated with the ballgame in many sculptures, and is often depicted in the form of decapitation (Scott 2009; Cohodas 1975). It is not possible to further investigate decapitation specifically with the Cusirisna Cave remains because there are no cervical vertebrae to examine. However, sacrifice is a possible explanation for the cranial trauma observed (see below). Finally, the placement of crania in guacales in Cusirisna recalls the passage from the *Popol Vuh* in which the head of One Hunahpu is hung in the jícaro tree, which then begins to bear fruit. One Hunahpu, like his twin brother and his sons, was a ballplayer—in fact he was *the* primordial ballplayer—and therefore the use of guacales can be seen as an allusion to the ballgame and associated sacrifices. There is an association between the ballgame, sacrifice, and rulership, and these relationships are demonstrated in the *Popol Vuh* as well as in iconography. We argue here that these variables are intertwined at Cusirisna Cave, strengthened by the presence of the guacales.

Sacrifice

"Human sacrifice, according to Spanish chroniclers, was a widespread religious practice in contact period (and Pre-Columbia) Mesoamerica" (Healy 2007:262). As suggested above, with regard to human sacrifice and victims or captives of war, there are numerous examples of blunt-force trauma on the crania of the sample from Cusirisna Cave. The trauma may be explained by violence and intentional conflict in battle or war, or by the dehumanization process that has been known to accompany sacrificial practices. "Osteological remains provide the only direct evidence of human sacrifice recoverable archaeologically. Skeletal mutilation is often indicative of a violent death and thus can be linked to sacrifice. Skeletal mutilation includes decapitation, severed limbs, throat slashing, and heart extraction" (Owen 2005:324). It seems likely that some of our data could support a hypothesis for sacrifice, because there are only a few instances of antemortem and healed trauma. The majority of the trauma we have observed are the perimortem fractures on the crania, which constitutes a violent death. We do not know if the individuals were decapitated because we have no cervical vertebrae to examine. Could the absence of data support decapitation? We have no evidence of whether the limbs were severed, but instead a commingled cluster of postcranial remains without evidence of separation perimortem. We have no evidence of throat slashing, again, because of the absence of cervical vertebrae. We also have no evidence of heart extraction. We have examined one individual's complete rib set, and no cutmarks were observed. However, there were no sterna or clavicles from the sample to observe chest trauma. While the pattern of trauma we observed in the crania might not fit the formula of other sacrificial trauma, there is still a possibility that sacrificial victims were deposited in this cave.

Verano (2005) has analyzed victims of war, and has ascertained that they were war captives given their demographic age and sex profile as well as the "presence of numerous healed fractures indicating prior experience with interpersonal violence" (Verano 2005:277). To support our hypothesis that the individuals from Cusirisna Cave indicate victims of sacrifice rather than war is the absence of postcranial trauma which might be expected to have accumulated over one's life as a participant in war or conflict. Sacrificial victims were often dehumanized prior to death, tortured and humiliated by means of genital mutilation, decapitation, heart excision, or throwing a victim down facades or into cenotes, breaking the body (Tiesler 2007; Fitzsimmons 2011). Using this model to understand the remains from Cusirisna Cave, we examine what could be considered evidence for sacrifice given the extant materials from the cave with reflection of other archaeological examples.

Several of these individuals demonstrate perimortem trauma, and we cannot simply assume that the other individuals died of natural causes. The other deaths may be explained by strangulation, decapitation, poisoning, or a number of other causes of death that would not be evidenced in the skeletal material. There is a combination of perimortem violence, evidenced by unhealed impact lesions, and surface alterations and body processing in the form of soft tissue removal and cutmarks. Using these observations, we can ascertain that something ritualistic occurred.

Frequently, sacrifice is associated with young individuals and children (Scott and Brady 2005). Brady (1995) suggests that the subadult skeletal remains at the Copán cave could have been sacrifices, based on the different treatment they received in comparison to the adults. Ballinger's MA thesis (1986) shows the age distribution of the skeletal remains, which is dominated by juveniles. "The finding of a significant number of children of this age therefore suggests something other than natural causes" (Scott and Brady 2005:277). Or perhaps, this could be an effect of the Neolithic Demographic Transition. It is more difficult to assess the premortem condition of adult sacrificial offerings, and the context of the cave itself has an important role in interpretation. Scott and Brady (2005) describe an adult case of sacrifice at Cueva de Sangre at Dos Pilas:

> The trench was completely carpeted although its entire length with artifacts, including ceramics, bone, shell, chipped stone, and jade. It

> appears that all of the ceramic vessels had been broken in place, probably at the conclusion of ceremonies. Human skeletal material was also found among the offerings in the sticky mud. The context, a wet muddy passage that seasonally floods and that may have been periodically disturbed by pedestrian traffic, is hardly one where the Maya normally chose to place the body of a loved one. The presence of innumerable offerings, clearly unassociated with the burials, suggests that the human skeletal material should be viewed as an offering as well. Thus, the several dozen individuals in the trench are tentatively considered sacrificial victims [Scott and Brady 2005:278].

With regard to Cusirisna Cave, the transcription of Dr. Flint's field notes and observations from Clifford Brown's visit to the site suggest the situation is similar. The cave, described as a small cavern, is not a "standard" place to bury the remains of a family member or those of elite status. The small and unusual volcanic Cusirisna Cave is unlike the spacious limestone caves in Honduras which allowed for placement of bundles of skeletal remains and associated artifacts on shelves or deep within the caves. At Cusirisna Cave, Dr. Flint's description gives the impression of a varied assortment of remains placed in an atypical cave.

> Skulls placed by themselves were found in the outer cave, or mouth. The inner cave was so ingeniously concealed that I did not see it – filled up with a cartload of ribs – and so narrow as to preclude an idea that it was a passage. Afterwards the guide (thinking that I was in search of treasure) visited it and crawled in, found more skulls, and each one was enclosed in a calabash, and a mummified entire skeleton was found on the bed of the cave. He brought me the skull, and one tibia and humerus of the mummy, also a wooden seat, used at the time of the conquest for a seat and pillow. On the last skulls pieces of brown hair were found. From these circumstances, I think the cave was re-occupied [Flint 1882:297].

Rather than a burial site, we find that a combination of data provides the potential for Cusirisna Cave to be interpreted as a depository for sacrificial victims. The chronology of cave use can at this time only be inferred by the differences in the skeletal remains, but due to taphonomic differences it appears that the cave was re-occupied and these individuals were deposited over a period of time. In the future, we may be able to strengthen this argument through additional radiocarbon dating and more detailed studies of post-depositional attrition processes. The cave is not a simple place for normal burial, it is something hidden away from sight and was filled to capacity, until no other bones could be stored inside. Dr. Flint described how the cave appeared on approach and how it was filled with material. In his field notes, he states that "five additional crania, from the cave of Cucirizna [sic], making eight from that locality were obtained by opening the left hand passage - (see last report) which was completely choked with loose bones – and being very narrow—some 2 to 2 ½ feet, was at the time of my visit, supposed to terminate at the distance of 20 feet" (Flint 1879:7). Combining what we know of the traumatic injuries to the crania, the presence of the flint knife and the *duho*, could one propose that the preform was used draw blood, to cut out hearts, or sever heads (Mauter 2005:131)? Could we further propose that the *duho* was used to present offerings, similar to the manner in which trophy skulls are presented (Hoopes 2007:460)? These speculations are worthy of thought, but we have no clear evidence for support.

In discussing mortuary customs of the Maya, Berryman (2007) lists five factors that might assist in drawing conclusions about the remains of victims of sacrifice:

> 1. Placement of bodies in highly visible public or ceremonial places (in contrast to the typical residential mortuary patterns for the region, with the exception of some high-status individuals)
> 2. Lack of investment in grave preparation; typically not buried within structures in plazas or left lying directly on the ancient surface (implying a lack of respect)

> 3. Presence of clear selection for certain members of the population (such as young to middle-aged adult males in the case of potential war captives)
> 4. Lack of mortuary offerings (human remains associated with ancestor veneration are more likely to be associated with dedicatory mortuary offerings)
> 5. Signs of dismemberment/decapitation (preferably supported by the observation of cut marks when preservation allows)
> [Berryman 2007:394].

Again, in comparing the data obtained from Cusirisna Cave, this is useful for understanding what was occurring at the cave in terms of function. The bodies were not placed in a highly visible place, but instead in a small atypical cave. The bodies were not buried, and were left on the cave floor. Young to old adult males, with the exception of one clearly female cranium, can demonstrate a clear selection for certain members of the population. While there is a lack of quantity in mortuary offerings in comparison to other funerary cave sites, the quality and type of artifacts are those that would suggest an elite funerary context. There is no clear evidence for dismemberment or decapitation, but there is perimortem cranial trauma as well as postmortem body treatments in the form of cutmarks and flesh removal. Thus, sacrifice is not a definitive conclusion, but a plausible suggestion at this juncture.

Location and context

The remote context of the cave, without any known nearby settlement, demonstrates that those buried within the cave were transported to a special location. Though we do not know the extent of the isolation, there are no known sites at this time, and the area needs to be thoroughly inventoried for settlements and other activity. This location was chosen for a reason by those placing the remains within this cave, and it is important to take this into account while interpreting the possible function of the cave.

Ashmore and Geller (2005) speak to the deliberate choice of space in mortuary practice. They specifically analyze Maya use of space, placement relative to landscape and construction, and relative to other decedents (2005:84). The cave itself is symbolic. Caves are associated with life, death, and the underworld; their role has changed over time in Mayan ritual (Pugh 2005). “As natural ‘in-between’ or luminal icons, caves were ideal ritual spaces for negotiating boundaries of cosmic plane” (Pugh 2005:50).

We question the significance of the volcanic landscape near Cusirisna Cave, and why this particular place was chosen for these few deceased individuals. If only a select few are represented in this cave, where were others buried, and why were those specific few chosen to be placed in this cave? What were the characteristics of these individuals that separated them from the rest of society? Was the cave, a rarity in this landscape, considered sacred or something else? As Scott and Brady have questioned, “if caves were not normal burial places, who were the individuals who were buried there, and what were the circumstances that led to their being interred in a cave?” (2005:264).

Though we have limited data of activity in the area, Dr. Brown’s visit to Cusirisina Cave provided information on the accessibility of the cave. The entrances are located in the face of a cave, located high in a very steep ravine. The route was treacherous, and there did not seem to be an easier access path. The land directly surrounding the cave was steeply inclines, and habitation would have been impossible in the immediate vicinity. While we don’t know if a habitation site was 1km or 5km away, we can speek to the special and unusual context of the cave because of its rarity in a volcanic landscape, inaccessibility, and unusualness (with a waterfall cloaking the entrance). Therefore, we argue that the cave is an important landmark and probably had special associations, such as sacred qualities.

Pilgrimage

When considering numerous variables in our conclusions, we might also examine the role of Cusirisna Cave as a destination of pilgrimage. We do not know whether Cusirisna Cave was an isolated place, the area has not been explored archaeologically and it is difficult to make a statement concerning settlement in the area. Not far away from the cave, Flint found a potsherd from Teustepe, but the area needs to be inventoried to increase our knowledge of the surrounding cultures. If Cusirisna Cave was removed from other sites in the area, it might have been a place for pilgrimage and represent a place for deposit of cultural members over time. "Perhaps pilgrimages to caves in antiquity were held for commemorative rites and ritual feasting, not unlike to annual Day of the Dead ceremonies in present-day Mexico, to honor the memory of deceased family members" (Zender *et al.* 2001)" (Healy 2007:264). This would explain the discrepancies we have noted in skeletal taphonomy, the variability in dental wear among the mandibles and crania, type variation within tabular erect modification styles on the extant crania, and Dr. Flint's comments on the re-occupation of the cave over time.

The Lacandon cave is one example of a shrine that is center to a pilgrimage today. Located in the rainforest of Chiapas near Lake Mensabok, the cave is isolated and access is limited, with the only entrance by way of a lagoon. This cave was mentioned previously in reference to cultural comparison because of the presence of cranial modification in the tabular typology (Blom 1954). The cave, as a place of ritual, houses an incense burner, gourd bowls filled with incense, pots and bowls of variable style, and skeletal remains (McGee 1990). “Arranged on the ground between the piles of bowls and god pots are four skulls with the flattened cranial deformation common to the Prehispanic Maya, one pelvis, four femurs, two humeri, one fibula, one tibia, and a small assortment of other unidentified bones” (McGee1990:57). McGee notes that the Lacandon Maya say that the skeletal remains belong to gods who were once human, and who left their bodies when they returned to the sky. “Although none of the material at the site has been dated, judging from the number of artifacts piled at the site it has been an important ritual place for a significant length of time” (McGee 1990:57-58). Petryshyn (2005) described his experience as a participant in a modern pilgrimage to the Cave of the God Tsibana, and remarked that “the Lacandon choose such remote places of worship in order to hide them from foreigners” (2005:332). In contrast to McGee, Petryshyn did not observe, or least did not mention, the occipital flattening or cranial modification, and that “the lack of skull deformation is one of the many pieces of evidence that they were deposited in the cave in modern times” (2005:333). Boremanse (1993) has also commented on the importance of the cave, and noted that ancient offerings were probably associated with the human skeletal material, and might represent a burial ground which had been raided multiple times. The skeletal material was most likely left on the surface, as there are no signs of dirt or discoloration on the bones which would be expected if the bones had been buried (Petryshyn 2005:338). So, then, how does this combination of characteristics match those of Cusirisna Cave? Cusirisna Cave also had material on the floor, not buried underneath it. The human remains from Cusirisna Cave also had the tabular type of cranial modification mentioned by Blom (1954) and McGee (1990). Cusirisna Cave also had gourd bowls, within which crania were placed. Could these gourd bowls have also been used for incense like the use at the Lacandon cave? Could the function of the bowls have changed over time?

This practice is similar to one observed in a sacred cave of the Tzeltal Maya (Vogt and Stuart 2005). "A few generations ago the most distinguished members of each lineage were buried in the cave" (Villa Rojas 1969:215). The cave does not serve as a general burial location, but is restricted to particular members in the past. No longer used as a contemporary place for remains, it continues to be a place for worship (Villa Rojas 1969). Even though Cusirisna Cave may not be contemporaneous with the Lacandon and Tzeltal caves, we can begin to see similarities in the presence of skeletal material in an isolated context and recurring visits over time. A fuller comparison will only be possible when we know of associated settlements near Cusirisna Cave.

Conclusions

We have presented interpretations that might explain the function of Cusirisna Cave, dedicating particular attention to the biocultural and life course approaches in bioarchaeology by considered multiple contextual threads (Glencross 2011). In consideration of the amalgamation of data, we have concluded that the demographic profile of the individuals placed within the cave indicates that it was not a burial place for all members of society, but instead held a special meaning for those decidedly and selectively placed there. The context, characteristics, and artifacts of the cave itself indicates that it might have been a burial context for elite and significant individuals. The high incidence of young to old adult males in general good health with evidence of blunt force trauma to the crania is curious. This could also be a case of the companion sacrifice of a woman, or indeed the reverse: the woman might the principal individual surrounded by her male companions, that is, husbands, consorts, servants, or slaves.

Although considerable uncertainty remains, I believe that the most likely conclusion is that Cusirisna Cave represents a place for at least some sacrificed individuals dedicated as offerings. Something ritualistic clearly did occur with these remains, evidenced by the placement of crania within calabashes. Dr. Flint noted that "one of the men, who accompanied me last year, was induced to go alone, and bring me, what was left—he reports that No 560 was found beside No 557 and the former visitants stated to him, that a 2^{d} "guacal" was used as a cover and that in one they had found cotton, underneath the skull" (Flint 1879:8). Thus, the bodies were not haphazardly discarded in the cave, but were purposely brought to this place with special objects that had religious or ritual meaning of some sort.

Several pieces of evidence make it seem likely that the cave was re-visited and depositions of remains occurred over a period of time. The evidence includes taphonomic differences among the bones, the presence of different degrees of mummification, two crania with hair remnants, and Dr. Flint's observation that Cusirisna Cave appeared re-occupied (1879, 1882). Additional rationale for this argument is the variability in cranial modification. This difference could be explained by individual cranial morphology and unique reaction to the modification methods, different methodologies or applications utilized by one group, which could indicate that these individuals were from different groups, or that the difference in modification is evidence for differential deposition of remains over time. "Romano (1987) says that only the oblique deformation is represented in the paintings of the classical Mayan period. This confirms that the cranial deformations were a permanently visible symbol of social affiliation" (Romero-Vargas 2010:4).

As cranial modification changes through time, we can trace this relationship by cultural practice (who practiced which type), spatially (where the types can be found), and temporally (when the types were used). The issue is then to understand the meaning behind the artifacts and the association between the cultural material and osteological remains. For example, Scott and Brady (2005:274) suggest that rather than bundles of bone, single and disarticulated remains could have become the focus of devotion over time. Others have proposed that due to sacking after military defeat, elite cave burials declined during the Classic period, while they were common throughout the Preclassic (Garza *et al.* 2001:20; Scott and Brady 2005:271). The focus on particular body parts also changed through time, some being more powerful than others. "The importance of certain body parts is seen throughout the vast span of time in Mesoamerica. Given the nature of the individual and partial person in Mesoamerica, specific body parts probably had distinct associations as well as serving as discrete portions of the self or personhood (Fitzsimmons 2009:168; Fowler 2004)" (Blomster 2011:125). Blomster (2011) also discusses the absence of certain bones from burials, indicating that some bones were more useful or powerful in a political or religious postmortuary context.

This is curious and possibly relative to our interpretation at Cusirisna Cave. The charged manner in which a single bone (b'aak in Maya Classic texts) can stand for the entire body and materialize social identity (as Blomster and several others here describe for a range of Mesoamerican societies) connotes a transcendence of death, regardless of whether the skeletal parts were those of a revered ancestor, a political captive, or both. In a sense, to be remembered – to be reanimated from a carved femur or other mnemonic object – is to triumph over death" (McAnany 2011:231). The presence of bones recovered from Cusirisna Cave is disproportionate (i.e. there are nine mandibles and only one complete set of ribs). Not one single complete individual is represented. There is an absence of hands and feet, carpals and tarsals (except one talus, calcaneous, and medial phalange), sterna, clavicles, patellae, cervical vertebrae, and all but one partial scapula. The only contextual information we have is from Flint's notes, that the bones were stacked within the cave, but nothing regarding position or totality of the remains before removal and shipment to the Peabody Museum. Flint's reference to the "cartload of ribs" indicated a much larger original sample of skeletal remains, thus we cannot assume that the sample analyzed for this research is representative of the original number of individuals. The other piece of contextual information is the isolation of the crania, indicating special significance (Tung 2007). Is this lack of completeness simply because Flint did not collect all the bones, that he only collected the more complete and easily transportable bones (this may be particularly true with the mummy, which might have been dismembered by Flint for shipping)? What can be inferred about what is missing and why? What was done with the remains not placed in the cave, were they used for other ritual purposes (i.e. finger and hand bone or tooth necklaces, Owsley *et al.* 2007;

Jacobi 2007)? Why were the crania treated differently than the mandibles and postcranial remains with placement in gourd bowls?

This chapter has presented several possible conclusions with regard to the function of Cusirisna Cave through examination of the osteological material, context, location, and relationship to other funerary caves in Mesoamerica. However, these variables may not be enough to definitely assign and interpret function.

Difficulty in assessment of function

We would like to argue that Cusirisna Cave was a repository for sacrificial victims given the evidence outlined throughout this chapter, but it is difficult to verify this type of hypothesis with the incomplete data that have been collected thus far. There are general obstacles to inferring sacrifice from osteological remains (Scott and Brady 2005:276-277). It is especially difficult to argue sacrifice in the context of Cusirisna Cave because we do not have complete skeletons, data on burial position, or understand the motivation for such sacrifice. Eeckhout and Owens (2008:376) point out that bioarchaeologists have explored sacrifice in the Central Andes by examination of context and artifact affiliation, historical documentation, as well as trauma to the remains related to strangulation (Fleming 1983; Uhle 1903), poison (Montoya 2004), dismemberment (Bourget 1998; Reinhardt 1999), and decapitation (Cordy-Collins 2001; DeLeonardis 2000; Proulx 2001). Sacrifice is manifested differently in other parts of the Americas, and bioarchaeologists have therefore focused on other features of sacrifice, such as cutmarks (Verano 2001), cranial trauma (Standen and Arriaza 2000; Torres-Rouff et al. 2005; Bourget 2001), and trophy taking (Andrushko et al. 2005; Verano 1986; Verano 2001;

Cordy-Collins 2001; Millaire 2004). "Positive identification of sacrifice in the archaeological record is somewhat problematic, for while violence may be identifiable from bioarchaeological and pathological studies of skeletal remains, differentiating violence (including what would forensically be described as "murder" or "manslaughter") from human sacrifice and other forms of ritual killing is a largely semantic issue that relies heavily upon contextual (including historical, epigraphical, artificial, and spatial) evidence" (Eeckhout and Owens 2008:380).

In the case of Cusirisna Cave, it is difficult to discern whether this trauma was caused by war, conflict, sacrifice, or a series of terrible (and coincidental) accidents. After review, discussion, and consultation with other bioarchaeologists, I believe the wounds appear intentional and were created with weaponry. What we do not understand is why violence was used in this context. The material we have does not allow deeper inference at this time.

In summary, with respect to the literature and comparative data on sacrifice in Mesoamerica, we can broadly say that Cusirisna Cave represents something different than the mortuary caves in Honduras as well as other skeletal samples in the surrounding area. We find that Cusirisna Cave represents an anomaly in Nicaragua, and cannot be affiliated culturally with the Honduran mortuary complex due to different use period and our choice of comparative criteria (cranial modification) at this time. Neither does it seem similar in detail to any of the Maya cave assemblages I have reviewed. "Burials throughout Nicaragua, both to the west in the Gran Nicoya subregion and to the east in the Department of Chontales (Gorin and Riga 1988), are either simple primary interments or secondary urn burials. Therefore, preservation is poor, cave burials are very unusual, and mummies are unheard of" (Brown 2012). After review of the available data on skeletal remains and burials in Mesoameria, Cusirisna Cave, by comparison, is unusual and special. For future research, we propose to expand beyond this complex and look at Central Mexican cave burials as well as Costa Rican ones, if there are any, especially in the Postclassic period.

Analysis of Cusirisna Cave has provided information specific to Nicaraguan prehistory, as well as baseline data for further studies on cave archaeology. This study contributes to the understanding of the function of caves, and the relationships among individuals who utilized caves for funerary purposes. One of the larger burdens in cave archaeology today is uncovering the association between skeletal remains and the artifacts they are affiliated with and what this means in a larger context. "Despite 100 years of study, the most noteworthy features of the investigation of human osteological remains in caves are the paucity of explanations for the material, the lack of consensus over its meaning, and the near absence of research questions dealing with skeletal material" (Scott and Brady 2005:266). Applying a biocultural approach, we have attempted to place the material in its proper cultural and chronological context and have attempted to answer research questions relating to the purpose of the cave and the nature of the population buried in it. Still, there is much more to be done.

RECOMMENDATIONS FOR FUTURE RESEARCH

This report outlines what has been done with the remains from Cusirisna Cave thus far, but in no way claims that the work is finished. Recommendations for future work include 1) genetic and biodistance studies, 2) radiocarbon dating, 3) skeletal analysis of the Cuyamel material if still within the cave, 4) a closer examination of cranial modification in Mesoamerica, 5) comparisons to other Mesoamerican cave sites and mortuary practices. Comparing general metric data, health and pathology, as well as statistics on trauma may provide clarity in understanding groups that utilized funerary caves.

We suggest examining the DNA of the soft tissue on a few of the bones, particularly the "mummy," because the preservation of the organic remains from the cave is exceptional and therefore the DNA may be in unusually good condition. Using isotopic analysis to find places of origin would be interesting, but of course would require first geological and geomorphic mapping and testing to establish the trace elemental and isotopic composition of the rock throughout the surrounding area. These techniques have been used by Price *et al*. (2007) to trace origins of sacrifice victims of Mayan sites. We can also conduct biodistance studies by using the epigenetic traits observed and collected. Statistical analyses with use of Osteoware or ForDisc software may also be an avenue for biodistance studies.

There is also prospective work to be done with radiocarbon dating. While a date for the cave has been established by dating one of the artifacts, this does not provide a complete chronology, but just the date of one gourd. The appearance and taphonomy of the bones implies that the remains were deposited over a period of time, and this observation is supported by Dr. Flint's field notes and his impression of reoccupation. Radiocarbon dating could and should be performed on multiple samples including the human bones in order to answer questions about reoccupation or reuse.

While we cannot connect Cusirisna Cave to the Honduran complex (either culturally and temporally), we still recommend re-exploring the Cuyamel cave, and noting whether skeletal material is still present within the cave or has been looted. In our review of the available literature concerning Cuyamel, there is a complete absence of skeletal analysis. This has potential to serve as a great comparative resource for other complexes in Honduras. While data has been collected on the ceramics, it would be useful to obtain as much information as possible from this isolated mortuary cave.

The use of cranial modification and type can be used to understand individual identity as well as demonstrate relationships between cultures. Research has been done on this among the pre-Inca Chiribaya of southern Peru, using cranial modification as a symbol to understand ethnicity (Lozado 2011). Cranial modification has also been used to understand the identity of pre-Columbian Mayan individuals and groups (Geller 2011). Cranial modification types have also been used to differentiate classes or those from special locales (Hoshower *et al.* 1995).

Future research can expand geographically and examine funerary caves outside of Nicaragua and Honduras in Costa Rica, Guatemala, Mexico, and other regions in order to cross reference cave utilization for funerary purposes, the frequency and type of cranial modification found within burials, and investigate cases of sacrificial deposits.

CONCLUDING REMARKS

This study provides new insights into Mesoamerican and Central American funerary and cave practices, as well as into the prehistoric cultures of Nicaragua. This is the first investigation into the only known funerary cave in Nicaragua, the first skeletal analysis of this site, the first dating of this cave, and the first exploration of the cultural relationship of Cusirisna to the northern Honduran mortuary complex and that of Olmec and Tlatilco practices, which has demonstrated that we cannot extend that complex farther south into Nicaragua as we originally proposed. This thesis project provides information specific to Nicaragua and Cusirisna Cave but also contributes to the overall understanding of cave archaeology and bioarchaeology in a manner that emphasizes the connection between biology and culture by examining skeletal remains within a unified cultural context.

"Bioarchaeology is uniquely situated to address a wide variety of archaeological questions with relevance to our understanding of both the past and the future. Although bioarchaeology as an approach may never shed its material definition we hope the line between this and other social sciences continues to blur a we make greater contributions to broader academia" (Knudson and Stojanowski 2008:415). This thesis has attempted to address questions of the lives of the individuals placed with the caves and the relationship to those who placed the deceased in the context of the cave. We have also attempted to address the function of the cave, and the relationship of Cusirisna Cave to other funerary traditions in Mesoamerica. Though we have not been able to offer definite conclusions regarding these questions, we have added to the literature on the bioarchaeology of caves with specific reference to a case in Nicaragua. We have also contributed to knowledge about the Postclassic period in what is today the Department of Boaco.

APPENDICES

Appendix 1. Inventory.

Peabody object number	Flint's number	Philmon's number	Element	Location
79-72-20 / 19906	n/a	Cr1	Cranium	32, 50 a, 4
79-72-20 / 19907	n/a	Cr2	Cranium	32, 50 a, 1
79-72-20 / 19905	n/a	Cr3	Cranium	32, 50 a, 4
79-72-20 / 19904	n/a	Cr4	Cranium	32, 50 a, 4
79-72-20 / 19903	554	Cr5	Cranium	32, 50 a, 4
78-42-20 / 15169	126	Cr6	Cranium	32, 50 a, 4
78-42-20 / 15168	n/a	Cr7	Cranium	32, 50 a, 6
78-42-20 / 15167	124	Cr8	Cranium	32, 50 a, 6
79-72-20 / 19908	554	Ma1	Mandible	32, 50 a, 2
79-72-20 / 19908	557	Ma2	Mandible	32, 50 a, 2
79-72-20 / 19908	555	Ma3	Mandible	32, 50 a, 2
79-72-20 / 19908	5	Ma4	Mandible	32, 50 a, 2
79-72-20 / 19908	n/a	Ma5	Mandible	32, 50 a, 2
78-42-20 / 15170	141	Ma6	Mandible	32, 50 a, 6
78-42-20 / 15170	n/a	Ma7	Mandible	32, 50 a, 6
78-42-20 / 15170	n/a	Ma8	Mandible	32, 50 a, 6
78-42-20 / 15170	n/a	Ma9	Mandible	32, 50 a, 6
79-72-20 / 19911	n/a	Fe1	Femur	32, 50 a, 2
78-42-20 / 15175	139	Fe2	Femur	32, 50 a, 3
78-42-20 / 15175	136	Fe3	Femur	32, 50 a, 3
78-42-20 / 15175	138	Fe4	Femur	32, 50 a, 3
78-42-20 / 15175	137	Fe5	Femur	32, 50 a, 3
79-72-20 / 19913	567	Ti1	Tibia	32, 50 a, 2
79-72-20 / 19913	565	Ti2	Tibia	32, 50 a, 2
79-72-20 / 19913	566	Ti3	Tibia	32, 50 a, 2
79-72-20 / 19914	591	Ti4	Tibia	32, 50 a, 2
78-42-20 / 15176	132	Ti5	Tibia	32, 50 a, 3
78-42-20 / 15176	131	Ti6	Tibia	32, 50 a, 3
78-42-20 / 15176	130	Ti7	Tibia	32, 50 a, 3
78-42-20 / 15176	135	Ti8	Tibia	32, 50 a, 3
78-42-20 / 15176	133	Ti9	Tibia	32, 50 a, 3
78-42-20 / 15176	134	Ti10	Tibia	32, 50 a, 3
79-72-20 / 19914	n/a	Fi2	Fibula	32, 50 a, 2
78-42-20 / 15173	n/a	Fi1	Fibula	32, 50 a, 3

Appendix 2. Inventory (continued).

Peabody object number	Flint's number	Philmon's number	Element	Location
79-72-20 / 19912	568	Hu1	Humerus	32, 50 a, 2
79-72-20 / 19912	569	Hu2	Humerus	32, 50 a, 2
79-72-20 / 19912	570	Hu3	Humerus	32, 50 a, 2
78-42-20 / 15174	128	Hu4	Humerus	32, 50 a, 3
78-42-20 / 15174	127	Hu5	Humerus	32, 50 a, 3
78-42-20 / 15174	129	Hu6	Humerus	32, 50 a, 3
78-42-20 / 15173	n/a	Ul1	Ulna	32, 50 a, 3
78-42-20 / 15173	n/a	Ul2	Ulna	32, 50 a, 3
78-42-20 / 15173	n/a	Ra1	Radius	32, 50 a, 3
78-42-20 / 15173	n/a	Ra2	Radus	32, 50 a, 3
78-42-20 / 15172	n/a	Sc1	Scapula	32, 50 a, 5a
78-42-20 / 15171	n/a	Sa1	Sacrum	32, 50 a, 6
78-42-20 / 15171	n/a	Sa2	Sacrum	32, 50 a, 6
78-42-20 / 15171	n/a	Sa3	Sacrum	32, 50 a, 6
78-42-20 / 15171	n/a	In1	Innominate	32, 50 a, 6
78-42-20 / 15171	n/a	In2	Innominate	32, 50 a, 6
78-42-20 / 15171	n/a	In3	Innominate	32, 50 a, 6
78-42-20 / 15171	n/a	In4	Innominate	32, 50 a, 6
78-42-20 / 15172	n/a	Ph1	Medial phalange	32, 50 a, 5a
78-42-20 / 15172	n/a	Ca1	Calcaneous	32, 50 a, 5a
78-42-20 / 15172	n/a	Ta1	Talus	32, 50 a, 5a
78-42-20 / 15172	n/a	Rir1 - Rir6	Ribs (right)	32, 50 a, 5a
78-42-20 / 15172	n/a	Ril1 - Ril10	Ribs (left)	32, 50 a, 5a
78-42-20 / 15173	n/a	Ril11	1st rib (left)	32, 50 a, 3
78-42-20 / 15172	n/a	Vet1 - Vet3	Thoracic vertebrae	32, 50 a, 5a
78-42-20 / 15172	n/a	Vel1 - Vel7	Lumbar vertebrae	32, 50 a, 5a

Appendix 3. Sexed elements.

Peabody object number	Flint's number	Philmon's number	Element	Side	Sex
79-72-20 / 19911	n/a	Fe1	Femur	Left	Male
78-42-20 / 15175	139	Fe2	Femur	Right	Male
78-42-20 / 15175	136	Fe3	Femur	Left	Female
78-42-20 / 15175	138	Fe4	Femur	Left	Male
78-42-20 / 15175	137	Fe5	Femur	Left	Male
79-72-20 / 19912	568	Hu1	Humerus	Right	Male
79-72-20 / 19912	569	Hu2	Humerus	Left	Male
79-72-20 / 19912	570	Hu3	Humerus	Right	Male
78-42-20 / 15174	128	Hu4	Humerus	Right	Male
78-42-20 / 15174	127	Hu5	Humerus	Left	Male
78-42-20 / 15174	129	Hu6	Humerus	Left	Male
78-42-20 / 15171	n/a	In1	Innominate	Right	Male
78-42-20 / 15171	n/a	In2	Innominate	Left	Male
78-42-20 / 15171	n/a	In3	Innominate	Right	Male
78-42-20 / 15171	n/a	In4	Innominate	Left	Male
79-72-20 / 19913	567	Ti1	Tibia	Right	Male
79-72-20 / 19913	565	Ti2	Tibia	Right	Male
79-72-20 / 19913	566	Ti3	Tibia	Right	Male
79-72-20 / 19914	591	Ti4	Tibia	Left	Male
78-42-20 / 15176	132	Ti5	Tibia	Left	Male
78-42-20 / 15176	131	Ti6	Tibia	Right	Probably female
78-42-20 / 15176	130	Ti7	Tibia	Left	Probably female
78-42-20 / 15176	135	Ti8	Tibia	Left	Male
78-42-20 / 15176	133	Ti9	Tibia	Right	Male
78-42-20 / 15176	134	Ti10	Tibia	Right	Male

Appendix 4. Sexed elements (continued).

Peabody object number	Flint's number	Philmon's number	Element	Side	Sex
79-72-20 / 19906	n/a	Cr1	Cranium		Female
79-72-20 / 19907	n/a	Cr2	Cranium		Male
79-72-20 / 19905	n/a	Cr3	Cranium		Male
79-72-20 / 19904	n/a	Cr4	Cranium		Male
79-72-20 / 19903	554	Cr5	Cranium		Male
78-42-20 / 15169	126	Cr6	Cranium		Male
78-42-20 / 15168	n/a	Cr7	Cranium		Male
78-42-20 / 15167	n/a	Cr8	Cranium		Male
79-72-20 / 19908	554	Ma1	Mandible		Male
79-72-20 / 19908	557	Ma2	Mandible		Probably female
79-72-20 / 19908	555	Ma3	Mandible		Intermediate
79-72-20 / 19908	5	Ma4	Mandible		Male
79-72-20 / 19908	n/a	Ma5	Mandible		Male
78-42-20 / 15170	141	Ma6	Mandible		Male
78-42-20 / 15170	n/a	Ma7	Mandible		Male
78-42-20 / 15170	n/a	Ma8	Mandible		Probably female
78-42-20 / 15170	n/a	Ma9	Mandible		Probably male

Appendix 5. Nonsexed elements.

Peabdy object number	Flint's number	Philmon's number	Element	Side	Sex
79-72-20 / 19914	n/a	Fi1	Fibula	Left	n/a
78-42-20 / 15173	n/a	Fi2	Fibula	Left	n/a
78-42-20 / 15171	n/a	Sa1	Sacrum		n/a
78-42-20 / 15171	n/a	Sa2	Sacrum		n/a
78-42-20 / 15171	n/a	Sa3	Sacrum		n/a
78-42-20 / 15173	n/a	Ra1	Radius	Left	n/a
78-42-20 / 15173	n/a	Ra2	Radius	Left	n/a
78-42-20 / 15173	n/a	Ul1	Ulna	Right	n/a
78-42-20 / 15173	n/a	Ul2	Ulna	Right	n/a
78-42-20 / 15172	n/a	Sc1	Scapula	Right	n/a
78-42-20 / 15172	n/a	Ril1	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril2	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril3	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril4	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril5	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril6	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril7	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril8	Rib	Left	n/a
78-42-20 / 15172	n/a	Ril9	Rib	Left	n/a
78-42-20 / 15172	n/a	Rir1	Rib	Right	n/a
78-42-20 / 15172	n/a	Rir2	Rib	Right	n/a
78-42-20 / 15172	n/a	Rir3	Rib	Right	n/a
78-42-20 / 15172	n/a	Rir4	Rib	Right	n/a
78-42-20 / 15172	n/a	Rir5	Rib	Right	n/a
78-42-20 / 15172	n/a	Rir6	Rib	Right	n/a
78-42-20 / 15172	n/a	Ril10	Rib	Left	n/a
78-42-20 / 15172	n/a	Vel1	Vertebra, lumbar		n/a
78-42-20 / 15172	n/a	Vel2	Vertebra, lumbar		n/a
78-42-20 / 15172	n/a	Vel3	Vertebra, lumbar		n/a
78-42-20 / 15172	n/a	Vel4	Vertebra, lumbar		n/a
78-42-20 / 15172	n/a	Vel5	Vertebra, lumbar		n/a
78-42-20 / 15172	n/a	Vel6	Vertebra, lumbar		n/a
78-42-20 / 15172	n/a	Vel7	Vertebra, lumbar		n/a
78-42-20 / 15172	n/a	Vet1	Vertebra, thoracic		n/a
78-42-20 / 15172	n/a	Vet2	Vertebra, thoracic		n/a
78-42-20 / 15172	n/a	Vet3	Vertebra, thoracic		n/a
78-42-20 / 15172	n/a	Ph1	Phalange		n/a
78-42-20 / 15172	n/a	Ca1	Calcaneous	Right	n/a
78-42-20 / 15172	n/a	Ta1	Talus	Right	n/a

Appendix 6. Age estimation through ectocranial scoring.

Peabody object number	79-72-20 / 19906	79-72-20 / 19907	79-72-20 / 19905	79-72-20 / 19904	79-72-20 / 19903	78-42-20 / 15169	78-42-20 / 15168	78-42-20 / 15167
Flint's number	n/a	n/a	n/a	n/a	554	126	n/a	124
Philmon's number	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8
Midlambdoid score	1	3	3	1	1	0	0	2
Lambda score	1	3	3	1	2	0	0	3
Obelion score	1	3	3	2	2	1	0	3
Anterior sagittal score	1	3	3	3	2	2	0	3
Bregma score	2	3	3	2	1	0	1	1
Midcoronal score	2	3	3	2	1	0	1	2
Pterion score	2	3	3	2	2	0	1	2
Sphenofrontal score	3	3	2	2	2	0	1	3
Inferior sphenofrontal score	3	3	2	2	2	0	1	3
Superior sphenofrontal score	3	3	2	2	2	0	2	3
Incisive suture score	3	n/a	2	2	3	n/a	2	3
Anterior medial palatine score	3	n/a	2	2	1	n/a	2	3
Posterior medial palatine score	3	n/a	2	2	3	n/a	2	3
Transverse palatine score	3	n/a	2	2	2	n/a	2	3
Vault scores - estimated age	39.4±9.1	>51.5	>51.5	45.2±12.6	39.4±9.1	34.7±7.8	34.7±7.8	48.8±10.5
Lateral anterior scores - estimated age	56.2±8.5	>56.2	56.2±8.5	51.9±12.5	51.9±12.5	<32	43.4±10.7	56.2±8.5
Combined ages	30.3 - 64.7	56.2+	51.5 - 64.7	32.6 - 64.4	30.3 - 64.4	26.9 - 32	26.9 - 54.1	38.3 - 64.7
Age class	Young to middle adult	Old adult	Old adult	Young to old adult	Young to old adult	Young adult	Young to old adult	Young to old adult

Appendix 7. Age estimation through epiphyseal closure.

Peabody object number	Flint's number	Philmon's number	Element	Side	Sex	Age	Age Class
79-72-20 / 19914	591	Ti4	Tibia	Left	Male	20 - 22	Adolescent to young adult
79-72-20 / 19914	n/a	Fi1	Fibula	Left	Male	20 - 22	Adolescent to young adult
79-72-20 / 19912	569	Hu2	Humerus	Left	Male	20 - 23	Adolescent to young adult
79-72-20 / 19912	570	Hu3	Humerus	Right	Male	20 - 23	Adolescent to young adult

Appendix 8. Estimation of stature.

Peabody object number	Flint's number	Philmon's number	Side	Sex	Maximum length (cm)	Calculation	Stature
79-72-20 / 19911	n/a	Fe1	Left	Male	46.2	2.26 x 46.2 + 66.379 ± 3.46	170.791 ± 3.46
78-42-20 / 15175	139	Fe2	Right	Male	44.5	2.26 x 44.5 + 66.379 ± 3.46	166.949 ± 3.46
78-42-20 / 15175	136	Fe3	Left	Female	38.7	2.59 x 38.7 + 49.742	149.975
78-42-20 / 15175	138	Fe4	Left	Male	43.9	2.26 x 43.9 + 66.379 ± 3.46	165.593 ± 3.46
78-42-20 / 15175	137	Fe5	Left	Male	42.5	2.26 x 42.5 + 66.379 ± 3.46	162.429 ± 3.46
79-72-20 / 19913	567	Ti1	Right	Male	37.1	1.96 x 37.1 + 93.752 ± 2.66	166.468 ± 2.66
79-72-20 / 19913	565	Ti2	Right	Male	39.1	1.96 x 39.1 + 93.752 ± 2.66	170.388 ± 2.66
79-72-20 / 19913	566	Ti3	Right	Male	37.3	1.96 x 37.3 + 93.752 ± 2.66	166.86 ± 2.66
79-72-20 / 19914	591	Ti4	Left	Male	36.1	1.96 x 36.1 + 93.752 ± 2.66	164.508 ± 2.66
78-42-20 / 15176	132	Ti5	Left	Male	36	1.96 x 36 + 93.752 ± 2.66	164.312 ± 2.66
78-42-20 / 15176	131	Ti6	Right	Probably female	33.8	2.72 x 33.8 + 63.781 ± 2.6	155.717 ± 2.6
78-42-20 / 15176	130	Ti7	Left	Probably female	32.45	2.72 x 32.45 + 63.78 ± 2.6	152.044 ± 2.6
78-42-20 / 15176	135	Ti8	Left	Male	39.5	1.96 x 39.5 + 93.752 ± 2.66	171.172 ± 2.66
78-42-20 / 15176	133	Ti9	Right	Male	37.35	1.96 x 37.35 + 93.752 ± 2.66	166.958 ± 2.66
78-42-20 / 15176	134	Ti10	Right	Male	39	1.96 x 39 + 93.752 ± 2.66	170.192 ± 2.66

Appendix 9. Estimation of stature, corrected.

Peabody object number	Flint's number	Philmon's number	Cadaveric stature adjustment	Middle to old age adjustment	Stature (cm)	Stature (in)	Stature (ft)
79-72-20 / 19911	n/a	Fe1	Add 2.5 cm	Subtract .06 cm	173.231 ± 3.46	68.2011	5' 8.2"
78-42-20 / 15175	139	Fe2	Add 2.5 cm	Subtract .06 cm	169.389 ± 3.46	66.6885	5' 6.68"
78-42-20 / 15175	136	Fe3	Add 2.5 cm	Subtract .06 cm	152.385	59.994	4' 11.9"
78-42-20 / 15175	138	Fe4	Add 2.5 cm	Subtract .06 cm	168.033 ± 3.46	66.1429	5' 6.14"
78-42-20 / 15175	137	Fe5	Add 2.5 cm	Subtract .06 cm	164.869 ± 3.46	64.909	5' 4.9"
79-72-20 / 19913	567	Ti1	Add 2.5 cm	Subtract .06 cm	168.908 ± 2.66	66.4992	5' 6.5"
79-72-20 / 19913	565	Ti2	Add 2.5 cm	Subtract .06 cm	172.83 ± 2.66	68.0433	5' 8"
79-72-20 / 19913	566	Ti3	Add 2.5 cm	Subtract .06 cm	169.30 ± 2.66	66.6535	5' 6.7"
79-72-20 / 19914	591	Ti4	Add 2.5 cm		167.008 ± 2.66	65.7511	5' 5.8"
78-42-20 / 15176	132	Ti5	Add 2.5 cm	Subtract .06 cm	166.752 ± 2.66	65.6503	5' 5.7"
78-42-20 / 15176	131	Ti6	Add 2.5 cm	Subtract .06 cm	158.157 ± 2.6	62.2665	5' 2.3"
78-42-20 / 15176	130	Ti7	Add 2.5 cm	Subtract .06 cm	154.484 ± 2.6	60.8204	5' .8"
78-42-20 / 15176	135	Ti8	Add 2.5 cm	Subtract .06 cm	173.612 ± 2.66	68.3511	5' 8.4"
78-42-20 / 15176	133	Ti9	Add 2.5 cm	Subtract .06 cm	169.398 ± 2.66	66.6912	5' 6.7"
78-42-20 / 15176	134	Ti10	Add 2.5 cm	Subtract .06 cm	172.632 ± 2.66	67.9653	5' 8"

Appendix 10. Cranial metrics.

Peabody object number	79-72-20 / 19906	79-72-20 / 19907	79-72-20 / 19905	79-72-20 / 19904	79-72-20 / 19903	78-42-20 / 15169	78-42-20 / 15168	78-42-20 / 15167
Flint's number	n/a	n/a	n/a	n/a	554	126	n/a	124
Philmon's number	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8
Sex	Female	Male	Male	Male	Male	Male	Male	Male
Maximum cranial length	151	160	156	167	152	152	148	150
Maximum cranial breadth	131	157	153	148	148	161	158	155
Bizygomatic diameter	123	n/a	140	144	152	n/a	137	149
Basion-bregma height	126	n/a	129	137	142	129	128	128
Cranial base length	98	n/a	95	100	98	n/a	95	94
Basion-prosthion length	93	n/a	88	86	98	n/a	98	101
Maxillo-alveolar breadth	64	n/a	72	60	60	n/a	54	67
Maxillo-alveolar length	55	n/a	54	48	55	n/a	55	n/a
Biauricular breadth	112	130	128	132	133	130	128	132
Upper facial height	60	n/a	61	69	76	n/a	65	71
Minimum frontal breadth	87	n/a	95	98	93	104	97	95
Upper facial breadth	101	n/a	104	110	112	112	114	71
Nasal height	44	n/a	49	52	58	n/a	35	48
Nasal breadth	25	n/a	25	24	28	n/a	29	28
Orbital breadth	n/a	n/a	37	41	43	n/a	41	39
Orbital height	33	n/a	38	41	38	n/a	36	38
Biorbital breadth	38	n/a	98	103	106	n/a	107	101
Interorbital breadth	23	n/a	25	26	24	n/a	33	27
Frontal chord	91	97	97	101	108	83	94	97
Parietal chord	99	99	92	117	103	106	89	99
Occipital chord	95	41	103	97	93	81	99	87
Foramen magnum length	22	n/a	37	40	39	37	34	34
Foramen magnum breadth	30	n/a	28	32	31	28	28	30
Mastoid length	24	27	31	31	31	25	25	32

Appendix 11. Nonmetric variation of crania.

Peabody object number	79-72-20 / 19906	79-72-20 / 19907	79-72-20 / 19905	79-72-20 / 19904	79-72-20 / 19903	78-42-20 / 15169	78-42-20 / 15168	78-42-20 / 15167
Flint's number	n/a	n/a	n/a	n/a	554	126	n/a	124
Philmon's number	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8
Metopic suture	0	0	0	0	0	9	0	1
Supraorbital notch (L)	0	1	1	0	1	1	0	1
Supraorbital notch (R)	0	1	1	2	1	1	0	1
Supraorbital foramen (L)	2	1	0	1	2	2	1	1
Supraorbital foramen (R)	2	2	0	0	2	1	1	1
Infraorbital suture (L)	0	9	0	2	0	9	0	0
Infraorbital suture (R)	2	9	1	2	0	9	0	0
Multiple infraorbital foramina (L)	0	9	0	0	0	9	0	0
Multiple infraorbital foramina (R)	9	9	0	0	3	9	0	0
Zygomaticofacial foramina (L)	2	9	0	1	2	1	0	2
Zygomaticofacial foramina (R)	2	9	0	2	1	0	1	1
Parietal foramen (L)	2	0	1	1	0	9	0	0
Parietal foramen (R)	2	0	1	1	0	1	1	1
Epiteric bone (L)	1	9	0	0	0	9	0	1
Epiteric bone (R)	1	0	9	0	0	1	2	0
Coronal ossicle (L)	0	0	0	0	0	9	0	0
Coronal ossicle (R)	0	1	9	0	0	9	0	0
Bregmatic bone	0	0	0	0	0	0	0	0
Sagittal ossicle	0	0	9	0	0	0	0	0
Apical bone	0	0	1	1	0	0	1	0
Lambdoid ossicle (L)	0	0	0	0	0	1	1	0
Lambdoid ossicle (R)	0	0	0	1	0	1	1	0
Asterionic bone (L)	1	1	0	0	0	9	0	0
Asterionic bone (R)	0	0	1	1	0	9	0	0

Appendix 12. Nonmetric variation of crania (continued).

Peabody object number	79-72-20 / 19906	79-72-20 / 19907	79-72-20 / 19905	79-72-20 / 19904	79-72-20 / 19903	78-42-20 / 15169	78-42-20 / 15168	78-42-20 / 15167
Flint's number	n/a	n/a	n/a	n/a	554	126	n/a	124
Philmon's number	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8
Ossicle in occipito-mastoid suture (L)	0	1	0	0	0	0	0	0
Ossicle in occipito-mastoid suture (R)	0	9	1	0	0	0	0	1
Parietal notch bone (L)	0	0	0	0	0	0	0	0
Parietal notch bone (R)	0	0	0	0	0	0	0	0
Inca bone	0	0	0	0	0	0	0	0
Condylar canal (L)	0	9	1	1	1	9	1	9
Condylar canal (R)	0	9	1	1	1	9	1	9
Divided hypogossal canal (L)	0	9	0	0	0	9	1	9
Divided hypogossal canal (R)	0	9	0	0	0	9	1	9
Flexure of superior sagittal sulcus	9	9	9	9	9	9	9	9
Foramen ovale incomplete (L)	9	9	0	0	0	0	0	0
Foramen ovale incomplete (R)	0	0	0	0	0	9	0	0
Pterygo-spinous bridge (L)	0	9	0	0	0	9	0	9
Pterygo-spinous bridge (R)	0	0	0	0	0	9	0	9
Pterygo-alar bridge (L)	0	9	2	3	0	9	0	9
Pterygo-alar bridge (R)	0	0	2	3	0	9	0	9
Tympanic dehiscence (L)	0	9	0	0	0	0	0	0
Tympanic dehiscence (R)	0	0	0	0	0	0	0	0
Auditory exostosis (L)	0	0	0	0	1	0	0	0
Auditory exostosis (R)	0	0	0	0	1	0	0	0
Mastoid foramen location (L)	4	2	1	4	4	9	4, 5	1
Mastoid foramen location (R)	4	2	4	4	4	4	4, 5	1
Mastoid foramen number (L)	3	2	2	2	1	9	3	3
Mastoid foramen number (R)	1	3	3	2	3	2	3	2

Appendix 13. Cranial indices.

Peabody object number	79-72-20 / 19906	79-72-20 / 19907	79-72-20 / 19905	79-72-20 / 19904	79-72-20 / 19903	78-42-20 / 15169	78-42-20 / 15168	78-42-20 / 15167
Flint's number	n/a	n/a	n/a	n/a	554	126	n/a	124
Philmon's number	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8
Sex	Female	Male	Male	Male	Male	Male	Male	Male
Cranial index: (*cranial breadth/cranial length) x 100*	86.75	98.13	98.08	88.62	97.37	105.92	106.76	101.3
Cranial module: *(cranial length + cranial breadth + craial height) / 3*	136	n/a	146	150.7	147.3	147.3	144.6	144.3
Cranial length-height index: *(cranial height/cranial length) x 100*	83.44	n/a	82.7	82.04	93.42	84.87	86.49	85.3
Cranial breadth-height index: *(cranial height/cranial breadth) x 100*	96.18	n/a	84.31	92.57	95.95	80.12	81.01	82.58
Upper facial index: *(upper facial height/bizygomatic breadth) x 100*	48.78	n/a	43.57	47.92	50	n/a	47.45	47.65
Nasal aperature index: *(nasal aperature breadth/nasal aperarure height) x 100*	56.82	n/a	51.02	46.15	48.28	n/a	82.86	58.33
Orbital index: *(orbital height/orbital width) x 100*	n/a	n/a	102.7	100	88.37	n/a	87.8	97.44

Appendix 14. Metrics of mandibles.

Peabody object number	79-72-20/ 19908	79-72-20/ 19908	79-72-20/ 19908	79-72-20/ 19908	79-72-20/ 19908	78-42-20/ 15170	78-42-20/ 15170	78-42-20/ 15170	78-42-20/ 15170
Flint's number	554	557	555	5	n/a	141	n/a	n/a	n/a
Philmon's number	Ma1	Ma2	Ma3	Ma4	Ma5	Ma6	Ma7	Ma8	Ma9
Bicondylar breadth	122	115	127	121	123	122	120	111	114
Bigonial breadth	105	99	105	91	106	110	112	93	98
Mandibular length	97	102	98	92	100	97	102	89	99
Mandibular angle	122	128	134	110	145	120	150	155	155
Maximum ramal breadth	50	45	45	42	43	41	46	43	46
Minimum ramal breadth	38	33	31	33	31	32	37	31	33
Maximum ramal height	72	54	61	69	58	72	n/a	n/a	n/a
Mandibular body height	29	26	22	29	32	37	27	30	34
Mental breadth	19	12	9.9	13	11	11	12	13	13
Symphyseal height	34	27	30	28	33	37	30	30	35

Appendix 15. Metrics of dentition.

Peabody object number	Flint's number	Philmon's number	Element	Medsiodistal crown diameter	Bucolingual crown diameter	Crown height	Wear
79-72-20 / 19908	557	Ma2	LM1	11.9	11	5.2	2
79-72-20 / 19908	557	Ma2	LM3	12.6	11	6.7	2
79-72-20 / 19908	557	Ma2	RM1	12	11	5.5	3
79-72-20 / 19908	557	Ma2	RM3	12.3	11	5.6	2
79-72-20 / 19908	5	Ma4	LM1	11.8	11	6.3	1
79-72-20 / 19908	5	Ma4	LM2	10.5	12	6.3	1
79-72-20 / 19908	5	Ma4	LM3	11.3	12	7.4	1
79-72-20 / 19908	5	Ma4	RM1	12	11	5.3	1
79-72-20 / 19908	5	Ma4	RM2	10.7	11	5.3	5
79-72-20 / 19908	n/a	Ma5	RM1	12.7	12	4.4	8
79-72-20 / 19908	n/a	Ma5	RM2	10.6	11	3.7	9
79-72-20 / 19908	n/a	Ma5	RM3	9.8	9.9	5.8	9
78-42-20 / 15170	141	Ma6	LP4	7.1	8.8	5.5	2
78-42-20 / 15170	141	Ma6	LM1	10.6	11	6.1	2
78-42-20 / 15170	141	Ma6	LM2	10.8	10	5.7	2
78-42-20 / 15170	141	Ma6	RM1	10.6	11	5	2
78-42-20 / 15170	141	Ma6	RM2	10.3	11	5.7	2
78-42-20 / 15170	141	Ma6	RM3	11.2	11	5.3	2
78-42-20 / 15170	n/a	Ma7	LM1	12.5	11	5.9	10
78-42-20 / 15170	n/a	Ma7	RP4	7.4	8.3	5.9	5
78-42-20 / 15170	n/a	Ma7	RM1	12.2	12	5.7	10
78-42-20 / 15170	n/a	Ma7	RM2	10.7	12	5.6	10
78-42-20 / 15170	n/a	Ma8	RC	6.7	7.1	10	2
78-42-20 / 15170	n/a	Ma8	LM3	11.4	11	6.1	3
78-42-20 / 15170	n/a	Ma9	RM1	11.6	12	6	3
78-42-20 / 15170	n/a	Ma9	RM2	11.4	11	6.4	3
78-42-20 / 15170	n/a	Ma9	RM3	11.9	11	3.8	5
79-72-20 / 19904	n/a	Cr4	LM2	n/a	n/a	n/a	10
79-72-20 / 19905	n/a	Cr3	RP4	6.4	9.9	6.7	1
79-72-20 / 19905	n/a	Cr3	RM1	11.2	12	6.7	4
79-72-20 / 19905	n/a	Cr3	RM3	8.4	12	5.7	1
79-72-20 / 19905	n/a	Cr3	LP4	6.9	10	6.2	1
79-72-20 / 19905	n/a	Cr3	LM1	11.2	13	6.2	4
79-72-20 / 19905	n/a	Cr3	LM2	9.3	12	4.7	4
79-72-20 / 19905	n/a	Cr3	LM3	8.1	12	4.5	1
79-72-20 / 19906	n/a	Cr1	LM1	10.5	10	5.9	4
79-72-20 / 19906	n/a	Cr1	LM2	11.2	11	5.2	4
79-72-20 / 19906	n/a	Cr1	RM1	10	11	5.3	4
79-72-20 / 19906	n/a	Cr1	RM2	9.3	11	5.8	4

Appendix 16. Metrics of humeri.

Peabody object number	79-72-20 / 19912	79-72-20 / 19912	79-72-20 / 19912	78-42-20 / 15174	78-42-20 / 15174	78-42-20 / 15174
Flint's number	568	569	570	128	127	129
Philmon's number	Hu1	Hu2	Hu3	Hu4	Hu5	Hu6
Side	Right	Left	Right	Right	Left	Left
Maximum length	293	296	299	312	326	311
Biomechanical length	293	294	297	307	324	307
Bicondylar breadth	51	57	57	58	54	61
Midshaft circumference	58	58	60	64	68	75
Vertical head diameter	38	42	44	43	45	44
Maximum midshaft diameter	20	19	20	21	20	25
Minimum midshaft diameter	13	14	14	19	21	18
Septal aperature	Present	Present	Present	Absent	Present	Absent

Appendix 17. Metrics of radii.

Peabody object number	78-42-20 / 15173	78-42-20 / 15173
Flint's number	n/a	n/a
Philmon's number	Ra1	Ra2
Side	Left	Left
Maximum length	248	243
Radial biomechanical length	239	234
Radial head anterioposterior diameter	21	20
Radial midshaft circumference	41	40
Radial anteroposterior midshaft diameter	11	13
Radial medioolateral midshaft diameter	13	13

Appendix 18. Metrics of ulnae.

Peabody object number	78-42-20 / 15173	78-42-20 / 15173
Flint's number	n/a	n/a
Philmon's number	Ul1	Ul2
Side	Right	Right
Maximum length	286	276
Ulnar biomechanical length	260	250
Ulnar physiological length	256	245
Maximum anteroposterior diameter	16	16
Maximum mediolateral diameter	14	14
Ulnar minimum circumference	34	39
Trochlear notch shape	Indented and hourglass	Hourglass

Appendix 19. Metrics of femora.

Peabody object number	79-72-20 / 19911	78-42-20 / 15175	78-42-20 / 15175	78-42-20 / 15175	78-42-20 / 15175
Flint's number	n/a	139	136	138	137
Philmon's number	Fe1	Fe2	Fe3	Fe4	Fe5
Side	Left	Right	Left	Left	Left
Sex	Male	Male	Female	Male	Male
Femoral length	462	445	387	439	425
Biomechanical length	427	419	343	395	395
Bicondylar length	260	442	382	436	421
Midshaft circumference	86	83	56	87	88
Epicondylar breadth	78	75.5	70	86.5	84
Anterior-posterior midshaft diameter	29.4	28.2	17.4	29	29
Medial-lateral midshaft diameter	24.8	24.2	15.1	24.8	27
Platymeric index	118.6	116.5	115.2	116.9	107.4
Fovea capitus shape	Oval	Oval	Oval	Circular	Circular

Appendix 20. Metrics of fibulae.

Peabody object number	79-72-20 / 19914	78-72-20 / 15173
Flint's number	n/a	n/a
Philmon's number	Fi1	Fi2
Side	Left	Left
Maximum length	350	363
Midshaft diameter	15.1	n/a
Midshaft circumference	45	n/a
Cross-section shape	Triangular	Triangular

Appendix 21. Metrics of tibiae.

Peabody object number	79-72-20 / 19913	79-72-20 / 19913	79-72-20 / 19913	79-72-20 / 19914	78-42-20 / 15176	78-42-20 / 15176	78-42-20 / 15176	78-42-20 / 15176	78-42-20 / 15176	78-42-20 / 15176
Flint's number	567	565	566	591	132	131	130	135	133	134
Philmon's number	Ti1	Ti2	Ti33	Ti4	Ti5	Ti6	Ti7	Ti8	Ti9	Ti10
Side	Right	Right	Right	Left	Left	Right	Left	Left	Right	Right
Sex	Male	Male	Male	Male	Male	Probably female	Probably female	Male	Male	Male
Maximum length	371	391	373	361	360	338	325	395	374	390
Biomechanical length	360	385	365	347	343	329	316	390	366	378
Maximum proximal breadth	71	76	80	68	74.5	70.5	66	74.5	77	80
Maximum distal breadth	46	51	47	43	45	n/a	42	49	53	50
Midshaft circumference	82	84	82	76	83	78	69	84	86	84
Circumference at nutrient foramen	90	93	93	87	95	86	76	94	94	93
Anterior-posterior midshaft diameter	30	31.9	32.5	27.7	31.7	28.5	26.9	31.9	32.1	31.9
Medial-lateral midshaft diameter	19.2	21.3	20	20.2	19.1	21.2	16.6	20	21.3	20
Maximum shaft diameter at nutrient foramen	34.4	35.6	35.2	30.5	36.8	32.4	29.5	37.8	36.9	35.7
Medial-lateral shaft diameter at nutrient foramen	20.1	22.1	26.8	22.3	19.9	22.3	18	22.1	21.3	22.6
Platycnemic index	58.43	62.08	76.14	73.11	54.08	68.85	61.02	58.47	57.72	63.31
Platycnemia / saber shins	Present	Present	Absent	Absent	Present	Absent	Present	Present	Present	Absent

Appendix 22. Sex determination of crania.

Peabody object number	79-72-20 / 19906	79-72-20 / 19907	79-72-20 / 19905	79-72-20 / 19904	79-72-20 / 19903	78-42-20 / 15169	78-42-20 / 15168	78-42-20 / 15167
Flint's number	n/a	n/a	n/a	n/a	554	126	n/a	124
Philmon's number	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8
Nuchal crest score	1	5	1	5	5	3	5	5
Mastoid process score	1	4	3	5	5	3	5	5
Supraorbital margin score	2	5	4	5	5	5	5	5
Glabella score	1	5	3	5	5	3	5	5
Sex determination	Female	Male	Male	Male	Male	Male	Male	Male

Appendix 23. Description of cranium, Cr1.

Peabody object number	79-72-20 / 19906
Flint's number	n/a
Philmon's number	Cr1
Location	32 50 A4
Date of observation	12/16/2011
Bones present	Parietals, tempoals, zygomaics, lacrimas, INCs maxillae, palatines, TMJs, frontal, sphenoid, ethmoid, vomer, occipital
Dentition present	LM1, LM2, RM1, RM2. Wear score: 3 - 4.
Dentition lost antemortem	None
Dentition lost postmortem	RM3, RP4, RP3, RC, RI2, RI1, LI1, LI2, LC, LP3, LP4, LM3
Sex	Femae
Age	30.3 - 64.7
Age class	Middle to old adult
Cranial modiffication	Absent
Modification type	n/a
Weather	Discoloration
Pathology	Absent
Notes	The basalar process is either unfused or has been degraded by postmortem processes: there is a complete separation of the bones with small spicules between the two aspects. The cranium is discolored, wich may be the result of being placed "vertex down" within the cave as Flint mentioned. The different colors and sediments present on the cranium appear as a dark brown to black substance which covers most of the face, and is especially thick on the maxillae, palatines, and sphenoid. This type of discoloration is only present on the female cranium from the sample, making it unique and possibly part of postmortem ritual. Additional features on this cranium include a small circular perforation on the posterior aspect of the right parietal. There is also the presence of a congenital defect on the inferior aspect of the occpital, depressions which are inferior to the occpiital protuberance. The occpital condyles are strangly absent, possibly eroded through weathering in the cave, or removed with a sharp tool. The conyles appear as an empty outline of very thin bone.

Appendix 24. Description of cranium, Cr2.

Peabody object number	79-72-20 / 19907
Flint's number	n/a
Philmon's number	Cr2
Location	32 50 A1
Date of observation	12/13/2011
Bones present	Left partial parietal, right complete parietal, lef partial temporal, right compelte temporal, fragmentary nasals, TMJs, frontal, right partial sphenoid, partial occipital
Dentition present	None
Dentition lost antemortem	All
Dentition lost postmortem	None
Sex	Male
Age	56.2+
Age class	Old adult
Cranial modiffication	Present
Modification type	Tabular erect
Weather	None
Pathology	Vault porosity, cribra orbitalia, DJD at TMJ
Notes	The cranium is a white cream in color, distinct from the other colors in the sample. The occipital protuberance is very large in comparison to the rest of the sample. There appear to be many features that have been affected by the cranial modification, including extreme parietal bossing, very deep postorbital constriction, and a second set of constrctions at the coronal suture that has impacted the parietals, sphenoid, and temporal.

Appendix 25. Description of cranium, Cr3.

Peabody object number	79-72-20 / 19905
Flint's number	n/a
Philmon's number	Cr3
Location	32 50 A4
Date of observation	12/15/2011
Bones present	Broken right parietal, complete left parietal, broken right temporal, complete left temporal, zygomatics, lacrimals, INCs, nasals, maxillae, palatines, TMJs, broken frontal, broken right aspect of sphenoid, complete left aspect of sphenoid, ethmoid, vomer
Dentition present	RM3, RM1, RP4, RP3, LP4, LM1, LM2, LM3. Wear score: 1 - 4.
Dentition lost antemortem	None.
Dentition lost postmortem	RM2, RC, RI2, RI1, LI1, LI2, LC, LP4
Sex	Male
Age	51.5 - 64.7 (through cranial suture closure scores, not agreeable with dentition)
Age class	Old adult, though the condition of the teeth suggest a much younger individual.
Cranial modiffication	Absent
Modification type	n/a
Weather	The left aspect of the cranium is disclored with a dark orange and brown which might be a reflection of that particular side's placement in sediment or exposed to elements rightside up that the other side was not affected. The right side of the cranium buldges laterally, which may be the result of water and weathering, causin expansion of the cranial vault.
Pathology	None.
Notes	This cranium appears most likely to be the young adult mummy that was discussed by Flint. The suture closures are that of an older individual, however this might not be accurate given the weathering and cave elements that may have affected the bones. I would argue that this individual is a young adult given the emaculate condition of the teeth (very little wear, little pathology). This cranium has the prenence of soft tissue in numerous areas, consistent with Flint's description of the mummy. This cranium might also match with a tibiae and fibula in the collection that also have remains of soft tissue, aged between 20 and 23 with epiphyseal closures. As described in detail in the trauma section, there are perimortem fractures on the right aspect, and a separate healed linar wound on the posterior aspect of the right parietal.

Appendix 26. Description of cranium, Cr4.

Peabody object number	79-72-20 / 19904
Flint's number	n/a
Philmon's number	Cr4
Location	32 50 A4
Date of observation	12/14/2011
Bones present	Parietals, temporals, zygomatics, lacrimals, INCs, nasals, maxillae, palatines, TMJs, frontal, sphenoid, ethmoid, vomer, occpital
Dentition present	LM1. Wear score: 10
Dentition lost antemortem	RM3, RM2, RM1, RP3, RC, RI2, RI1, LI1, LI2, LC, LP3, LP4, LM2
Dentition lost postmortem	RP4
Sex	Male
Age	32.6 - 64.4
Age class	Middle to old adult
Cranial modiffication	Absent
Modification type	n/a
Weather	None.
Pathology	Dental infections, DMD at TMJ and occpital condyles.
Notes	
	This cranium is discolred with yellows, browns, and light tans. There are two parallel cutmarks which run anterior to posterior on the frontal bone, as well as two cutmarks on the right parietal. There is a white substance within the right orbit, which may be remains of cotton (discussed by Flint as placed within the calabashes with the crania). Most of the cranial vault consists of very thick bone, but the facial bones are particularly thin as paper. The vomer is twisted and distorted. There is one thin piece of soft tissue on the left parietal. Upon inspection of the cranium, five smal seeds fell out of the cranium, and their presence is curious, whether they are there from the cave environment, placed within at time of burial, or if Flint or other curators were measuring cranial capacity without making note.

Appendix 27. Description of cranium, Cr5.

Peabody object number	79-72-20 / 19903
Flint's number	554
Philmon's number	Cr5
Location	32 50 A4
Date of observation	12/15/2011
Bones present	Parietals, temporals, zygomatics, lacrimals, INCs, nasals, maxillae, palatines, TMJs, frontal, sphenoid, ethmoid, vomer, occpital
Dentition present	None.
Dentition lost antemortem	RM3, RM2, Rm1, RP4, RP3, LP4, LM1, LM2, M3
Dentition lost postmortem	RC, RI2, RI1, LI1, LI2, LC, LP3
Sex	Male
Age	30.3 - 64.4
Age class	Young to old adult
Cranial modiffication	Present
Modification type	Tabular erect
Weather	Discoloration
Pathology	DMD at TMJ and occipital condyles. Lytic reactions at alveolar ridge.
Notes	This cranium is discolored with brown, orange, and yellow. The lytic reaction at the alevolar ridge is extreme. One perimortem fracture is present on the left maxilla, which appears to share a relationship with the dental infection. The tabular erect cranial modification appears to be unique for this cranium as the frontal bone is much more posteriorly sloped. This may reflect a different style, different technique, or simply a more extreme reaction to the modification for this individual.

Appendix 28. Description of cranium, Cr6.

Peabody object number	78-42-20 / 15169
Flint's number	126
Philmon's number	Cr6
Location	32 50 A6
Date of observation	12/16/2011
Bones present	Parietals, temporals, TMJs, frontal, partial sphenoid, occpital
Dentition present	n/a
Dentition lost antemortem	n/a
Dentition lost postmortem	n/a
Sex	Male
Age	26.9 - 32
Age class	Young adult
Cranial modiffication	Present
Modification type	Tabular erect
Weather	None
Pathology	None
Notes	
	This cranium is a very light white and cream color, distinct from the others. It is also unique as it is fragmentary and held together with a light colored tape wrapped around the vault. The cranium is very fragile, and many of the sutures have separated, indicated a fairly young individual. Whether it was damaged prior to Flint's collection, during transport, or sometime within curation is not known. It is also not known how the cranium was wrapped, there is no indication within the Peabody records for explanation. The indiviual was originally recorded as a female, but it appears more likely to be a more gracile young male given the supraorbital margins. There is one perimortem frcture on the right parietal.

Appendix 29. Description of cranium, Cr7.

Peabody object number	78-42-20 / 15168
Flint's number	n/a
Philmon's number	Cr7
Location	32 50 A6
Date of observation	12/16/2011
Bones present	Parietals, temporals, zygomatics, lacrimals, INCs, nasals, maxillae, palatines, TMJs, frontal, sphenoid, ethmoid, vomer, occipital
Dentition present	None
Dentition lost antemortem	RM3, RM2, RM1, RP4, RP3, RI2, RI1, LP4, LM1, LM2, LM3
Dentition lost postmortem	RC, LI1, LI2, LC, LP3
Sex	Male
Age	26.9 - 54.1
Age class	Young to old adult
Cranial modiffication	Present
Modification type	Tabular erect
Weather	None
Pathology	Porosity at occipital condyles
Notes	This cranium is yellow in color, different from the others. This individual in particularly unique in terms of cranial modification and other facial features. The modification is very symmetrical, more so than the others, and has a slanted forehead (similar to Cr5). The face appears to be more prognahic. The nasals are also unique in that they are flat without a bridge. There is one perimortem fracture on the right aspect of the frontal at the juncture of the parietal, frontal, and sphenoid.

Appendix 30. Description of cranium, Cr8.

Peabody object number	78-42-20 / 15167
Flint's number	124
Philmon's number	Cr8
Location	32 50 A6
Date of observation	12/16/2011
Bones present	Parietals, temporals, zygomatics, partial lacrimals, partial INCs, nasals, maxillae, partial palatines, TMJs, frontal, sphenoid, partial ethmoid, fragmentary vomer, occipital
Dentition present	None
Dentition lost antemortem	RM3, ~RM2, RM1, RP4, ~RI1, LP3, LP4, LM1
Dentition lost postmortem	RP3, RC, RI2, LI1, LI2, ~LC, LM2, ~LM3
Sex	Male
Age	38.3 - 64.7
Age class	Middle to old adult
Cranial modiffication	Present
Modification type	Tabular erect
Weather	This is the only element from the collection that exhibits weathering damage from extensive contact with a water source. It appears that the cranium was placed upright, all weathering occurs on the inferior aspect, which has destroyed the sphenoid, parts of the occipital, and the mastoids. Initially, I thought this was a strange pathology. The effect is similar to rock erosion from a stream or river, with pitting and smooth surface perforations from water contact. Perhaps this was from dripping in the cave, or a stream of water running within the cave. The cave is noted as being dry by Flint, however the cave could have had a water supply in previous times.
Pathology	DJD at TMJ and occipital condyles
Notes	This cranium is yellow and tan in color. In place of the right central incisor, there is a brown clay substance with a circular perforation. This sticky substance might have help a prosthetic tooth or decoration, perhaps a substance which would have help a shell insert. The tooth is not present, but the root cavity is in perfect condition. This brings to mind what might have been postmortem cultural modification, and may answer why such a large proportion of teeth are missing from the collection: whether intentionally removed and replaced with decoration, or simply lost as an effect of secondary burial.

Appendix 31. Transcription of Dr. Flint's field notes.

Accession file No. 79-72
Archaeological materials from Nicaragua Various localities Peabody Museum Expedition Dr. Earl Fliny "Report of Explorations in Nicaragua, n.d. (13 sheets) Drawing of some inscriptions [missing correspondance?] Original label, 19903-7 Transcription by Dr. Clifford T. Brown and Kendra L. Philmon

Report of explorations in Nicaragua – Continued

Rock inscriptions

In addition to those found here, forward two from Liberia, Costa-Rica, taken from the face of a ledge, on the margin of Río Colorado, Hacienda of Guachipilin, - in May 1877, expedition of Flint and Bransford for the Smithsonian, Private No. 97 [37?], also No. 14 from a head stone of one of 21 guacas, near Culebra – on the right hand corner a piece was broken off with part of the inscription, - their character is different from those found here.

The following from No. 103 Figs. to 14 inclusive were found on dead mans island, selected from among many in part obliterated. This island is mentioned in my 2^{d} report – when speaking of a specimen of the rock on which they occur, No. 583 – and one of the specimens from Zapatera. In explaining the three periods, there mentioned, they are maintained as occurring after the disappearance of the "rock middens", as their implements and idols, occur in the soil above them. That was formed by eruptions from the neighboring volcano of Mombacho.

These inscriptions were probably made, at the same period as those at San Rafael, in the cave at San Andres. The same catastrophe involving both. At that time the present lake was a part of the ocean, shut in by the upheaval of the coast range. One of the inscriptions, Fig 136 that seems to represent an octopus, a monster of marine origin confirming this, two marine animals, gradually became accustomed to a life in fresh water, and are still found here in abundance, the shark and sawfish. The latter quite large. When the lake is low, inscriptions are seen below its present level—on the rocky banks of the lake, also on the ocean beach, at low tide, below Bocana.

Altho[ugh] of an inferior type to the inscriptions in the cave mentioned, they are none the less important extending as they do over a large district, and to the summit of the Cordilleras, if like those in Guatemala, time will show, and add more importance to them. The ultimate disappearance of their authors from the mountains was probably caused by this glacial epoch. One indelible mark, showing that those of the mountains were not involved in the Cataclysm, are their foot-prints on the plastic ocean bed, left exposed on the hills above San-Rafiel [sic: should be "San Rafael"]—on one of which, some 18 miles above that place, one of them, who must have visited the region soon after in jumping across a small ravine made by the retiring wash, left his footprints as he ascended the rise, followed, or following a tiger with his dog or coyote, as all three are in line. This now hard sedimentary rock is filled with fossil leaves specimens of which I have forwarded to the Smithsonian. That these people remained long after, their inscriptions testify, as they occur in the deep ravines about San Rafiel [sic], cut through this sedimentary rock.

In different localities, where the lime stone crops out, and has been worked in upper surfaces, contains compact maps [?] of fossil shells, growing harder as you descend—becoming difficult to work without blasting—and is then abandoned by the natives. These superimposed fossils, at the time of the upheaval, were undoubtedly alive in many locations, on the ocean bed—as many of them, in a fossil state, contain the entire contends—see specimens Private No. 225 to 232 at Smithsonian. They were undoubtedly the food of the cave dwellers, and perished with them.

The time that elapsed after the upheaval, and the commencement of the glacial epoch, cannot be determined; that it succeeded them and <u>preceded</u> the advent of the men of the old stone age, is plainly proven by glacial action, on that same lime-stone mentioned, southwest from Bocana, at the summit of the Guyacan Mnt [?]. (In the seams of which I have found small round, yellowish pearl shells often [?] at one side). This immense ledge, rising from the bed of the sea, to the summit of the coast range, was abraded by glacial action, leaving [bearing?] no trace of fossils. On the beach of Bocana—they are not continuous—often the rock is broken off by the waves—and the water worn shells are found there filled with solid liken [?] limestone, some of still existing species.

How to account for the different debths [sic: depths], at which some beds are found under the sedimentary rock mentioned, it being deposited around where they lay, was rolled back on itself burying the shells in the live state, often an immense debth [depth] as they occur undisturbed, lying as natural as those of the present day.

I cannot believe that men of the old stone age were pre-glacial on the hills about [above?] San-Rafiel, or if so, there its action was local, or confined to the hills south for their implements are undisturbed, lying over the supposed burials of the cave dwellers—of whose interments they seemed to be entirely ignorant—using their mounds as workshops to fabricate their rude potting & celts—implements classed as Paleolithic—over their extinct occupants, whose so called Neolithic instruments were only a few feet below, see last report Private No. 100 to 120.

The descendants of the 3^{d} period living here at the time of the conquest, were said to be Chorotegas, undoubtedly true as regards the region to the west & NW of the lake and Ometepe—yet at the islands and about Rivas, there has been found a few relics supposed to pertain to the Corbias [sic: Curlias?] of the Atlantic Coast.

Thus for this region west and south that [sic?] of the lake seems to be the point at which the northern immigration was checked; have often though that there was an intermingling of races on the island of Ometepe—in my first report of the pottery found there, the idea was broached of grade distinction, to account for three distinct modes of burial—so situated as to preclude an idea of disturbance—burials together of 3 distinct modes, if not four—one in shoe shaped jars, one in large round jars, and the last in inverted vases—besides these loose [?] burials:- am at a loss which to adopt—preferring to wait for other collections of filling [?] distant [?] from [?] here, and compare them.

Volcanic eruptions destroying a tribe would leave their handiwork for the next occupants, this would in part explain it.

As yet we have but a meager lot of drawings, none from other locations for comparison, little more is to be added, passing them to abler hands for comparison—their collection is slow and tedious – many are in places difficult of access—often on ledges in ravines, cut away below them, have in view farther explorations of the coast and other caves, and mountains. In figure 104 the cross is allied to the mountain inscriptions, while the head ornamentation of figs 106 – 14 + 19 show a similarity of tribal customs – more noticeable in fig 108-24, although in the latter figure in profile with features more apish than human—while in fig 122, the double head, surmounting the marine monster, altho [sic] dissimilar to Fig 38 of first report and of inferior execution suggests a similar conception. Figs 116 + 20 are representations of animals with a trunk or proboscis—and the latter with a prominence over the crown, quite high in comparison with the size of the animal. Fig 118 whose upper half is similar the ill figured monkeys—has a curious shaped projection or neck terminating in a large head with open mouth. fig 125-30 & 131 are certainly unique. Whether the dots were intended for unfinished line engravings or stars cannot say as no inscriptions of the kind on stone, have been found here in the Nandaime pottery, sent with my first report various figures of 5 & 8 painted stars are seen—surrounded by dots supposed to represent stars—yet this pottery pertained to the 3^{d} period. In fig 126 a huge bird with a human head in its mound, reminds one of the large stone tablets at Esquintla—in Guatemala—where a human figure, suspended by its middle from the mouth of what appears to be the head of an eagle, carved in relief was discovered by Prof Bastian—a drawing of which Dr. Berendt forwarded me in a letter, referring it to some of the sacred rites of the Quiches. The class of inscriptions seen in Fig 132 are found in many locations—occurring also in the caves, altho in the latter they are better made—our fig 36 of field report is notably well made, the angles of the cutting being acute. It might have been made by descendants long after, or the cave was exhumed, long after the upheaval and re-occupied being some 50 feet from the bottom of the ravine, which at the opposite side is 200 feet high, of that same sedimentary rock mentioned and underneath which a few miles below, occur shells 15 feet thick on the same rocky formation as the cave—back of which the ledge rises over 40 feet, then gradually runs back and rises into a hill beyond it. This cave was … [2 illegible words]—and has 2 classes of inscription—and below it, on the sides of the ravine occur others – see field report – Figs 133 & 4 occupy on east & west position being in some respects similar – Fig 135 an unrecognized animal.

Figs: 109-10-13-23-27-28-29-37-39-40-42 & 46—are probably symbolical records of actions or events, similar ones appended to Fig 126 are without doubt descriptive of what is there depicted as taking place. Figs 138&41 are probably serpents, the dots cut in line may have been left for subsequent union into one continuous line—as the figures 125-20 & 131.

Report

Explorations in Nicaragua, continued.

By Dr. Earl Flint.

19900 [Peabody accession number written in pencil in the margin] No. 551 – Zapatera – small round jaw. Above the bulge takes on a conical from, ending in a plain mouth slightly over 1 in in diameter, diam of bulge 4 in base of cone 2 ½ in , height of same 1 in height of jaw 3 ¾ in – sides strong-thick—material course clay and sand—on one side human face. Luted [sic] on – waterworn – very symmetrical.

19901 [Peabody accession number written in pencil in the margin] No. 552 – very small deep dish – coarse clay – unevenly made – sides thick – drawn in above the bulge to form the mouth, which is 1 ¾ in diameter bulge 2 ¼ and depth 1 ½ inches, use not known, probably used as a toy, Granada, east side.

19902 [Peabody accession number written in pencil in the margin] No. 553 – small stone celt – polished, conical, sides flattened, head evenly rounded – slightly truncated one side flattened – edge nearly straight evenly beveled—extreme width 1 5/8 inches length 2 ½ thickness ¾ found with No 552 in excavating for adobes in alluvium at least 10 feet below original surface –

19903-19906 [Peabody accession number written in pencil in the margin] No 554-5-6-7-8 – five additional crania, from the cave of Cucirizna [sic], making eight from that locality were obtained by opening the left hand passage - (see last report) which was completely choked with loose bones – and being very narrow—some 2 to 2 ½ feet, was at the time of my visit, supposed to terminate at the distance of 20 feet. After my return, some natives led by a desire to find treasure – cleaned it out – penetrating some 15 yds, encountering skulls, placed vertex down, in “guacales” – also the wooden stool No 561. They took some of the best “guacales” and the stool, upsetting the skulls, save one, which was found in situ as forwarded. Their light gave out, causing them to abandon it – one of the men, who accompanied me last year, was induced to go alone, and bring me, what was left—he reports that No 560 was found beside No 557 and the former visitants stated to him, that a 2^{d} “guacal” was used as a cover and that in one they had found cotton, underneath the skull. The 3 remaining skulls lay on the floor of the cave and the jaws apart from them. No 558 had been pitched to the bottom of the ravine, during a visit by a priest some 17 years ago with a number of others, its extreme thickness preventing fracture.

Viewed together, these skulls show a remarkable difference—No 554 appears much larger than No 557 while in circumference it exceeds it by one an ½ inches—in the former the parietal protuberance and occipital are largely developed on the right side, notwithstanding the flatness of the occipital, the bulk of brain was back of the mesial line – the skull falling back when lying on a level surface. The zygoma is remarkably developed greatest diameter six 1/8 in – while internally from articular to zygomatic process it is one and ½ inches showing very large temporal muscles: the superciliary ridge is prominent, the orbital cavities deep and quadrangular, (in all) skull thick, weighing 1/3 more than usual. In all, the convolutions are deep under the protuberances, while around them the arterial canals are deep and profuse, showing augmented blood supply at these places. Notwithstanding the width of the zygoma, it remains hidden when looking down from the back centre of the parietal bones. Both No 554 & 57 have the nasal bones prominent—the latter altho it has a cerebral protuberance—maintains an upright position on a level surface. The same applies to No 555. Both of these are symmetrical, the latter has the flattened cerebrum but the coronal prominence is quite marked. The frontal bone prominently arched. No distortion noticeable in either: in the latter the depression between the parietal bones is wanting and is only slight in the former and in No 556. In 554 & 7 the incisors project—more than in the other two, this is more noticeable if viewed by the vertical method, of Professor Blumenbach. No 557 is of an adult female, in the bottom of the "guacal" and adherent to it—are a few short, straight, brownish hairs – also on skull 554 are two pieces of dry integument, with a few short yellowish hairs, the hair was probably cut short before preparing the skull for interment. There seems to be no substance used to preserve them, altho the female skull has a smoky appearance—sweating in moist air—on the roof of the upper maxillary, the integument is still adherent – of a black color. A piece also adheres to a lower jaw No 556 – this suggests their accompanying the skulls, originally. Before packing the "Guacal" No 559, a faint impression was noticed on one side of fine cloth – No comparison of weight of jaw to skull was made, of those accompanying the skulls, were selected from 6 brought me by the native[1]. In No 554 the long diameter is .12 less lateral .69, and vertical .75 more- in No 555 long Diam .25 lateral .37, and vertical .87 more. In 556 long .25 less lateral .50 and vertical .62 more – in 557 ling[l] .50 and lateral .33 less and vertical .18 more in No 558 (broken) ling[l] .12 and lateral .75 more—than the average Caucasian – measured in inches.

The average index of breath in the five is 923, of the width in four .883, which is over the average of the mound builders and the California skulls tabulated in the 11th report of the museum while the average facial angle is only 71 ½.

The following table in inches shows the measurement—complete for the four perfect ones and in part for the broken one.

Facial angle	Capacity	Longitudinal diameter	Lateral diameter	Vertical diameter	Frontal breadth	Foramen magnum anter-posterior diameter	Trasverse diameter	Frontal arch	Parietal arch
69	72	6 3/8	6 3/16	5 3/4	3 3/4	1 1/2	1 1/8	12	10 1/2
74	83	6 3/4	5 7/8	5 13/16	3 7/8	1 9/16	1 1/4	10 1/4	12 1/2
73	Broke	6 1/4	6	5 5/8	3 3/4	1 3/8	1 1/8	11 1/2	12 1/2
70	69	6	5 3/16	5 3/16	3 7/16	1 1/4	15/16	10	11 1/2
Broke	Broke	6 5/8	6 1/4		4				

Occipital arch	Longitudinal arch	Length of frontal	" " parietal	" " occipital	Zygomatic diameter	Circumference	Distance of occipital protuberance from foramen magnum after Hyman (?)
10	13 1/4	4 3/8	5 1/4	4 1/2	6 1/8	19 1/2	2
10 3/4	13 1/2	4 1/4	5 1/4	4	5 3/4	19 1/2	2
9 3/4	12 1/2	3 1/2	5	4 1/4	5 1/2	19 1/4	1 7/8
9 1/4	12 1/4	3 1/2	5	4	4 7/8	18	2+

[1] Intending to visit the cave in person, sent a man previously, fearing to lose them before I could realize my trip.

The succeeding table shows the measure of 4 tibiae, three humeri, and one femur (this femur was mentioned in my last report and was overlooked in packing). Tibia and humeri are playenemic. Humerus No 570 and tibia 571 with attached fibula were parts of a skeleton lying on the bottom of the cave, and as the integument, was in part adherent. The bones being similar to those found separated, it is supposed to have been placed there with the rest, right humerus and left tibia 565, 6 & 7 are left tibia, 569 left humerus, 568 right.

Bone	Length in centimeters	Largest diameter in mil m.	Smallest diameter in mm	Approximate heigh of individual in ft + in
Tibia 565	39 1/2	35	22	5 3/4
" 566	37 1/2	33	21	5 7/12
" 567	37 1/2	31	20	5 7/12
" 571	36 1/2	30	21	5.6 1/2 [sic]
Humerus 570	33			[parentheses on right margin indicate connection to row above]
Humerus 569	30			5 1/2
568	28			5 1/6
Femur 140				6 1/12

Humerus N° 569 has the perforation at the sigmoid cavity complete it is 4 mm long by 3 mm wide. In N° 570 it is 4 ½ mm long by 3 ½ mm wide. While in No 568 two small perforations are seen.

On tibia No 565 a small node is seen near the center in front – result of some injury. In detached jaws, the caudal tooth fully developed with two complete fangs.

The guacals N° 559 & 560 are well preserved – first contains the female skull – is cracked in 3 places – on each side of which holes were drilled to mend it. No signs of cord found – this mode of mending is still in vogue here.

No 561—Wooden stool, as perfect as when it was made—the only specimen in wood I ever saw in a residence of here of over 28 years. At the time of the conquest mention was made of them, at El Viejo—used by the chiefs for a seat of state in the day and as a pillow at night—called "Duho". In 1875, sent one made of stone supporting an Idol—both of one block—to the Smithsonian—another similar one was forwarded by Cap^{tn} Branch—to same place but not delivered. It was 7 in high, including Idol, beautifully made—description was received by Prof. Baird. The stool shows marks of the tool used in its cutting—material resembles the ordinary rosewood—still found here—feet project toward the end, giving the seat, at the point requiring the greatest resistance—and also avoid tilting—feet 2 ¾ inches long and 1 ½ thick—point 1 ¾ wide 1 thick. Seat 11 ½ inches long, ends 5 1/8 in wide centre 5 ½. Thickness ½ inch—depression of curve at centre 7/8 of an inch—upper surface well polished.

No 582 – two cylindrical beads wrought from sea shells – 12 & 14 mm long 6 mm diameter – hole 2 mm decreasing at centre – drilled from each end – Another No 563 of similar make from soft green-stone 1 in long 5/16 in diameter. No 564 part of a small sea shell ...[illegible] … These were [found at?] bottom of cave.

(End transcription)

REFERENCES

Adams, Bradley J., and Lyle W. Konigsberg
2008 How Many People? Determining the Number of Individuals Represented by Commingled Human Remains. *In* Recovery, Analysis, and Identification of Commingled Human Remains. Bradley J. Adams and John E. Byrd, eds. Pp. 241-256. Totowa, NJ: Humana Press.

Aguero, Adriana, and Annick Daneels
2009 Playing Ball – Competition as a Political Tool. *In* Blood and Beauty: Organized Violence in the Art and Archaeology of Mesoamerica and Central America. Heather Orr and Rex Koontz, eds. Pp. 117-138. Los Angeles, CA: The Cotsen Institute of Archaeology Press.

Baker, Suzzanne M.
2007 Discovery of Rock Art in Nicaragua. http://www.bradshawfoundation.com/news/index.php?subaction=showfull&id=1188901883&archive=&start_from=&ucat=2&.

Ballinger, Diane A.
1986 Ossuary Burial of Cremated Human Remains from Copan, Honduras. Houston, TX: University of Houston-University Park.

Bass, William M.
2005 Human Osteology: A Laboratory and Field Manual, 5th edition. Missouri Archaeological Society Inc.

Beeker, Charles D., Geoffrey W. Conrad, and John W. Foster
2002 Taino Use of Flooded Caverns in the East National Park Region, Dominican Republic. Journal of Caribbean Archaeology 3:1-26.

Berryman, Carrie Anne
2007 Captive Sacrifice and Trophy Taking Among the Ancient Maya. *In* The Taking and Displaying of Human Body Parts as Trophies by Amerindians. Richard J. Chacon and David H. Dye, eds. Pp. 377-399. Boston, MA: Springer.

Beta Analytic Inc.
2012a Pretreatment Glossary: Standard Pretreatment Protocols at Beta Analytic. 4985 SW 74 Court, Miami, FL 33155.

Beta Analytic Inc.
2012b Final Report – Analysis. 4985 SW 74 Court, Miami, FL 33155.

Beta Analytic Inc.
2012c Calendar Calibration at Beta Analytic. 4985 SW 74 Court, Miami, FL 33155.

Blom, D.E.
2005 Embodying Borders: Human Body Modification and Diversity in Tiwanka Society. Journal of Anthropological Archaeology 24:1-24.

Blom, D.E., B. Hallgrimsson, L. Keng, M.C. Lozada Cerna, J.E. Buikstra
1998 Tiwanka "Colonization": Bioarchaeological Implications for Migration in the Moquegua Valley, Peru. World Archaeology 30:238-261.

Blom, Frans
1954 Ossuaries, Cremation and Secondary Burials among the Maya of Chiapas, Mexico. Journal de la Societe des Americanistes. Tome 43:123-136.

Blomster, Jeffrey P.
2002 What and Where is Olmec Style? Regional Perspectives on Hollow Figurines in Early Formative Mesoamerica. Ancient Mesoamerica 13:171-195.

Blomster, Jeffrey P.
2011 Bodies, Bones, and Burials: Corporeal Constructs and Enduring Relationships in Oaxaca, Mexico. *In* Living with the Dead: Mortuary Ritual in Mesoamerica. James L. Fitzsimmons and Izumi Shimada, eds. Pp. 102-160. Tucson, AZ: The University of Arizona Press.

Boremanse, Didier
1993 The Faith of the Real People: The Lacandon of the Chiapas Rain Forest. *In* South and Meso-American Native Spirituality: From the Cult of the Feathered Serpent of the Theology of Liberation. G. Gossen, ed. Pp. 325-351. New York, NY: Crossroad.

Bovallius, Carl
1886 Nicaraguan Antiquities. Svenska sallskapet for antropologi och geografi.Stockholm.

Brady, James E.
1991 Caves and Cosmovision at Utatlan. California Anthropologist 18(1):11-24.

Brady, James E., and George Veni
1992 Man-made and Pseudo-Karst Caves: The Implications of Subsurface Features within Maya Centers. Geoarchaeology 7(2):149-167.

Brady, James E.
1995 A Reassessment of the Chronology and Function of Gordon's Cave #3, Copan, Honduras. Ancient Mesoamerica 6:29-38. Cambridge: Cambridge University Press.

Brady, James E., George Hasemann, and John Fogarty
1995a Harvest of Skulls and Bones. Archaeology 48(3):36-40.

Brady, James E., George Hasemann, and John Fogarty
1995b Buried Secrets, Luminous Find. Archaeology 48(3):36-40.

Brady, James E., George Hasemann, and John Fogarty
1996 In the Palace of the Sacred Ancestors: Exploring Honduras' Cave of the Glowing Skulls. Aboard Magazine, Jan/Feb. Pp. 10-18.

Brady, James E., and Wendy Ashmore
1999 Mountains, Caves, Water: Ideational Landscapes of the Ancient Maya. *In* Archaeologies of Landscape: Contemporary Perspectives. Wendy Ashmore and A. Bernard Knapp, eds. Pp. 124-145. Malden, MA: Blackwell Publishers.

Brady, James E.
2000 Scientific Summary of the Talgua Archaeological Project. www.calstatela.edu/academic/anthro/tagua.htm. Accessed 01/2012.

Brady, James E.
2000 Scientific Summary of the Talgua Archaeological Project. www.calstatela.edu/academic/anthro/tagua.htm. Accessed 01/2012.

Brady, James E., Christopher Begley, John Fogarty, Donald J. Stierman, Barbara Luke, and Ann Scott
2000 Talgua Archaeological Project: A Technical Assessment. www.calstatela.edu/academic/anthro/talgua_pre.htm. Accessed 01/2012.

Brady, James E. and Keith M. Prufer
2005 In the Maw of the Earth Monster: Mesoamerican Ritual Cave Use. Austin, TX: University of Texas Press.

Bransford, John Francis
1881 Archaeological Researches in Nicaragua. Volume 25, Issue 2. Washington, D.C.: Smithsonian Institute.

Brothwell, Don, and A.T. Sandison (eds.)
1967 Disease in Antiquity: A Survey of the Diseases, Injuries and Surgery of Early Populations. Springfield, IL: Charles C Thomas Publisher.

Brown, Clifford T.
2005 Caves, Karst, and Settlement at Mayapán, Yucatán. *In* In the May of the Earth Monster: Mesoamerican Ritual Cave Use. James E. Brady and Keith M. Prufer, eds. Pp. 373 – 402. Austin, TX: University of Texas Press. The Linda Schele Series in Maya and Pre-Columbian Studies.

Brown, Clifford T.
2012 Personal communication, artifact analysis at Harvard University's Peabody Museum.

Buikstra, Jane E., and Douglas H. Ubelaker
1994 Standards for Data Collection from Human Skeletal Remains: Proceedings of a Seminar at The Field Museum of Natural History Organized by Jonathan Haas. Arkansas Archeological Survey Research Series No. 44.

Buikstra, Jane E., T. Douglas Price, Lori E. Wright, and James A. Burton
2004 Tombs from the Copan Acropolis: A Life-History Approach. *In* Understanding Early Classic Copan. Ellen E. Bell, Marcello A. Canuto, and Robert J. Sharer, eds. Pp. 191-212. Philadelphia, PA: University of Pennsylvania Museum of Archaeology and Anthropology.

Buriánek, David, and Petr Hradecký
2011 The volcano-tectonic evolution of the Miocene Santa Lucía Volcano, Boaco district, Nicaragua. Journal of Geosciences 56:27-41.

Buxton, LHD
1938 Platymeria and Platycnemia, Journal of Anatomy 73:31-36. (63.31).

Buzon, M.R.
2006 Health of the Non-elites at Tombos: Nutritional and Disease Stress in New Kingdom Nubia. American Journal of Physical Anthropology 130:26-37.

Coe, Michael D., and Rex Koontz
2008 Mexico: From the Olmecs to the Aztecs, 6th edition. London: Thames and Hudson Ltd.

Cohodas, Marvin
1975 The Symbolism and Ritual Function of the Middle Classic Ball Game in Mesoamerica. American Indian Quarterly 2(2):99-130.

Conrad, Geoffrey W., John W. Foster, Charles D. Beeker
2001 Organic Artifacts from the Manatial de la Aleta, Dominican Republic: Preliminary Observations and Interpretations. Journal of Caribbean Archaeology 2:1-20.

Cope, Janet M., Alison C. Berryman, Debra L. Martin, and Daniel D. Potts
2006 Robusticity and Osteoarthritis at the Trapeziometacarpal Joint in a Bronze Age Population from Tell Abraq, United Arab Emirates. American Journal of Physical Anthropology 126:391-400.

Curet, L. Antonio
1996 Ideology, Chiefly Power, and Material Culture: An Example from the Greater Antilles. Latin American Antiquity 7(2):114-131.

D'Ambrosia, Robert D., and Gerald L. MacDonald
1975 Pitfalls in the Diagnosis of Osgood-Schlatter Disease. Clinical Orthopedics and Related Research110:206-209.

Diehl, Richard A.
2004 The Olmecs: America's First Civilizations. London: Thames and Hudson.

DiGangi, Elizabeth A., Jonathan D. Bethard, and Lynne P. Sullivan
2010 Differential Diagnosis of Cartilaginous Dysplasia and Probable Osgood-Schlatter's Disease in a Mississippian Individual from East Tennessee. International Journal of Osteoarchaeology 20:424-442.

Dixon, Boyd, George Hasemann, Pastor Gomez, James Brady, and Marilyn Beaudry-Corbett
1998 Multiethnicity or Multiple Enigma: Archaeological Survey and Cave Exploration in the Rio Talgua Drainage, Honduras. Ancient Mesoamerica 9:327-340.

Duncan, William N.
2009 Cranial Modification among the Maya: Absence of Evidence or Evidence of Absence. *In* Bioarchaeology and Identity in the Americas. Kelly J. Knudson and Christopher M. Stojanowski, eds. Pp. 177-193. Gainesville, FL: University Press of Florida.

Eeckhout, Peter, and Lawrence Stewart Owens
2008 Human Sacrifice at Pachacamac. Latin American Antiquity 19(4):375-398.

Ehrenbord, Jan
1996 A New Stratigraphy for the Tertiary Volcanic Rocks of the Nicaraguan Highland. Geological Society of America Bulletin 108(7):830-842.

Espinoza Pérez, Edgar, Laraine Fletcher, and Ronaldo Salgado Galeano
1996 Arqueología de las Segovias: Una Secuencia Cultural Preliminar. Managua: Instituto Nicaragüense de Cultura and Organización de los Estados Americanos.

Espinoza Pérez, Edgar
1999 Investigationes Arqueológicas en el Trópico Seco de Boaco: San Lorenzo. En revista Huellos 1:35-48. Instituto Nicaragüense de Cultura

Faulhaber, J.
1965 La población de Tlatilco, Mexico, caracterizada por sus entierros. *In* Homenaje a Juan Comas en su 65 Aniversario, Vol. 2, Pp. 83-121. Mexico City: Instituto Indigenista Interamericano.

Fernandez de Oviedo, and G. Valdez
1959 Historia general y natural de las Indias. In Biblioteca de Autoer Espanoles, vols. 117-122. Madrid: Ediciones Atlas.

Fitzsimmons, James L.
2009 Death and the Classic Maya Kings. Austin, TX: University of Texas Press.

Fitzsimmons, James L.
2011 Perspectives on Death and Transformation in Ancient Maya Society: Human Remains as a Means to an End. *In* Living with the Dead: Mortuary Ritual in Mesoamerica. James L. Fitzsimmons and Izumi Shimada, eds. Pp. 53-77. Tucson, AZ: The University of Arizona Press.

Flint, Earl
1879 Report of Explorations in Nicaragua, n.d. Archaeological Material from Nicaragua, Various Localities. Manuscript. Peabody Museum Expedition. Accession File 79-72.

Flint, Earl
1880 Field Correspondence between Flint and Putnam, Archaeological Material from Nicaragua – Various Localities. Peabody Museum Expedition. Accession File 80-27.

Flint, Earl
1882 Antiquities of Nicaragua – Origin of the Palenque Builders: A Letter from Dr. Earl Flint to Dr. Engelman. The American Antiquarian and Oriental Journal (1880 – 1914) 4(4):289-303.

Fowler, Chris
2004 The Archaeology of Personhood: An Anthropological Approach. New York, NY: Routledge.

Galloway, Alison
1999 Fracture Patterns and Skeletal Morphology: Introduction and the Skull. *In* Broken Bones: Anthropological Analysis of Blunt Force Trauma. Alison Galloway, ed. Pp. 63-80. Springfield, IL: Charles C Thomas Publisher LTD.

García Moll, Roberto, Daniel Juárez Cossío, Carmen Pijoan Aguade, María Elena Salas Cuesta, and Marcel Salas Cuesta
1991 Catálogo de Entierros de San Luis Tlatilco, México, Temporada IV. Instituto Nacional de Antropología e Historia. México: Serie Antropología Física-Arqueología.

Garza, Sergio, James E. Brady, and Christian Christensen
2001 Balam Na Cave 4: Implications for Understanding Preclassic Cave Mortuary Practices. California Anthropologist 28(1):15-21.

Geller, Pamela L.
2011 Getting a Head Start in Life: Pre-Columbian Maya Cranial Modification from Infancy to Ancestorhood. *In* The Bioarchaeology of the Human Head: Decapitation, Decoration, and Deformation. Michelle Bonogofsky, ed. Pp. 241-261. Gainesville, FL: University Press of Florida.

Genovés, Santiago
1964 Introduccion al Estudio de la Proporcion Entre los Huesos Largos y la Reconstruccion de la Estatura en Restos Mesoamericanos. Anales de Antropologia 1:47-62. Mèxico: Instituto de Investigaciones Historicas, Univeridad Nacional Autonoma de Mexico.

Genovés, Santiago
1967 Proportionality of Long Bones and Their Relation to Stature among Mesoamericans. American Journal of Physical Anthropology 26:67-77.

Ginter, J.
2005 A Test of the Effectiveness of the Revised Maxillary Suture Obliteration Method in Estimating Adult Age at Death. Journal of Forensic Sciences 50:1303-1309.

Glassman, David M., and Juan Luis Bonor Villarejo
2005 Mortuary Practices of the Prehistoric Maya from Caves Branch Rock Shelter, Belize. *In* Stone Houses and Earth Lords: Maya Religion in the Cave Context. Keith M. Prufer and James E. Brady, eds. Pp. 285-296. Boulder, CO: University of Colorado Press.

Glencross, Bonnie A.
2011 Skeletal Injury Across the Life Course. *In* Social Bioarchaeology. Sabrina C. Agarwal and Bonnie A. Glencross, eds. Pp. 390-409. Malden, MA: Wiley-Blackwell.

Gordon, George Byron
1898 Memoirs of the Peabody Museum of American Archaeology and Ethnology, Harvard University. Vol. 1 – No. 5. Caverns of Copan, Honduras. Report on Explorations by the Museum, 1896-97. Cambridge: Published by the Museum.

Gorin, franck, and D. Riga
1988 Archéologie de Chontales, Nicaragua: ultimes recherches t esquisse d'un cadre chronologique. Journal de la Sociee des Américanistes. Tome 74. Pp. 183 – 192.

Guillemin, George F.
1967 The Ancient Cakchiquel Capital of Iximche. Expedition, Winter:22-35.

Guimarães, Paulo R., Jr., Mauro Galetti, and Pedro Jordano
2008 Seed Dispersal Anachronisms: Rethinking the Fruits Extinct Megafauna Ate. PLoS ONE 3(3): e1745.doi:10.1371/journal.pone.0001745.

Haberland, Wolfgang
1986 Settlement Patterns and Cultural History of Ometepe Island, Nicaragua. *In* Prehistoric Settlement Patterns of Costa Rica. F.W. Lange and L. Norr, eds. Urbana: Journal of the Steward Anthropological Society 14 (1982-1983):369-386.

Haberland, Wolfgang
1992 The Culture History of Ometepe Island: Preliminary Sketch (Survey and Excavations, 1962-1963). *In* The Archaeology of Pacific Nicaragua. Albuquerque, NM: University of New Mexico Press. Pp. 63 – 117.

Hauser, Vienna G., and G.F. De Stefano
1989 Epigenetic Variants of the Human Skull. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung.

Healy, Paul F.
1974 The Cuyamel Caves: Preclassic Sites in Northeast Honduras. American Antiquity 39(3):435-447.

Healy, Paul F.
1980 The Archaeology of the Rivas Region, Nicaragua. Ontario, Canada: Wilfrid Laurier University Press.

Healy, Paul F.
1989 The Archaeology of Honduras. *In* The Archaeology of Lower Central America. Frederick W. Lange and Doris Z. Stone, eds. Pp. 113- 161. Albuquerque, NM: University of New Mexico Press.

Healy, Paul F.
2007 The Anthropology of Mesoamerican Caves. Reviews in Anthropology 36:245-278.

Heaton, T.J., P.J. Reimer, M.G.L. Baillie, E. bard, A. Balyliss, J.W. Beck, P.G. Blackwell, C. Bronk Ramsey, C.E. Buck, G.S. Burr, R.L. Edwards, M. Friedrich, P.M. Grootes, T.P. Guilderson, I. Hajdas, A.G. Hogg, K.A. Hughen, K.F. Kaiser, B. Kromer, F.G. McCormac, S.W. Manning, R.W. Reimer, D.A. Richards, J.R. Southon, S. Talamo, C.S.M. Turney, J. van der Plicht, and C.E. Weyhenmeyer
2009 INTCAL09 and MARINE09 Radiocarbon Age Calibration Culves, 0-50,000 Years Cal BP. Radiocarbon 51(4):1111-1150.

Herrera, Antonio de
1728 Historia General de las Indias Occidentles o Los Hechos de los Castellanos en las Islas y Terra Firme del Mar Oceano. Amberes: Juan Bautista Verdussen.

Herrmann, Nicholas
2002 GIS Applied to Bioarchaeology: An Example from the Rio Talgua Caves in Northeast Honduras. Journal of Cave and Karst Studies 64(1):17-22.

Herrmann, Nicholas, Derek C. Benedix, Ann M. Scott, and Valerie A. Haskins
n.p. A Brief Comment on Function Use of Intentionally Filed Teeth: Cuerva de las Aranas Tooth Paper. http://130.18.228.15/Aranas/aranpap.htm.

Hirschhorn, Joel N., Cecilia M. Lindgren, Mark J. Daly, Andrew Kirby, Stephen F. Schaffner, Noel P. Burtt, David Altshuler, Alex Parker, John D. Rioux, Jill Platko, Daniel Gaudet, Thomas J. Hudson, Leif C. Groop, and Eric S. Lander
2001 Genomewide Linkage Analysis of Stature in Multiple Populations Reveals Several Regions with Evidence of Linkage to Adult Height. American Journal of Human Genetics 69: 106-116.

Hoshower, Lisa M., Jane E. Buikstra, Paul S. Goldstein, and Ann D. Webster
1995 Artificial Cranial Deformation at the Omo M10 Site: A Tiwanka Complex from the Moquegua Valley, Peru. Latin American Antiquity 6(2):145-164.

Howe, Henry F.
1985 Gomphothere Fruits: A Critique. The American Naturalist 125(6):853-865.

Jacobi, Keith P.
2007 Disabling the Dead: Human Trophy Taking in the Prehistoric Southeast. *In* The Taking and Displaying of Human Body Parts as Trophies by Amerindians. Richard J. Chacon and David H. Dye, eds. Pp. 299-338. Boston, MA: Springer.

Janzen, Daniel H. and Paul S. Martin
1982 Neotropical Anachronisms: The Fruits the Gomphotheres Ate. Science 215:19-27.

Joyce, Rosemary A.
1999 Social Dimensions of Pre-Classic Burials. *In* Social Patterns in Pre-Classic Mesoamerica. David C. Grove and Rosemary A. Joyce, eds. Pp. 15-47. Washington, D.C.: Dumbarton Oaks.

Joyce, Rosemary A.
2001 Burying the Dead at Tlatilco: Social Memories and Social Identities. *In* New Perspectives on Mortuary Analysis. Meredith Chesson, ed. Pp. 12-26. Papers of the Archaeology Division of the American Anthropological Association No. 10. Washington, D.C.

Joyce, Rosemary A., and John S. Henderson
2001 Beginnings of Village Life in Eastern Mesoamerica. Latin American Antiquity 12(1):5-23.

Jurmain, Robert
1999 Stories from the Skeleton: Behavioral Reconstruction in Human Osteology. Amsterdam, The Netherlands: Gordon and Breach Publishers.

Killam, Edward W.
1990 The Detection of Human Remains. Springfield, IL: Charles C Thomas Publisher.

Knudson, Kelly J., and Christopher M. Stojanowski
2008 New Directions in Bioarchaeology: Recent Contributions to the Study of Human Social Identities. Journal of Archaeological Research 16:397-432.

Larsen, Clark Spencer
2002 Bioarchaeology: The Lives and Lifestyles of Past People. Journal of Archaeological Research 10(2):119-166.

Lekovic, Gregory P., Brenda J. Baker, Jill M. Lekovic, Mark C. Preul
2007 New World Cranial Modification Practices: Historical Implications for Pathophysiology of Cognitive Impairment in Deformational Plagiocephaly. Neurosurgery 60:1137-1147.

Logan, M.H., C.S. Sparks, R.L. Jantz
2003 Cranial Modification among 19th Century Osages: Admixture and Loss of an Ethnic Marker. Plains Anthropologist 48:209-224.

Lovejoy, C.O.
1985 Dental Wear in the Libben Population: Its Functional Pattern and Role in the Determination of Adult Skeletal Age at Death. American Journal of Physical Anthropology 68:47-56.

Madrigal, Lorena
1998 Statistics for Anthropology. New York, NY: Cambridge University Press.

Mann, Robert
2005 Photographic Regional Atlas of Bone Disease: A Guide to Pathologic and Normal Variation the Human Skeleton, 2nd edition. Springfield, IL: Charles C Thomas Publisher Ltd.

Marcus, Joyce
2003 Recent Advances in Maya Archaeology. Journal of Archaeological Research 11(2):71-148.

Márquez, Lourdes, and Andres del Ángel
1997 Height among Prehispanic Maya of the Yucatan Peninsula: A Reconsideration. *In* Bones of the Maya: Studies of Ancient Skeletons. Stephen L. Whittington and David M. Reed, eds. Pp. 51-61. Washington, D.C.: Smithsonian Institution Press.

Mauter, Carlos Rincon
2005 Sacred Caves and Rituals from the Northern Mizteca of Oaxaca, Mexico: New Revelations. *In* In the Maw of the Earth Monster: Mesoamerican Ritual and Cave Use. James E. Brady and Keith M. Prufer, eds. Pp. 117-152. Austin, TX: University of Texas Press.

Mays, Simon
2006 The Osteology of Monasticism in Medieval England. *In* Social Archaeology of Funerary Remains. R. Gowland and C.J. Knusel, eds. Pp. 179-189. Oxford: Oxbow Books.

Mays, Simon
2010 The Archaeology of Human Bones, 2nd edition. New York, NY: Routledge.

Mazariegos, Oswaldo Chinchilla
2009 Games, Courts, and Players at Cotzumalhuapa, Guatemala. *In* Blood and Beauty: Organized Violence in the Art and Archaeology of Mesoamerica and Central America. Heather Orr and Rex Koontz, eds. Pp. 139-160. Los Angeles, CA: The Cotsen Institute of Archaeology Press.

McAnany, Patricia A.
2011 Towards a Hermeneutics of Death: Commentary on Seven Essays Written for Living with the Dead. *In* Living with the Dead: Mortuary Ritual in Mesoamerica. James L. Fitzsimmons and Izumi Shimada, eds. Pp. 231-240. Tucson, AZ: University of Arizona Press.

McCafferty, Geoffrey G., and Larry Steinbrenner
2005 Chronological Implications for Greater Nicoya from the Santa Isabel Project, Nicaragua. Ancient Mesoamerica 16:131-146.

McCafferty, Sharisse, Geoffrey McCafferty, Celise Chilcote, and Andrea Waters-Rist
2011 Raising the Dead: Mortuary Patterns in Pacific Nicaragua. Paper presented in the symposium Re-Conceptualizing Nicaraguan Prehistory, SAA conference, 2011, Sacramento, CA.

McGee, R. Jon
1990 Life, Ritual, and Religion Among the Lacandon Maya. Belmont, CA: Wadsworth Publishing Company.

McNatt, Logan
1996 Cave Archaeology of Belize. Journal of Cave and Karst Studies 58(2):81-99.

MetCalfe, Jessica Z.
2005 Multiple Histories: The Archaeology, Ethnohistory, Oral History, and National History of Iximche', Guatamala. Totem: The University of Western Ontario Journal of Anthropology, Article 9, 13(1):61-72.

Moss, Melvin L.
1958 The Pathogenesis of Artificial Cranial Deformation. The American Journal of Physical Anthropology 16(3):269-286.

Nagy, Annie
2008 An Osteological Analysis of Ten Human Crania from Costa Rica. Annals of Carnegie Museum 76(4):265-278.

Nickens, Paul R.
1976 Stature Reduction as an Adaptive Response to Food Production in Mesoamerica. Journal of Archaeological Science 3:31-41.

O'Brien, T.G., and I. L-A. Sensor
2008 On the Effect of Cranial Deformation in Determining Age from Ectocranial Suture Closure. Growth, Development & Aging 71:23-33.

O'Brien, T.G., and A.M. Stanley
2011 Boards and Cords: Discriminating Types of Artificial Cranial Deformation in Prehispanic South Central Andean Populations. International Journal of Osteoarchaeology. Doi: 10.1002/oa. 1269.

Oeschger, H., U. Siegenthaler, U. Schotterer, and A. Gugelmann
1975 A Box Diffusion Model to Study the Carbon Dioxide Exchange in Nature. Tellus 27(2):168-192.

Ortner, Donald
2003 Identification of Pathological Conditions in Human Skeletal Remains, 2nd edition. New York, NY: Academic Press.

Ostapkowicz, Joanna, Christopher Bronk Ramsey, Alex Wiedenhoeft, Fiona Brock, Tom Higman, and Samuel Wilson
2011 'This relic of antiquity': Fifth to Fifteenth Century Wood Carvings from the Southern Lesser Antilles. *In* Communities in Contact: Essays in Archaeology, Ethnohistory, and Ethnography of the Amerindian Circum-Caribbean. Corrine L. Hofman and Anne van Duijvenbode, eds. Pp. 137-170. Leiden: Sidestone Press.

Ostapkowicz, Joanna, Alex Wiedenhoeft, Christopher Bronk Ramsey, Erika Ribechini, Samuel Wilson, Fiona Brock, and Tom Higman
2011 'Treasures…of Black Wood, Brilliantly Polished': Five Examples of Taino Sculpture from the Tenth-Sixteenth Century Caribbean. Antiquity 85:942-959.

Owen, Vanessa A.
2005 A Question of Sacrifice: Classic Maya Cave Mortuary Practices at Barton Creek Cave, Belize. *In* Stone Houses and Earth Lords: Maya religion in the Cave Context. Keith M. Prufer and James E. Brady, eds. Pp. 323-340. Boulder, CO: University Press of Colorado.

Owsley, Douglas W., Karin S. Bruwelheide, Laurie E. Burgess, and William T. Billeck
2007 Human Finger and Hand Bone Necklaces from the Plains and Great Basin. *In* The Taking and Displaying of Human Body Parts as Trophies by Amerindians. Richard J. Chacon and David H. Dye, eds. Pp. 124-166. Boston, MA: Springer.

Peregrine, Peter N., and Melvin Ember
2001 Encyclopedia of Prehistory Volume, Volume 5: Middle America. New York, NY: Kluwer Academic/ Plenum Publishers, published in conjuncture with the Human Relations Area File at Yale University.

Perez, S. Ivan
2007 Artificial Cranial Deformation in South America: A Geometric Morphometrics Approximation. Journal of Archaeological Science 34:1649-1658.

Petryshyn, Jaroslaw Theodore
2005 A Lacandon Religious Ritual in the Cave of God Tsibana at the Holy Lake of Mensabok in the Rainforest of the Chiapas. Pierre Robert Colas, translator and editor. *In* The Maw of the Earth Monster: Mesoamerican Ritual Cave Use. James E. Brady and Keith M. Prufer, eds. Pp. 326-341. Austin, TX: University of Texas Press.

Piña Chan, R.
1958 Tlatilco. 2 vols. Instituto Nacional de Antropología e Historia. Serie Investigaciones, No. 1-2. México, D.F.

Pool, Christopher A.
2007 Olmec Archaeology and Early Mesoamerica. Cambridge, NY: Cambridge World Archaeology.

Porter, Muriel N.
1953 Tlatilco and the Pre-Classic Cultures of the New World. Viking Fund Publications in Anthropology No. 19. New York: Wenner-Gren Foundation for Anthropological Research.

Prufer, Keith M., and James E. Brady, eds.
2005 Stone Houses and Earth Lords. Boulder, CO: University Press of Colorado.

Pugh, Timothy W.
2005 Caves and Artificial Caves in Late Postclassic Maya Ceremonial Groups. *In* Stone Houses and earth Lords: Maya Religion in the Cave Context. Keith M. Prufer and James E. Brady, eds. Pp. 47-70. Boulder, CO: University Press of Colorado.

Ricketson, Olivia
1925 Burials in the Maya Area. American Anthropologist 27:381-401.

Roberts, Charlotte
2007 The Archaeology of Disease, 3rd edition. Ithaca, NY: Cornell University Press.

Romano Pacheco, Arturo
1974 Deformacion cegalica intencional. In Antropologia fisica: Epoca prehispaanica, 3. J. Romero, ed. Pp. 195-227. Mexico City: Coleccion Mexico, Panorama Historico y Cultural, Institito Nacional de Anthropologia e Historia.

Romero, Javier
1970 Dental Mutilation, Trephination, and Cranial Deformation. *In* Handbook of Middle American Indians, Volume 9, Physical Anthropology. Pp. 50-67. Austin, TX: University of Texas Press.

Rouse, I.
1992 The Tainos: Rise and Decline of the People Who Greeted Columbus. New Haven, CT: Yale University Press.

Rue, David J., Ann Corinne Freter, and Diane A. Ballinger
1989 The Caverns of Copan Revisited: Preclassic Sites in the Sesemil River Valley, Copan, Honduras. Journal of Field Archaeology 16(4):395-404.

Saul, Julie Mather, Keith M. Prufer, and Frank P. Saul
2005 Nearer to the Gods: Rockshelter Burials from the Ek Xux Valley, Belize. *In* Stone Houses and Earth Lords: Maya Religion in the Cave Context. Keith M. Prufer and James E. Brady, eds. Pp. 297-322. Boulder, CO: University of Colorado Press.

Saville, Marshall Howard
1910 Contributions to South American Archeology: The George G. Heye Expedition. The Antiquities of Manabi, Ecuador: Final Report. New York.

Scott, Ann M., and James E. Brady
2005 Human Remains in Lowland Maya Caves. *In* Stone Houses and Earth Lords: Maya Religion in the Cave Context. Keith M. Prufer and James E. Brady, eds. Pp. 261 – 284. Boulder, CO: University Press of Colorado.

Scott, John
2009 Human Sacrifice in the Iconography of Veracruz Ballgame Sculptures. *In* Blood and Beauty: Organized Violence in the Art and Archaeology of Mesoamerica and Central America. Heather Orr and Rex Koontz, eds. Pp. 99-116. Los Angeles, CA: The Cotsen Institute of Archaeology Press.

Serafin, Stanley
2012 Personal communication through e-mail. February 7 – 16, 2012.

Spence, Michael W., and Christine D. White
2009 Mesoamerican Bioarchaeology: Past and Future. Ancient Mesoamerica 20:233-240.

Steckle, Richard H., and Jerome C. Rose
2002 The Backbone of History: Health and Nutrition in the Western Hemisphere. Cambridge, NY: Cambridge University Press.

Steinbock, R. Ted
1976 Paleopathological Diagnosis and Interpretation: Bone Disease in Ancient Human Populations. Springfield, IL: Charles C Thomas Publisher.

Stevens, John Lloyd
1848 Incidents of Travel in Yucatan. New York, NY: Harper & Brothers.

Stevens, John Lloyd
1871 Incident of Travel in Central America, Chiapas, and Yucatan: Volume 2. New York, NY: Harper & Brothers, Publishers.

Stewart, Thomas Dale
1953 Skeletal Remains from Zaculeum Guatemala. *In* The Ruins of Zaculea, Guatemala, Volume 1. Richard B. Woodbury and Aubrey S. Trik, eds. Pp. 295-311.Richmond, VA: The William Byrd Press, Inc.

Stewart, Thomas Dale
1979 Essentials of Forensic Anthropology Especially as Developed in the United States. Springfield, IL: Charles C Thomas Publisher.

Stirland, Ann
1986 Human Bones in Archaeology. Aylesbury, Bucks, UK: Shire.

Stuiver, Minze, and Paula J. Reimer
1993 Extended ^{14}C Data Base and Revised Calib 3.0 ^{14}C Age Calibration Program. Radiocarbon 35(1):215-230.

Sullivan, Amy
2004 Reconstructing Relationships among Mortality, Status, and Gender at the Medieval Libertine Priory of St. Andrew, Fishergate, York. American Journal of Physical Anthropology 124:330-345.

Squier, Ephraim George
1956 Nicaragua: Its People, Scenery, Monuments, and the Proposed Interoceanic Canal with Numerous Original Maps and Illustrations. New York, NY: D. Appleton & Co., Publishers.

Talma, A.S., and J.C. Vogel
1993 A Simplified Approach to Calibrating ^{14}C Dates. Radiocarbon 35(2):317-322.

Taube, Karl, and Marc Zender
2009 American Gladiators: Ritual Boxing in Ancient Mesoamerca. *In* Blood and Beauty: Organized Violence in the Art and Archaeology of Mesoamerica and Central America. Heather Orr and Rex Koontz, eds. Pp. 161-220. Los Angeles, CA: The Cotsen Institute of Archaeology Press.

Taube, Karl A., and Reiko Ishihara-Brito
2012 From Stone to Jewel: Jade in Ancient Maya Religion and Rulership, in Ancient Maya Art at Dumbarton Oaks, Pre-Columbian Art at Dumbarton Oaks, Number 4, edited by Joanne Pillsbury, Miriam Doutriaux, Reiko Ishihara-Brito, and Alexandre Tokovinine, Pp. 135-271. Washington, D.C.: Dumbarton Oaks Research Library and Collection.

Tiesler Blos, Vera
1998 La costumbre de la deformacon cefalica entre los antiguos mayas: Aspectos morfologicos y culturales. Mexico City: INAH.

Tiesler, Vera
1999 Head Shaping and Dental Decoration Among the Ancient Maya: Archaeological and Cultural Aspects. Paper presented at the 64th Meeting of the Society of American Archaeology, Chicago 1999. Pp. 1-11.

Tiesler, Vera
2005 What Can the Bones Really Tell Us? The Study of Human Skeletal Remains from Cenotes. *In* Stone Houses and Earth Lords: Maya Religion in the Cave Context. Keith M. Prufer and James E. Brady. Pp. 341 – 363. Boulder, CO: University Press of Colorado.

Tielser, Vera
2007 Funerary or Nonfunerary? New References in Identifying Ancient Maya Sacrificial and Postsacrifical Behaviors from Human Assemblages. *In* New Perspectives on Human Sacrifice and Ritual Body Treatments in Ancient Maya Society. Vera Tiesler and Andrea Cucina, eds. Pp. 14-44. New York, NY: Springer Science + Business Media, LLC.

Tolstoy, Paul and Louise I. Paradis
1970 Early and Middle Preclassic Culture in the Basin of Mexico. Science 167:344-351.

Tolstoy, Paul
1989 Coapexco and Tlatilco: Sites with Olmec Materials in the Basin of Mexico. *In* Regional Perspectives on the Olmec. Robert J. Sharer and David C. Grove, eds. Pp. 85-121. Cambridge: Cambridge University Press.

Torres-Rouff, C.
2002 Cranial Vault Modification and Ethnicity in Middle Horizon San Pedro de Atacama, Chile. Current Anthropology 43:927-935.

Torres-Rouff, Christina
2009 The Bodily Expression of Ethnic Identity: Head Shaping in the Chilean Atacama. *In* Bioarchaeology and Identity in the Americas. Kelly J. Knudson and Christopher M. Stojanowski, eds. Pp. 212-230. Gainesville, FL: University Press of Florida.

Trik, Aubrey S.
1953 Graves. *In* The Ruins of Zaculea, Guatemala, Volume 1. Richard B. Woodbury and Aubrey S. Trik, eds. Pp. 77-111.Richmond, VA: The William Byrd Press, Inc.

Tung, Tiffiny
2007 From Corporeality to Sanctity: Transforming Bodies into Trophy Heads in the Pre-Hispanic Andes. *In* The Taking and Displaying of Human Body Parts as Trophies by Amerindians. Richard J. Chacon and David H. Dye, eds. Pp. 481-504. Boston, MA: Springer.

Ubelaker, Douglas H.
1999 Human Skeletal Remains: Excavation, Analysis, Interpretation, 3rd edition. Taraxacum: Washington DC: Smithsonian Institution.

van Arsdale, A.P., and J.L. Clark
2012 Re-examining the Relationship between Cranial Deformation and Extra-Sutural Bone Formation. International Journal of Osteoarchaeology 22:119-126.

Verano, John W.
2005 Human Sacrifice and Postmortem Modification at the Pyramid of the Moon, Moche Valley, Peru. *In* Interacting with the Dead: Perspectives on Mortuary Archaeology for the New Millennium. Gordon F.M. Rakita, Jane E. Buikstra, Lane A. Beck, and Sloan R. Williams, eds. Pp. 277-289. Gainesville, FL: University Press of Florida.

Villa Rojas
1969 The Tzeltal. *In* Handbook of Middle American Indians, Volume 7. E.Z. Vogt, ed. Pp. 195-225. Austin: University of Texas Press.

Vogt, Evon Z., and David Stuart
2005 Some Notes on Ritual Caves among the Ancient and Modern Maya. *In* In the Maw of the Earth Monster: Mesoamerican Ritual Cave Use. James E. Brady and Keith M. Prufer, eds. Pp. 155-185. Austin: University of Texas Press.

Waldron, Tony
2009 Palaeopathology. Cambridge: Cambridge University Press.

Weiss-Krejci, Estella
2003 Victims of Human Sacrifice in Multiple Tombs of the Ancient Maya. A Critical Review. *In* Antropología de la etenidd. La muerte en la cultura Maya. Andrés Ciudad Ruiz, Mario Humberto Ruz Sosa and María Josefa Iglesias Ponce de León, eds. Pp. 355 – 381. Sociedad Española de Estudios Mayas, Centro de Estudios Mayas, Madrid.

Wells, Calvin
1964 Ancient People and Places: Bones, Bodies, and Disease: Evidence of Disease and Abnormality in Early Man. New York: Frederick A. Praeger.

Wenham, S.J.
1989 Anatomical Interpretations of Anglo-Saxon Weapon Injuries. *In* Weapons and Warfare in Anglo-Saxon England. Sonia Chadwick Hawkes, ed. Pp. 123-140. Oxford: Oxford University Committee for Archaeology.

Whisnant, David
1995 Rascally Signs in Sacred Places: The Politics of Culture in Nicaragua. Chapel Hill: University of North Carolina Press.

White, Tim D., Michael T. Black, and Pieter A. Folkens
2011 Human Osteology, 3rd edition. New York: Academic Press.

Wilke, Sacha
2009 The Archaeology of Death on the Shore of Lake Nicaragua. 4th Annual Students' Union Undergraduate Research Symposium, November 18-19, 2009. Calgary, AB: University of Calgary.
http://dspace1.acs.ucalgary.ca/bitstream/1880/47649/1/Wilke_2009.pdf

Wilke, Sacha, Geoffrey McCafferty, and Brett Watson
2011 The Archaeology of Death on the Shore of Lake Nicaragua. *In* Identity Crisis: Archaeological Perspectives on Social Identity Proceedings of the 42nd Annual Chacmool Conference Proceedings. Lindsay Amundsen-Meyer, Nicole Engel and Sean Pinkering, eds. Pp. 178 – 188. Calgary, AB: University of Calgary.

Witschey, Walter R.T., and Clifford T. Brown
2012 Historical Dictionary of Ancient Mesoamerica. Lanham, MD: Scarescrow Press, A Division of Rowman and Littlefield.

Wood, Randy, and Joshua Berman
2005 Nicaragua, Moon Handbook, 2nd edition. Emeryville, CA: Avalon Travel Publishing.

Woodbury, Richard B., and Aubrey S. Trik
1953 The Ruins of Zaculeu, Guatemalam Volume 2. Richmond, VA: The William Byrd Press, Inc.

Zender, Marc, Karen Bassie, and Jorge Perez de lara
2001 Art and Ritual in Jolia' Cave, Chiapas, Mexico. Paper presented at the 66th Annual Meeting of the Society for American Archaeology, New Orleans.